Relying on Satiety Cues in Food Consumption

Studies on the Role of Social Context, Appearance Focus, and Mindfulness

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Thesis

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Chapter 1

General Introduction

A complex interplay of cognitive, social, environmental, and physiological influences determines consumers' food intake. The amount that people consume at a certain moment may depend simultaneously on the presence of other people, the perception of the number of calories in the food, how food tastes or smells, and how hungry or full people feel. Food intake is further complicated by the fact that people eat at various sequential occasions throughout the day and that such consumption episodes are not independent from each other. Over the course of the day people alternate meals with snacks and generally consume portions that differ in size. How do factors of one consumption episode, such as whether people eat with friends or strangers, influence the amount that is eaten at a subsequent episode, and which factors determine the adjustment to previous consumption? In this thesis we study such consumption sequences; consumption episodes that follow each other closely in time. Drawing upon insights from psychology, consumer behavior, and nutrition, we will address the question of how one consumption episode can affect the amount of consumption at a subsequent episode.

Understanding consumption sequences rather than single consumption episodes is important because it relates to the broader question of how consumers balance consumption across eating episodes or regulate their food intake. Incidental overeating may not be problematic, as long as consumers are able to compensate for this in later consumption. However, prior studies on consumers' ability to adjust their food intake according to previous consumption have produced mixed results. Several studies have demonstrated that people indeed compensate for additional calories by lowering their subsequent consumption (e.g. Foltin, Fischman, Moran, Rolls, & Kelly, 1990; McKiernan, Hollis, & Mattes, 2008). Also, some studies have found that introducing additional snacks or high calorie foods in the diets of

individuals over a period of time does not necessarily increase individuals' body weight, as individuals have been found to compensate by lowering consumption of other foods (Johnstone, Shannon, Whybrow, Reid, & Stubbs, 2000; Viskaal-van Dongen, Kok, & de Graaf, 2010). Nevertheless, several other studies have shown that people do not compensate for previous consumption and have suggested that people's compensatory mechanisms are weak or imprecise (e.g., Kral, Roe, & Rolls, 2004; Levitsky, 2005; Mrdjenovic & Levitsky, 2005). A final class of studies posit that whereas some individuals show good compensation for previous consumption, others do not. Particularly overweight or obese individuals have been found to demonstrate poor compensation for previous consumption (Cornier, Grunwald, Johnson, & Bessesen, 2004; Ebbeling et al., 2004; Kral et al., 2007). This suggests that compensation for previous consumption is important for maintaining a healthy body weight, even though it is not clear whether normal-weight individuals have managed to stay slim because of enhanced compensation or whether an overweight status somehow makes it harder for individuals to compensate for previous consumption.

The failure to adjust food intake according to previous consumption is often attributed to the effects of environmental food cues on food consumption. For example, consumers have been found to eat more when served bigger portions (Rolls, Morris, & Roe, 2002), when food is served on bigger plates (Wansink, van Ittersum, & Painter, 2006) or when they eat with others (Hetherington, Anderson, Norton, & Newton, 2006) and these effects may override compensation mechanisms. Also the finding that children's ability to compensate for previous consumption deteriorates as they grow older has been attributed to the fact that they become more aware of their surroundings, including the food environment (Kral et al., 2007; Rolls, Engell, & Birch, 2000). One of the ways in which consumers may compensate for

previous consumption is by relying on internal cues; eating when hungry and stopping to eat when feeling full. The literature on consumers' ability to compensate for previous consumption is closely linked to a long research history which has centered around the discussion of which types of individuals regulate their food intake according to internal hunger and satiety signals and whose food intake is determined by external cues such as the availability, portion size, or smells of food (for an overview see Herman & Polivy, 2008). The recent accumulation of findings that demonstrate the effect of the food environment on the food intake of all consumers (e.g., Geier, Rozin, & Doros, 2006; Raghubir & Krishna, 1999; Rolls et al. 2002; Wansink, 2004; Wansink & Cheney, 2005; Wansink & Park, 2001) along with concerns about the modern 'obesogenic environment' has led the consumer behavior literature to focus primarily on external cues in food intake, suggesting that internal physiological cues play but a small role in food consumption.

The fact that external cues often impact food intake, does not make the question of when consumers *do* rely on internal cues less relevant and in our view this question has received insufficient attention. The physiological homeostatic system that humans are equipped with is one way in which consumers are able to compensate for previous food consumption. Operating via complex signalling pathways in the mouth, brain, and gut, this appetite regulating system informs us when energy is needed, how much energy is needed and when we should stop and re-start food intake. The processes involved in the termination of food intake within a consumption episode are termed *satiation*, the feeling of fullness that persists some time after consumption serving to suppress subsequent food intake is referred to as *satiety* (Blundell, Rogers, & Hill, 1987). Relying on internal cues is one of the ways in which consumers may balance consumption across consumption

episodes, and in this thesis we will address the circumstances under which consumers are better or worse at doing so.

Relying on internal cues is not the only way in which consumers may balance consumption across consumption episodes. The remainder of this introduction will first provide a short overview of the key processes addressed in this thesis underlying how one consumption episode can affect the amount of food consumed at a subsequent consumption episode. Even though a consumption episode can also affect a subsequent consumption episode in the *types* of food that consumers choose to eat, we will focus specifically on how a consumption episode may affect the *amount* of food that consumers eat at a subsequent consumption episode. Finally, this introduction will end with a general outline of the chapters of this thesis.

Processes underlying consumption sequences

Figure 1.1. illustrates key processes through which one consumption episode can affect the amount of food that is consumed at a later point in time. Three processes are distinguished. First, consumption produces physiological cues, which subsequently come into awareness as subjective feelings of hunger and fullness and can ultimately be reflected in food intake. Second, people hold cognitions or memories about previous consumption and these may affect subsequent food intake directly or via feelings of fullness or hunger. We will argue and review evidence that for both of these processes of compensation the attentional resources that consumers have available are crucial. Third, consumption episodes may deplete self-control resources, and this can affect the amount of consumption at a later point in time. Again, we argue that resources that consumers have available are a crucial factor, but in this case

the amount of resources that consumers have available for resisting food intake.

Physiological regulation of food intake

As one starts putting food in the mouth, sensory and cognitive factors start to influence satiation through the taste, smell, texture and expectations about the food (Blundell et al., 1987). As food reaches the stomach, the expansion of the stomach activates receptors in the muscles of the stomach and this sends signals of satiation to the brain (Benelam, 2009). As food then passes through the gastro-intestinal tract, a variety of hormones are released and these act on areas in the brain, specifically the hypothalamus, to signal satiety. A few examples of these hormones that act as short-term satiety signals include Cholecsytokinin (CCK), glucagon- like peptide (GLP-1), Oxyntomodulin (OXM), Peptide YY (PYY) and pancreatic polypeptide (PP) (Benelam, 2009).

These processes of satiation and satiety are reflected in subjective feelings of hunger and fullness and in individuals' immediate and subsequent food intake. Short term satiety is most often assessed through the use of a preload paradigm where participants are required to consume a food product (the preload) of which the macronutrient or energy content (or other variable of interest) is varied across a test and control condition. After a time interval participants are served a second consumption of which they are free to consume as much as they would like. Consumption at this second moment of consumption is measured and compared across the conditions. Essential to this paradigm is that the preloads in the test and control condition are carefully matched (e.g., on taste or texture) such that differences in subsequent food intake can in fact be attributed to the difference of interest between the preloads.

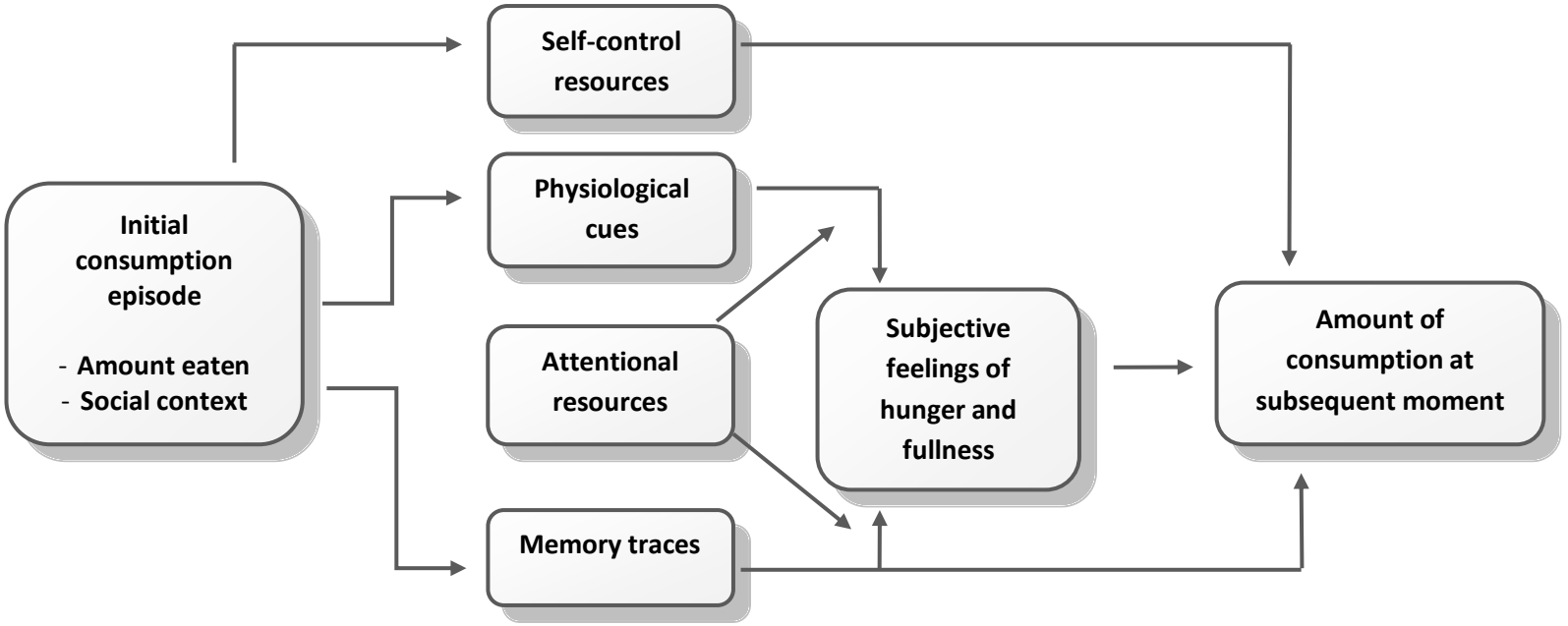


Figure 1.1. Key processes that underlie the effect of one consumption episode on amount of consumption at a subsequent consumption episode.

Furthermore, if participants would be aware of the energy content (or other variable of interest), their subsequent intake is likely to be a result of both the physiological effects of the preload as well as cognitions about these preloads. Therefore, in order to test the physiological effect of the preload, it is important that differences between preloads are covertly manipulated so that cognitive effects can be excluded.

A wealth of research has addressed the question of how the form and macronutrient composition of food affects satiety. For example, the weight or volume of a food impacts satiety (Rolls et al., 1998; Rolls, Bell, & Waugh, 2000), and several studies have suggested that solid foods have a lower satiating capacity than foods in liquid forms (de Graaf, 2011; DiMeglio & Mattes, 2000). Energy from protein has been found to have a stronger effect on satiety than similar levels of energy from carbohydrates or fat (Gerstein, Woodward-Lopez, Evans, Kelsey, Drewnowski, 2004; Stubbs, Ferres, & Horgan, 2000) and certain kinds of fibres have also been found to enhance satiety (Slavin & Green, 2007).

Besides the effects of different foods on satiety, there is also substantial interindividual variance in how consumers compensate for these food products. Obese individuals have been found to show poorer energy regulation than normal weight individuals and there is some evidence that men are better at compensating for previous energy content of foods than women (Davy, van Walleghen, & Orr, 2007; Ranawana & Henry, 2010). Some initial findings have suggested that individuals who frequently exercise are better at compensating for food intake than less active individuals (Jokisch, Coletta, & Raynor, 2012; Long, Hart, & Morgan, 2002), and there may also be a genetic component to appetite regulation (Kral et al., 2012). Finally, restrained eaters are typically associated with an impaired energy regulation as they have been have been shown to eat more rather than less following a preload

(Herman & Mack, 1975; Hibscher & Herman, 1977; Polivy, Heatherton, & Herman, 1988). However, most of these studies have not manipulated the preload covertly, making it difficult to exclude differences in cognitive responses to the preloads as a mechanism. Also, several studies have failed to find differences in compensation between restrained and unrestrained individuals (Ogden & Wardle, 1990; Wardle & Beales, 1987).

In sum, although there is quite a lot known on how compensation may differ for different foods and for different people, little is known on whether certain circumstances may also affect people's ability to compensate through this physiological route. We will return to this issue later and first discuss the role of cognition in compensation processes.

Memory traces: the role of cognition in compensation

Knowing what one has previously eaten also plays a crucial role in the extent to which consumers are able to compensate for previous consumption. Cognitions about previous consumption can affect later consumption by coloring feelings of fullness or hunger ("I have eaten a big lunch, I feel rather full") or can affect consumption directly in a more strategic manner ("I have eaten a big lunch, I should eat less now"). Knowing what one has eaten involves registering or encoding how much one eats at a consumption episode, and remembering or retrieving this amount of consumption at a subsequent point in time. A striking example of this process is that individuals with memory loss have been observed to continue eating because they fail to remember the amount of food that they have eaten previously (Rozin, Dow, Moscovitch, & Rajaram, 1998). More generally, many consumption situations that distract individuals, such as television watching, eating while playing videogames, listening to music, or driving interfere with memory processes of

amount of food consumption (Ogden et al., 2013; Oldham-Cooper, Hardman, Nicoll, Rogers, & Brunstrom, 2001; Stroebele & de Castro, 2006).

Visual cues can direct individuals' attention to how much they consume. For example, clear discrete units of consumption (such as a cookie) or visual cues of previous consumption (such as candy wrappers or chicken bones) make it easier for consumers to register the amount they eat (Kennedy-Hagan et al., 2011; Wansink & Payne, 2007). Visual cues have primarily been studied with regard to their effects on consumption within the meal (Kennedy-Hagan et al., 2011; Wansink & Payne, 2007), rather than across consumption episodes. It is to be expected that, by increasing the salience of amount of previous consumption, visual cues can reduce later consumption, in a similar fashion as enhancing memory of previous consumption. Initial support for this is provided by Scheibehenne, Todd, and Wansink (2010) who showed that when consumers had a meal in the dark they compensated less for how much they had consumed during dinner in their dessert consumption than when consumers were able to see how much they had eaten during dinner.

Attentional resources in cognitive and physiological processes of compensation

For both the cognitive and physiological processes of consumption the amount of attentional resources that consumers have available are crucial for the extent to which they are able to compensate for previous consumption. As mentioned previously, situations that direct attentional resources away from consumption disrupt the cognitive registration or encoding of how much one consumes. For example, Higgs and Woodward (2009) showed that consumers, following a lunch consumed in front of the television, had a less vivid and accurate memory of what they had eaten, and a higher snack consumption

later in the afternoon. Directing attentional resources towards food consumption enhances the registration or recall of food intake and decreases later amount of consumption. For example, instructing people to focus on the food they eat has been found to lead to more vivid memories of their food intake and reduce later food intake (Higgs & Donohoe, 2011). Similarly, asking people to recall what they have previously eaten decreases amount of consumption (Higgs, Williamson, & Attwood, 2008).

Attentional resources (or the lack thereof) have mostly been related to people's (in)ability to remember previous consumption, but we argue that attentional resources are also crucial for the awareness of physiological cues that develop after consumption. Attentional resources may in this way moderate the extent to which consumers are able to compensate for previous consumption through reliance on physiological cues. Initial evidence for this comes from a study by Bellissimo et al. (2007) who showed that whereas boys could normally adjust food intake according to whether they previously consumed a milkshake containing sugar or a covertly manipulated sugar free substitute, they could not when they had watched television while consuming the preload. As the milkshakes were similar in volume and the energy content was manipulated covertly, these findings could not be attributed to an impaired memory of how much they had consumed, rather it seems that distraction impaired their awareness of satiety cues. Also recently Ogden and colleagues (2013) have argued that distraction may limit the attention that consumers can pay to signals of satiety. Being able to sense the physiological consequences of consumption is important as the extent to which feelings of fullness develop after a meal has been found to be related to a lower overall food intake (Drapeau et al., 2005) and may in this way be useful in predicting consumption more generally.

Since distraction thus appears to decrease the ability to compensate through relying on physiological cues, perhaps increased attention can enhance people's ability to compensate using physiological cues. We propose that in this physiological process of compensation, not attention in general, but particularly directing attentional resources at the body is crucial for being able to compensate for previous consumption. A long research tradition in (psycho)physiology and neuroscience has studied how individuals are aware of information arising from within the body (Mehling et al., 2012). Body awareness is often conceptualized as "an attentional focus on and awareness of internal body sensations" (Mehling et al., 2009). These body sensations include perceptions of physical sensations such as heartbeat, respiration, satiety, nervous system activity related to emotion (together also defined as interoception) and perception of muscle tension, posture and balance (often defined as proprioception) (Mehling et al., 2012). The awareness of several physical sensations has been related to activations in specific brain areas, specifically in the right anterior insula (Critchley, Wiens, Rotshtein, Öhman, & Dolan, 2004). Directing attention towards body sensations is a central aspect of many popular mind-body approaches, such as yoga and mindfulness. Mindfulness is an enhanced attention to and non-judgemental awareness of what is going on at the present moment and is often trained by focusing attention on the body (Brown & Ryan, 2003). In this thesis we test whether directing attentional resources towards body sensations enhances compensation for previous consumption by making hunger and satiety cues more accessible.

In contrast to information coming from within the body, there is also an external visual channel of perception of the body, providing information about how the body looks. Directing attention to the body as perceived from the outside rather than as being experienced from the inside, has been related

to a poorer awareness of internal body cues in general (Ainley & Tsakiris, 2013, Daubenmier, 2005; Fredrickson & Roberts, 1997), and hunger and satiety cues in particular (Myers & Crowther, 2008). In this thesis we therefore test whether directing attentional resources to the outside of the body may hinder individuals in compensating for previous food intake. Self-objectification theory points to the increasing emphasis on body appearance in Western societies as a cause for why (especially female) individuals come to see themselves as an object, leading to insensitivity to internal body cues. Although such a possible relationship between a focus on appearance and awareness of hunger and satiety cues has been documented (Myers & Crowther, 2008), this is based on correlational evidence. As far as we know, no studies have provided causal evidence for this relationship.

Self-control resources

Even when consumers are aware of how much they have previously eaten and are aware of how full they feel, they may overeat at a second moment of consumption, particularly because consumers may find it difficult to resist (especially tempting) food. Self-control or self-regulation refers to the ability to control one's behavior, impulses, or natural urges, in order to meet a longer term goal, or conform to rules or norms (Muraven & Baumeister, 2000). For example, everyone may hold to a certain extent the norm of avoiding excessive overeating (Herman, Roth, & Polivy, 2003) and when smelling freshly baked cookies, many consumers will have to exert will-power to resist the immediate reward of such a good tasting cookie (cf., Baumeister, Bratslavsky, Muraven, & Tice, 1998). Again, the notion of resources that people have available is crucial. However, this does not relate to the resources that people have to direct attention to the food or their body sensations, but to their abilities to

resist temptation. Exerting will-power has been found to rely on resources and these resources become depleted after people have had to control their behavior, impulses or emotions for some time, such that initial constraint makes consumers less successful at subsequent attempts at self-control (Baumeister et al., 1998).

As an initial act of self-control makes consumers less succesful in exerting will- power later on, contexts which draw upon consumers' self-control resources may thus lead consumers to become less capable of resisting snack consumption later on. Some studies have indeed shown that instructing participants to engage in resource depleting activities such as resisting tempting snacks or suppressing emotional reactions, leads consumers to subsequently consume more snacks, even though this was specifically found among dieters (Kahan, Polivy, & Herman, 2003; Vohs & Heatherton, 2000). Interactions with others have also been found to deplete self-control resources, for example when individuals have to present themselves in a certain way (Vohs, Baumeister, & Ciarocco, 2005) or by having to keep a conversation going (Finkel et al., 2006). Interactions with others are often a central aspect of consumption moments, and may in this way affect the ability of consumers to resist later snack consumption, independent of the food that is eaten. We therefore propose that the social context in which consumption takes place may affect later food intake by affecting the resources that people have available to resist later temptations.

Aims and outline of this thesis

The overall aim of this thesis is to examine how a consumption episode affects consumption at a later consumption episode, focusing specifically on the social context during a consumption episode and on how consumers are able to

balance amount of food intake across consumption episodes through the awareness of hunger and satiety cues.

Chapter 2 examines how the social context of a first moment of consumption affects how much consumers eat later on. Whereas the social context of a meal has been found to affect how much consumers eat within a meal, to our knowledge no study has addressed the question of how this context affects a subsequent consumption episode. We propose that social contexts also affect self- control resources and through this process may affect how much consumers snack after a meal. We focus specifically on how familiarity between eating partners and smoothness of conversations affect snacking after a meal.

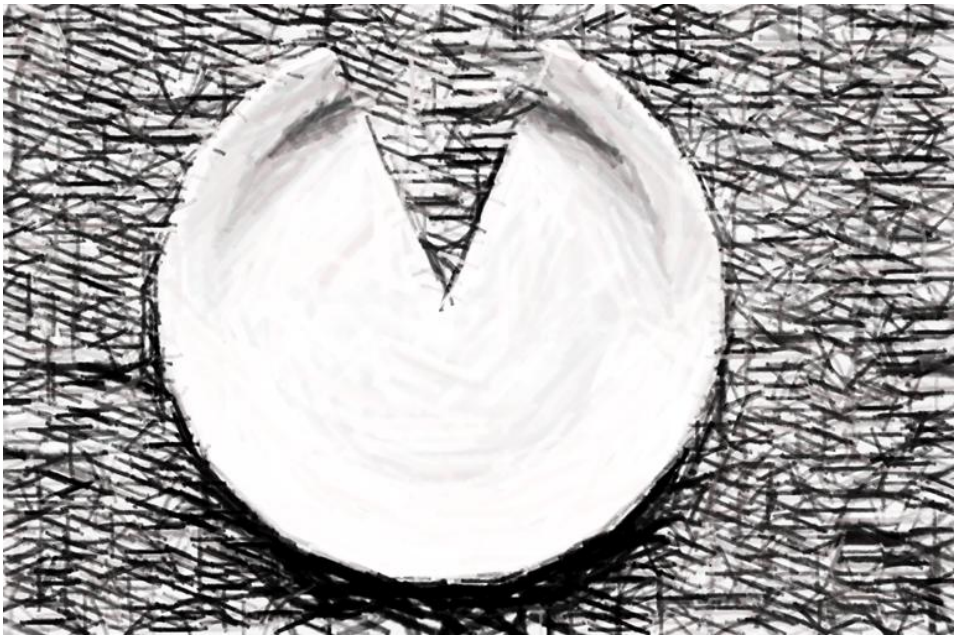
The remainder of this dissertation examines when consumers are more or less able to compensate for previous consumption through the awareness of hunger and satiety cues. Whereas the ability to regulate energy has been related to individual difference variables and macronutrient composition of food products, this thesis aims at gaining insight into situations that weaken or facilitate compensation mechanisms. Drawing upon research findings in consumer science and psychology, we propose that the extent to which attention is directed at body sensations is crucial for the extent to which consumers are able to compensate for previous consumption.

Chapter 3 tests whether cues, such as mirrors and model advertisements, direct consumers' attention towards outward appearance aspects of their body, diverting attention away from internal hunger and satiety cues. It then addresses the question of whether such a focus affects consumers in their ability to compensate for a milkshake that is covertly manipulated to contain additional calories, or to adjust their food intake according to whether they previously had lunch.

Chapter 4 examines whether mindfulness enhances compensation for previous consumption. Even though some studies have related mindfulness to an enhanced awareness of internal body cues (Holzel et al., 2011, but see also Khalsa et al., 2008) and mindfulness has been shown to aid adaptive eating styles in clinical or eating disorder populations (Alberts, Mulkens, Smeets, & Thewissen, 2010), to our knowledge no study has assessed whether mindfulness can help consumers in general to compensate for previous consumption by becoming more aware of hunger and satiety cues. A first experiment tests how trait mindfulness is related to people's ability to compensate for a milkshake that is covertly manipulated to contain additional calories. We then examine whether short mindfulness exercises can focus consumers' attention on internal body sensations and whether these mindfulness exercises lead to more compensation for previous consumption, compared to mindfulness exercises with a different focus of attention or a control condition. This chapter also examines whether focusing mindful attention on the body makes hunger and fullness feelings more accessible and how these exercises affect participants' responses to more cognitive cues of previous consumption. Finally, this chapter addresses longer term consequences of directing attention towards body sensations. We examine how mindful attention directed at the body, general mindfulness and experience in mindfulness and yoga practice relate to body weight and stability of body weight. **Chapter 5** summarizes the findings of this thesis, and discusses limitations and implications of the research findings.

Chapter 2

Eating together and Snacking Alone: Effects of Familiarity of Eating Partner and Seating Arrangement During a Meal on Subsequent Solitary Snacking



Abstract

In between meals that are shared with others, consumers are regularly confronted with temptations to have a snack by themselves. This study examines how two aspects of the social context during a meal - whether eating companions know each other and how they are seated - affect how much consumers snack by themselves, after this meal. We hypothesize that mealtime conversations with a familiar other are experienced as smoother than with a stranger, and that this would leave consumers with more regulatory resources to resist later snack consumption. We also explore the effect of seating arrangement on conversation smoothness and later solitary snacking. In a naturalistic dinner setting, same-sex dyads - either familiar or unfamiliar to each other - shared a pasta meal while sitting either next to each other, facing each other, or at right angles from each other. After the meal, solitary snacking was assessed by a taste test of cookies. Participants with a familiar dinner partner consumed fewer cookies after the meal than participants with an unfamiliar dinner partner. Participants with a familiar dinner partner also experienced the mealtime conversation as smoother, but this did not mediate the effect on later snacking. Participants who were seated directly facing their eating companion perceived the conversation as less smooth, but seating did not affect later cookie consumption. These findings suggest that the social context during a meal, which has previously been found to affect consumption during the meal, also affects how much consumers eat later on, although the underlying mechanism is not yet clear.

Eating not only fulfills a biological need but is also an inherently social activity. Meals shared with friends or family are used as an occasion to catch up, discuss the day at work or school, or to simply have a relaxing time together. Sharing meals can also be stressful when one wants to impress a co-eater or has difficulty to keep a conversation going, for example when having dinner with a date or someone one doesn't know very well. Whereas it has been shown that the level of familiarity between co-eaters can impact how much consumers eat during a meal (de Castro, 1994; Salvy, Jarrin, Paluch, Irfan, & Pliner, 2007) little is known on whether its influence extends beyond the meal. We propose that a meal shared with familiar others constitutes a very different experience for consumers than a meal shared with strangers, and that this affects how much individuals consume later on by themselves. In between social meals, we often find ourselves in situations with temptations to snack, often when alone. However, little is known on how the context of social meals affects later solitary eating. The present research examines how two aspects of the social context during a meal, whether eating companions know each other and how they are seated, affect subsequent solitary snacking.

A vast literature on social cues in eating behavior has demonstrated that people eat different amounts of food when they are with others: The presence of others had been found to lead consumers to eat both more (de Castro, 1994; Hetherington, Anderson, Norton, & Newton, 2006; Redd & de Castro, 1992) and less (Mori, Chaiken, & Pliner, 1987; Roth, Herman, Polivy, & Pliner, 2001) than when they eat by themselves. The level of familiarity between eating companions may be an important determinant of the kind of social influence that operates during a meal (Salvy et al., 2007; Salvy, Vartanian, Coelho, Jarrin, & Pliner, 2008). For example, social facilitation of eating, the general finding that consumers increase their food intake when

they are with others, compared to when they would eat by themselves (Redd & de Castro, 1992) has been found to be particularly strong among families and friends (de Castro, 1990; 1994). This has been attributed to the fact that meals with others, and in particular with friends and families, tend to be longer and more distracting than solitary meals, in this way leading to an increased intake (de Castro, 1990, 1994). Findings of suppressed eating in the presence of others, on the other hand, have been found mostly among eating companions that do not know each other (Mori et al., 1987; Pliner & Chaiken, 1990; Roth et al., 2001; Salvy et al. 2007). These findings have been interpreted in terms of impression motives: Individuals, especially females, suppress their food intake in order to make a good impression on others (Pliner & Chaiken, 1990) and it is likely that these impression motives are stronger when individuals do not know each other (cf., Leary et al., 1994).

Based on these processes that drive the levels of consumption among familiar and unfamiliar eating companions, we hypothesize that not only consumption levels but also interactions during a meal are likely to be different in these two situations, and we propose that this is relevant for later consumption. That is, the finding that meals tend to be longer among friends (de Castro, 1994) suggests that conversations might generally be easier and run more smoothly. At the same time, the finding that when eating with strangers, individuals are concerned about conveying a positive impression of themselves, makes it plausible that interactions in these types of setting generally require more effort. The smoothness of a conversation, or the ease with which a conversation flows, is an important component of individuals' perception of the quality of the interaction that they have with others (Duck, Rutt, Hoy, & Strejc, 1991) and may be central in the effect that eating with familiar versus unfamiliar people has on later solitary snacking. Even though people are generally motivated to get along with interaction partners and to

have easy and enjoyable interactions (Snyder, 1992), interactions may require more effort when interaction partners have difficulties to keep a conversation going. High maintenance interactions have been argued to use up self-regulatory resources to override responses such as becoming rude at the interaction partner (Finkel et al., 2006). Finkel et al. (2006) showed that after subjecting participants to a high maintenance interaction with a confederate, participants generally scored worse on an unrelated subsequent task that required self-control. We propose that effortful social interaction during an eating session may similarly deplete self-regulatory resources and, as the availability of such resources has been found to affect consumers' ability to resist temptations (Muraven & Baumeister, 2000), increase later snack consumption. Thus, whereas eating with strangers may suppress food intake *during* a meal, we predict that it is also more likely to deplete self-regulatory resources due to a more effortful interaction, leading to more snacking *after* the meal. A meal with friends, even though commonly assumed to be more distracting (Herman, Roth, & Polivy, 2003) and increasing food intake (de Castro, 1994) may require less effort, and leave consumers with more resources to resist later snack temptation.

The smoothness of a conversation can also be affected by situational determinants. Early research within environmental psychology has demonstrated that the physical environment can impact how individuals interact with each other (Stokols & Schumaker, 1981) and in this respect seating arrangements may be particularly important in shaping interactions during eating situations. How individuals are oriented towards each other while seated- sitting next to each other side by side, sitting at right angles around the corner of a table, or sitting opposite and facing each other- has been related to different kinds of social interactions. Sommer (1965) found that individuals show a preference for sitting around the corner of a table

when engaging in casual conversations, that individuals choose to sit side by side when carrying out tasks that require cooperation, and that individuals most often seat themselves opposite each other in competitive contexts. In an experimental study it was shown that sitting side by side impaired conversations more than the other two seating arrangements, possibly because participants have to turn to face each other (Mehrebian & Diamond, 1971). On the other hand, sitting opposite each other has been found to be less relaxing for individuals than being seated next to each other (Mehrebian & Diamond, 1971) and to lead to a higher heart rate than sitting next to each other or at right angles (Osato & Ogawa, 2003), presumably because direct eye contact is intimidating to individuals. It has been proposed that individuals often choose corner seating when having a conversation because it enables eating companions to sit close to each other, and at the same time allows individuals to avoid direct eye contact (Sommer, 1965).

Overall, the picture that emerges from these early findings on seating arrangement is that corner seating may lead to smoother conversations, as reflected by individuals' preferences for this type of seating during conversations, and that sitting face to face may be most uncomfortable for individuals, which could reduce smoothness of conversations. However, Mehrebian and Diamond (1971) found no differences between these two conditions in terms of conversation quality but found that sitting side by side was least conducive to conversations. In the current study we will therefore explore how seating arrangement affects perceptions of smoothness of a conversation and subsequent snacking. Also, we will explore whether seating arrangements affect smoothness of conversations differently depending on whether eating partners know or do not know each other.

Overview of hypotheses and study

In the current study we test whether sharing a meal with a familiar or unfamiliar partner and how one is seated with respect to this partner, affects solitary snacking after the meal. We expect that conversations held during a meal with a familiar dinner partner are experienced as smoother than conversations held with an unfamiliar partner. Based on findings that smoothness of conversations are related to self-regulatory resources, and resisting palatable snacks has been found to rely on such resources (Baumeister, Bratslavsky, Muraven, & Tice, 1998), we hypothesize that, through a smoother conversation, eating with familiar others will lead to less solitary snacking after the meal than eating with strangers. Following a similar logic, we explore how seating affects the smoothness of conversations and in this way subsequent solitary snacking. Also, seating arrangements may affect smoothness of conversations differently depending on whether eating partners know or do not know each other, and we will explore this potential interaction.

We test our hypotheses by inviting participants to a dinner study, where they are seated in pairs either next to each other, opposite each other, or around the corner of a table (making a 45 ° angle) while consuming a pasta dinner. Afterwards, participants are led to individual cubicles where, under the guise of a taste test, their solitary snack consumption is assessed, and participants indicate whether they knew their eating partners, and how smooth they experienced their conversation with their dinner partner.

Method

Participants and design

Participants were 107 students from a university in upstate New York who were recruited through announcements in class. Sixty-one participants received course credit and 46 participants received five dollars. Participants were told that the study involved dinner and they could sign up for different days and sessions that were held at 5.30 pm or 7 pm. Participants were seated either next to each other (side by side condition), facing each other (opposite condition) or around the corner of the table at a 45 ° angle (corner condition). Seventeen students were excluded from analyses because they accidently received a smaller portion of pasta and four participants were excluded because they sat alone during dinner due to an uneven number of participants. Three participants were excluded because of allergies and/or not following instructions. This left a total of 83 participants (40 men, 43 women, M = 21.1 years) in the analyses. For the analyses involving cookie consumption, 1 participant was excluded because his/her consumption was above three standard deviation above the mean and two participants because they expressed a strong dislike of both types of cookies (a mean lower than 2 on a 7-point scale). For the dyadic analyses involving matching of pasta consumption, two dyads that included a non- eating participant were excluded.

Procedure and measures

The study took place at a former canteen for university employees. Tables were set for two participants with trays and cutlery in such a way that

participants either sat next to each other, facing each other, or around the corner of the table. Upon arrival at the dinner study, participants were matched on gender and were seated in pairs at separate tables. Twelve tables were set up, so there was a maximum of 24 participants in each session. Each participant was served an individual plate with 500 grams of pasta with vegetarian tomato sauce. Also, each participant was provided with a bottle of water and 60 grams of salad. On each table there were four cups of salad dressings (Ranch, Italian, each in regular and light) and four cups of cheese that participants could share. Participants were explained they could eat as much as they would like, that they were not obliged to finish their plate, and that they would have approximately half an hour to eat dinner.

When participants were finished, they were asked to take the questionnaire that was hidden under their tray and were led to another room opposite the dinner room. In this second part of the study, participants were seated individually in cubicles and were served two bowls of cookies (50 grams of bite-size chocolate chip cookies and 40 grams of bite-size Oreos). Participants were asked to taste and rate the cookies, ostensibly as part of a taste test of cookies. Participants rated the cookies on a number of dimensions (e.g., sweetness, taste, healthiness, texture, willingness to buy) and could take as many cookies as they liked. When participants were done, they were asked to raise their hand, after which the cookies were taken away and participants were instructed to continue with the remainder of the questionnaire.

In the next part of the questionnaire, participants were instructed to think back to the pasta dinner they had and answered questions concerning the food that was served during the dinner, their dinner partner, the smoothness of the conversation they had with their dinner partner and their feelings of hunger before and after dinner. Participants were asked to indicate whether the person they had dinner with was someone they knew (*1* =

strongly disagree, *7* = strongly agree). Participants scoring below the midpoint of the scale were recoded as having dinner with an unfamiliar other, and all others as having dinner with a familiar other.[1] The extent to which participants perceived the interaction they had during dinner as smooth was assessed by the following five ratings of the conversation: " *The conversation I had during dinner was..: Awkward, stressful, fun, smooth, natural* (*1* = strongly disagree, *7* = strongly agree) and the following two items: "*It was easy to keep the conversation going during dinner.*", and "*My dinner partner and I talked a lot during dinner.*" (*1* = strongly disagree, *7* = strongly agree). Negatively framed items were recoded such that higher scores on the smoothness of conversation measure denote conversations that are perceived as being smoother. Crombach's alpha was α =.90. Furthermore, participants' perceptions of their own body size and that of their eating companion were assessed using figures of the figure rating scale (Stunkard, Sorensen, & Schulsinger, 1983) and positive and negative affect were measured by the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). Also, the restraint scale (Herman & Polivy, 1980) was administered.

Finally, participants provided demographics (including their weight and length). In the end participants were thanked and received either five dollar or signed up for course credit. After participants had left, the individual

[1] We are aware of the problems that surround the practice of dichotomizing continuous predictor variables (e.g., Irwin & McClelland, 2003). However, we felt it was justified and more appropriate to treat familiarity of the eating companion as a categorical variable because the distribution showed a large number of observations at the extreme ends (particularly at the left 'not knowing' end) and there was little variability in the middle part of the distribution. Such a highly skewed distribution is one of the few specific situations in which dichotomization can be justified (DeCoster, Iselin, & Gallucci, 2009). We divided participants along the midpoint of the scale as this closely reflected the underlying distribution of the scale.

plates with left over pasta were weighed and matched with participant's identification number in order to assess consumption. Remaining salad was also weighed and consumption of salad dressing and cheese were noted per table[2]. Remaining cookies were also weighed in order to assess individual cookie consumption. At the end of the semester, participants received a debriefing by email.

Results

Baseline levels of hunger

Baseline levels of hunger were only assessed retrospectively, which is problematic as it is unclear whether participants can accurately recall earlier feelings of hunger. Nevertheless, we checked whether this measure of baseline level of hunger was equal across conditions. Recalled hunger feelings at the beginning of the study were equal across seating conditions ($F(2, 74) = .31$, *ns*) and between participants who had dinner with someone they knew and participants who didn't know their eating companion ($F(1, 74) = 0.39$, *ns*). Separate analyses with baseline levels of hunger taken up as a covariate indicated that its inclusion did not affect any of our findings, and baseline levels of (recalled) hunger were therefore not included in the main analyses. Additionally, we checked whether controlling for the time of the session that participants were in affected our results, but this was not the case.

[2] The consumption of salad could not be accurately estimated as the addition of dressing to the salad increased the weight of the salad. The remaining weight of the salad could therefore not be used to calculate the amount of salad consumed. Consumption of salad (and salad dressing and cheese) will therefore not be reported on.

Effects of familiarity of co-eater and seating arrangement on smoothness of conversation

First of all we tested our hypotheses for familiarity of co-eaters and seating arrangement on perceptions of smoothness of the conversation during the meal. Whether participants had dinner with someone they knew and the seating arrangement condition were entered as independent variables in an ANOVA, and participants' perceptions of the smoothness of the conversation during the meal as a dependent variable. Gender was taken up as a covariate. As expected, a main effect of familiarity emerged, such that participants who had dinner with someone they knew experienced the conversation they had during the meal as smoother (M = 4.82, SD = 0.80) than participants who had dinner with someone whom they did not know (M = 3.82, SD = 1.10, $F(1, 73)$ = 17.91, p <.01).

The seating arrangement condition participants were assigned to also affected participants' perceptions of the smoothness of the interaction during the meal ($F(2, 73)$ = 4.11, p <.05). Participants who were seated facing each other experienced the conversation as less smooth (M = 3.81, SD = 1.21) than participants who were seated either around the corner of the table (M = 4.43, SD = 0.94, t (75) = 2.29, p <.05) or side by side (M = 4.55, SD = 0.97, $t(75)$ = 2.47, p <.05). There was no significant difference between the latter two conditions ($t(75)$ = 0.29, *ns*). The effect of seating condition was similar for participants who knew or did not know each other, as evidenced by a non-significant interaction effect between seating condition and familiarity of participants ($F(2, 73)$ = 0.30, *ns*). Finally, the covariate gender significantly affected perceptions of the smoothness of the conversation ($F(1, 73)$ = 5.24, p <. 05), with men rating conversations as smoother (M = 4.37, SD = 1.00) than women (M = 4.10, SD = 1.18).

Effects of familiarity of co-eater and seating arrangement on later solitary snacking

In order to test the effects of familiarity of the co-eater and seating arrangement on later solitary snacking, an ANOVA was carried out with whether or not participants knew their eating companion, and how they were seated (side by side, opposite, or corner seating) as independent factors and the amount of cookies consumed in the second taste test as a dependent variable. Gender and amount of pasta consumed during the meal were taken up as a covariate. The results show that the familiarity of the person with whom they were eating significantly affected the amount of cookies that were consumed ($F(1, 72) = 6.39$, $p < .05$). When participants consumed their dinner together with someone they knew, they consequently consumed fewer cookies ($M = 23.25$ grams, $SD = 11.90$) than when they consumed their dinner in the companion of a stranger ($M = 28.52$ grams, $SD = 15.83$). How participants were seated with respect to the other during dinner did not affect later solitary snacking ($F(2, 72) = 2.04$, *ns*). No interaction effect between familiarity of co-eater and seating arrangement appeared ($F(2, 72) = 2.14$, *ns*). The covariate gender had a marginally significant effect on later snacking ($F(1, 72) = 3.43$, $p = .07$), with women consuming fewer cookies than men. Also, the amount of pasta consumed during the meal affected later cookie consumption ($F(1, 72) = 16.24$, $p < .01$), with a larger amount of pasta consumed during the meal predicting a higher cookie consumption later. Means are reported in Table 2.1.

Table 2.1. Later solitary snacking (amount of cookies consumed in grams) as a function of familiarity of co-eater and seating condition during dinner.

	Seating condition		
Familiarity of co-eater	Next to each other	Facing each other	Corner seating (45 degree angle)
Familiar	30.10 (11.65) *N* = 10	18.89 (9.60) *N* = 9	21.00 (11.99) *N* = 13
Unfamiliar	28.54 (17.93) *N* = 13	23.18 (10.85) *N* = 22	37.54 (17.71) *N* = 13

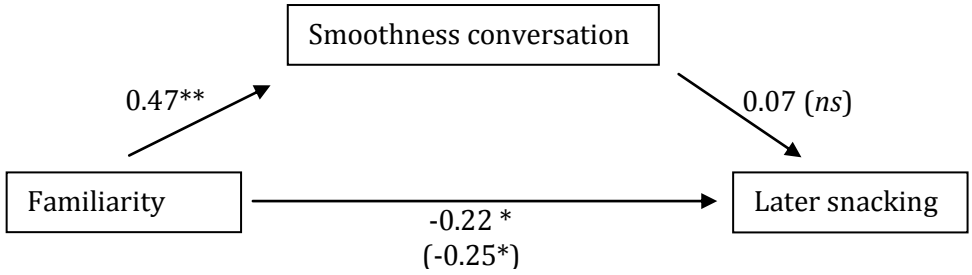
Note. Values reported between parentheses are standard deviations.

Mediation tests of the effects of familiarity and seating arrangement on later solitary consumption through smoothness of interaction

A mediation test was carried out in order to test whether the main effect of familiarity on later solitary snacking was mediated through smoothness of conversation. We used the bootstrapping method in the SPSS PROCESS macro (Hayes, 2012) to compute a confidence interval around the indirect effect, as recommended by Preacher and Hayes (2004). In order to test whether perceived smoothness of the interaction can (partially) account for the effect of familiarity on later snacking, familiarity was entered as an independent variable (1= familiar eating companion, 0 = unfamiliar eating companion), smoothness of interaction as a mediator and later snacking as a dependent variable. Gender and amount of pasta consumed during the meal were controlled for. Results showed that the indirect effect of familiarity on later

snacking via smoothness of interaction was 0.89, with a 95 % confidence interval ranging from -1.87 to 4.96. The inclusion of zero in this confidence interval indicates a non-significant indirect effect of familiarity through smoothness. Thus, we do not find any support for our hypothesized mediation effect (see Figure 2.1).

Figure 2.1. Standardized regression coefficients for the relationship between familiarity of eating companion and later snacking through perceived smoothness of the conversation.

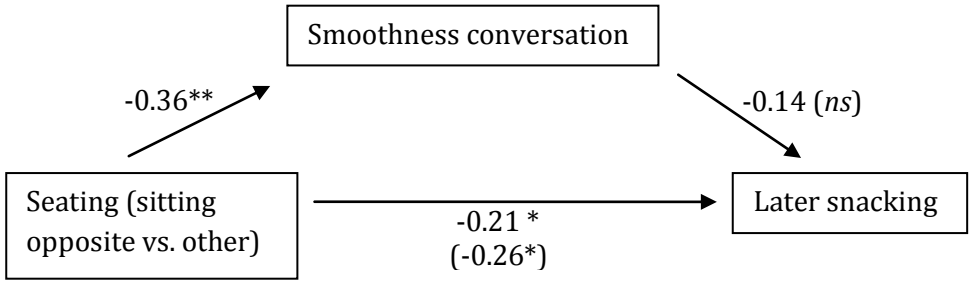


Note. * $p < .05$, ** $p < .01$. Gender of participant and amount of pasta consumption during meal were controlled for. The standardized regression coefficient for the relationship between familiarity and later snacking controlling for perceived smoothness of the conversation is in between parentheses.

Even though no direct effect of seating condition on later snacking was observed, it has recently been argued that the lack of a direct effect does not necessarily preclude a mediation effect (Hayes, 2009). Therefore, we used a similar procedure as outlined above to test for an indirect effect of seating condition on later solitary snacking through smoothness. The three seating conditions were recoded such that it formed a dichotomous variable which could be entered in the OLS regression (1 = sitting opposite each other, 0 = corner or side by side seating) as the independent variables. The opposite condition was contrasted with the other two seating conditions as this

comparison showed a difference in smoothness of interaction. As in the previous mediation analysis, smoothness of interaction was entered as a mediator and later solitary snacking as the dependent variable, controlling for gender and amount of pasta consumption during the meal. The results showed that when comparing sitting opposite each other with the two other seating conditions, there was a direct effect of seating on later snacking such that participants in the facing condition subsequently consumed fewer cookies than in the other two conditions combined (β = -.21, $p < .05$). Results further showed that the indirect effect of seating condition on later snacking via smoothness was 1.47. The 95 % confidence interval ranging from -0.34 to 5.06 indicated that the indirect effect was not significant (see also Figure 2.2).

Figure 2.2. Standardized regression coefficients for the relationship between seating condition and later snacking through perceived smoothness of the conversation.



Note. * $p < .05$, ** $p < .01$. Gender of participant and amount of pasta consumption during meal were controlled for. The standardized regression coefficient for the relationship between seating condition and later snacking controlling for perceived smoothness of the conversation is in between parentheses.

Effects of BMI, body shape, and restrained eating on solitary snacking

In separate analyses we examined whether controlling for participants' BMI, perceived body shape, and restrained eating affected our observed findings of the effects of the familiarity of the eating companion and seating arrangement on later solitary snacking. Neither BMI nor participants' score on the Restraint Scale affected the amount of cookies that participants consumed (BMI: $F(1, 71) = 0.01$, *ns*; Restrained eating: $F(1, 71) = 0.00$, *ns*), and controlling for these did not change any of our findings. Participants' perceptions of their own body figure also did not have an effect on later snacking ($F(1, 70) = 0.60$, *ns*), but participants' perception of their eating companion's body figure significantly affected later cookie consumption ($F(1, 70) = 6.35$, $p < .05$), with a higher consumption of cookies when participants perceived their eating partner as being heavier. Including perceptions of own and other's body figure as covariates did not substantially affect our findings.

Effects of familiarity of co-eater and seating arrangement on amount of pasta consumption during the meal and positive and negative affect after the meal

We also tested two alternative accounts that could explain the effects of familiarity and seating arrangement on later snacking: Whether familiarity and seating condition affected either the amount of pasta consumed during the meal and/or positive affect after the meal, which in turn could have affected later cookie consumption. In the above reported mediation tests we controlled for amount of pasta consumption, but did not test whether it could function as a mediator.

Results of ANOVA analyses showed that participants consumed similar amounts of pasta during the meal when they ate together with someone they

knew compared to when they ate with a stranger (F (1,73) = 0.61, *ns*). Additionally, a mediation test showed that the indirect effect of familiarity through amount of pasta consumption was not significant (Indirect effect: 1.13, 95 % confidence interval between -1.65 and 4.89). Gender significantly affected the amount of consumption (F (1, 73) = 44.83, p < .01), male participants consumed more pasta (M = 369.55 grams, SD = 122.34) than female participants (M = 228.42 grams, SD = 117.26). Also, the seating condition participants were assigned to did not affect consumption levels (F (2, 73) = 1.40, *ns*) nor was there an indirect effect of seating condition (contrasting facing condition with the others) on later snacking through amount of consumption (Indirect effect: -1.59 , 95 % confidence interval between -4.68 and 1.02). There was also an interaction effect between familiarity of eating partner and seating condition on how much pasta participants consumed (F (2, 73) = 4.50, p < .05), such that participants in the side by side condition ate more pasta when they had dinner with a familiar other (M = 356.60 grams, SD = 95.37) than with a stranger (M = 245.85 grams, SD = 152.90, F (1, 20) = 9.57, p < .05), whereas familiarity did not affect consumption of pasta in the other seating conditions.

Similar analyses were performed for positive and negative affect after the meal, but the results show that neither familiarity of the eating companion nor seating arrangement, nor their interaction influenced positive affect (Familiarity: F(1, 73) = 1.22, *ns*; Seating: F(2, 73) = 0.24, *ns*; Interaction: F(2, 73) = .53, *ns*) or negative affect (Familiarity: F(1, 73) = 0.17, *ns*; Seating: F(2, 73) = 1.19, *ns*; Interaction: F(2, 73) = 0.53, *ns*). Additional mediation tests also showed that positive or negative affect did not mediate the effect of familiarity on later cookie consumption (Indirect effect familiarity through positive affect: -0.93, 95 % confidence interval between -3.16 and 0.28; indirect effect familiarity through negative affect: 0.06, 95 % confidence interval between

-0.52 and 1.39). Thus, both amount of pasta consumption and affect are unlikely to explain the effects of familiarity on later solitary snacking.

Additional analyses on matching of amount of consumption

Using the dyad as the unit of analysis, we also assessed whether participants matched the amount of pasta consumption to that of their eating companion. We assessed matching by looking at the absolute difference between the amount that eating companions consumed in an ANOVA and by looking at the relationship between individuals' amount of pasta consumption within the dyad. An ANOVA was conducted with the absolute difference in amount of pasta consumption between the two eating companions as a dependent variable and whether or not members knew each other and the seating condition as independent variables, controlling for the gender of the dyad. Dyads composed of individuals who knew each other did not differ from dyads composed of individuals who did not know each other with respect to the difference in pasta consumption ($F(1, 32) = 0.94$, *ns*). Gender also did not affect the difference in pasta consumption within the dyad ($F(1, 32) = 0.74$, *ns*), nor did seating condition ($F(2, 32) = 0.06$, *ns*). No interaction was found between seating condition and familiarity on difference in pasta consumption ($F(2, 32) = 0.19$, *ns*).

We also computed intraclass correlation coefficients (ICC's) in order to assess the relationship between participants' amount of pasta consumption within the dyad (cf., Brunner, 2012; Robinson, Tobias, Shaw, Freeman, & Higgs, 2011). ICC's for dyads are interpreted similarly as Pearson correlations and were computed using a one-way random model in the SPSS 19.0 "reliability" procedure (cf. Salvy et al., 2007). Overall, the relationship between participants' amounts of pasta consumption was high as indexed by an overall

intradyadic correlation = .54 (p <.01). When comparing dyads that know each other to dyads that do not know each other, results show that the degree of matching was not significantly different between these groups (z= 0.41, *ns*; dyads that know each other: ICC= .62, p <.01, dyads that do not know each other: ICC= .52, p <.01). Also, there was no difference in the degree of matching between the three seating conditions (Opposite: ICC = .62, p < .01; Corner: ICC = .58, p < .05; Side by side: ICC = .43, p =.08; difference: |z| <.58, *ns*). Finally, male and female dyads were similar in the degree of matching of amount of pasta consumption (Male dyads: ICC =.43, p <.05, female dyads: ICC= .34, p =.06, z = 0.3, *ns*).

General Discussion

The current study shows that the social context within which meals take place may affect how much consumers snack afterwards, when they are alone. We found that when individuals share dinner with someone they know, they later consume fewer cookies than individuals who have had dinner with a stranger. We hypothesized that conversations with familiar others run smoother than conversations with strangers and, based on research in self-regulation, that this would predict later snack consumption. Indeed, conversations with familiar others were perceived as flowing smoother than with strangers. Also, sitting next to each other or around the corner of the table produced smoother conversations. However, the extent to which participants perceived the conversations during dinner as running smoothly did not affect later cookie consumption, thus we did not find evidence for our hypothesized mechanism.

The current study adds to a growing literature of social influence processes in eating, in that the social context within which meals are eaten is not only relevant for how much consumers may eat within that meal but also

affects how much consumers snack later on. Social eating, and in particular with friends and family, is often characterized as a cause of overeating and conversations during the meal are seen as a distraction to people's monitoring abilities of how much they have eaten (Herman, et al., 2003). The current findings provide a more positive outlook on social meals shared with familiar others, as it shows that the amount of snacking after a meal may be lower. In this way, overall consumption levels may not be different for people who regularly eat with friends and families, although examination of longer term consumption patterns are necessary to establish this. Also, the current study contributes to the study of environmental cues in eating situations, by looking at seating arrangement. Although some earlier studies have looked at the effects of seating arrangement on conversation (Mehrabian & Diamond, 1971; Sommer, 1965), seating is little studied in eating situations, where it could be very relevant. Our findings show that participants perceived the conversations they had during dinner as running less smooth when they were seated directly opposite each other. This is in line with findings that show that directly facing each other in an interaction may provoke anxiety (Osato & Ogawa, 2003). Although people have been found to prefer sitting around corners during conversations (Sommer, 1965) and sitting next to each other has been found to hinder conversations (Mehrabian & Diamond, 1971), we did not find any differences between these two types of seating arrangements.

An important limitation of the current study is that we cannot explain why eating with familiar others led to a lower snack consumption than eating with strangers. In line with our hypotheses, eating with familiar others indeed led to smoother conversations during dinner, but smoothness of conversation was unrelated to later cookie consumption. One possibility is that overall, conversations during dinner were perceived to be rather smooth, and that smoothness of conversations only affects later cookie consumption through

self-regulation after more extreme high-maintenance interactions. We examined two alternative routes that could explain our findings. One is that eating with families and friends, or familiar others in general, has been found to increase consumption (de Castro, 1994; Salvy et al., 2007). Reduced snacking after a meal shared with familiar others could then reflect compensation for the increased food intake during the meal. However, in our study food intake during the meal was not affected by the familiarity of the co-eater, thus making it an unlikely explanation for our findings. Findings of increased food intake among friends and families are often explained by a longer meal duration (de Castro, 1994), and the fact that participants in our study were limited in the time they had to consume dinner could explain why we did not find an increased food intake among familiar co-eaters. Our findings also ruled out a second alternative account that, rather than specifically the smoothness of the conversation, a more general positive affect that is produced by eating with familiar others reduced later cookie consumption.

The question that remains is: What did account for our findings of reduced cookie consumption? One possibility that could account for our findings of familiarity is that the motive to convey a positive impression on the unfamiliar eating partner led individuals to consume more cookies afterwards. The motive of conveying a positive impression may not entirely be captured by our measure of smoothness of conversation. Strangers may have invested a lot of resources in making sure that they had a nice conversation with each other, and they may have succeeded in this and felt they had a smooth conversation. This may have left unaffected that their investment of resources drained their self-control, which led to a higher consumption of cookies afterwards. Future research should therefore examine the availability of self-control resources more directly rather than using smoothness as a proxy for

this, as was done in the current study. Related to this, because our study did not have a condition where participants ate alone, something which should be improved in future research, it is hard to determine whether familiar co-eaters ate fewer cookies or strangers ate more.

Despite the fact that the mechanism underlying our findings is not yet clear, we think that studying in greater detail what goes on during social meals is a worthwhile route in order to understand food intake across consumption episodes. One avenue which future research could pursue is the question of the topics that eating companions discussed during their meal, for example the extent to which they talked about the food, the portion size or how satiated they were. Examining in greater detail the dynamics of conversations during meals may help future research in understanding consumption patterns of social eating and solitary eating.

Chapter 3

How Do I Look? Focusing Attention on the Outside Body Reduces Responsiveness to Internal Signals in Food Intake

This chapter has been invited for revision for publication as: Van de Veer, E., Van Herpen, E. & Van Trijp, H.C.M. Distracted by the Man in the Mirror: Focusing Attention on the Outside Body Reduces Responsiveness to Internal Signals in Food Intake.

An extended abstract of this chapter has been published as: Van de Veer, E., Van Herpen, E. & Van Trijp, H.C.M (2011). Distracted by the Man in the Mirror: Focusing Attention on the Outside Body Reduces Responsiveness to Internal Signals in Food Intake. In: Dahl, D.W., Johar, G.V., & van Osselaer, S.M.J. (eds.) *Advances in Consumer Research, 38* , Duluth, MN : Association for Consumer Research.

Abstract

Paradoxically, Western societies witness a simultaneous increase in the emphasis on thinness and beauty ideals and in the number of overweight individuals. In the current study we examine the effect that cues that elicit a focus on body appearance have on food consumption at an individual level. We hypothesize that focusing on the external body reduces the impact of internal hunger and satiety cues in food consumption. In two experiments we show that focusing on appearance through a short mirror exposure (Experiment 1) or by looking at advertisements of models (Experiment 2) hinders individuals in compensating for previous consumption (Experiment 1) and leads individuals to rely less on hunger and satiety signals in their eating behavior (Experiment 2). These findings suggest that environmental cues that lead individuals to emphasize outer body appearance reduce reliance on internal body cues.

Western societies place an increasing emphasis on thinness ideals and outward appearance, a trend which is especially apparent in modern-day TV commercials and music video clips (Sypeck, Gray, & Ahrens, 2004). Ironically, in contrast to how individuals are depicted in the media, the number of people that are overweight or obese has increased steadily since the 1980s (WHO, 2004) and most western societies face a range of public health problems related to food consumption. This raises the question of how a focus on appearance and food consumption may be related. At the individual level there are indications that a focus on appearance is actually detrimental to achieving the thinness ideal: Individuals that are more focused on their appearance have more difficulties in keeping a diet and have a higher chance of developing unhealthy eating patterns such as restrained eating, and even eating disorders such as bulimia and anorexia nervosa (Botta, 2003; Harrison & Cantor, 1997). We will demonstrate that even a temporary focus on appearance impacts eating behavior. More specifically, we will argue that a focus on the outside appearance of the body reduces responsiveness to internal hunger and satiety cues from the inside of the body.

What and how much individuals eat, is influenced by the complex interplay of various factors such as internal physiological cues (e.g., hunger and satiety), environmental cues in the eating environment (e.g., food availability, portion size of food; Wansink, 2004), psychosocial factors (e.g., influences of family or friends; Herman, Roth, & Polivy, 2003), cognitive factors (e.g., attentional resources; Mann & Ward, 2007) and individual differences (e.g., restrained eating; Herman & Mack, 1975). These influences on food consumption are often categorized as either internal - the physiological cues of hunger and satiety regulating food intake - or external - all other cues in the food environment that affect consumption but do not directly operate through physiological mechanisms (Herman & Polivy, 2008;

Schachter, 1968). External cues can drive food consumption by appealing to the senses, for example the sight or smell of food, or by suggesting an appropriate amount to eat, for example portion sizes or someone else's consumption (Herman & Polivy, 2008). Cues in the eating environment that are unrelated to the properties of food, such as music or the presence of others, can also increase food consumption in a more indirect fashion by extending the duration of meals or hindering monitoring of how much one has eaten (Hetherington, Anderson, Norton, & Newton, 2006; Stroebele & de Castro, 2006). We propose that there is also a class of external cues that affect eating behavior because they change the way individuals look at themselves, shifting attention from the functioning of the body to its outward appearance. We argue that these cues affect food consumption by influencing the extent to which people rely on internal hunger and satiety cues in food.

A long research tradition has addressed the question of whether certain individuals are differentially affected by internal cues versus external cues in their eating behavior. Initially, it was argued that external cues govern consumption patterns of the obese and internal cues regulate that of normal weight individuals (Schachter, 1968) and later the same argument was made for restrained eaters, a type of chronic but often unsuccessful dieters (Herman & Mack, 1975). Restrained eaters have indeed been found to be more affected by sensory related food cues such as smell and sight of food (Federoff, Polivy, & Herman, 1997) and to demonstrate an attentional bias towards palatable foods (Papies, Stroebe, & Aarts, 2008). However, there is also a substantial literature demonstrating that everyone is susceptible to influences of external cues on food consumption, at least some of the time. For example, normal-weight, non-restrained individuals also eat more when portion sizes, plates, and serving utensils are larger (Rolls, Morris, & Roe, 2002; Wansink, van Ittersum, & Painter, 2006; Wansink & van Ittersum, 2007), when food is more

varied (Rolls et al., 1981), or when their eating companion eats more (Herman, Roth, & Polivy, 2003). On the basis of this, we assume that everyone may be more or less affected by external or internal cues at times, and we propose that the question that should be asked is *when* are people to a greater or lesser extent affected by internal cues in their eating. Relatively little is known about variations in people's ability to rely on internal hunger and satiety cues, yet this is important because it indicates how well they can balance food consumption over time.

In our view, the perspective one takes towards one's body is crucial as to when someone is better or worse at attending to internal hunger and satiety cues. Advertisements and media depicting beauty ideals can lead to body dissatisfaction (Bessenoff, 2006; Harper & Tiggemann, 2008), to social comparison (Tiggemann & Slater, 2004) and have been found to affect consumption levels (Anschutz, Engels, Becker, & van Strien, 2009; Strahan, Spencer, & Zanna, 2007). At a more fundamental level these ads change the focus from an experiential first person perspective concerned with "how do I feel" towards a visual third person perspective having to do with "how do I look?" (Aubrey, 2006). We build on findings in the self-objectification literature and in neuroscience which suggest that a visual perspective on the body may outweigh information coming from internal bodily cues, making it harder for individuals to assess their physiological state (Eshkevari, Rieger, Longo, Haggard, & Treasure, 2012; Fredrickson & Roberts, 2007; Tsakiris, Tajadura-Jimenez, & Costantini, 2011). Based on these emerging findings, we propose that cues in the eating environment can temporarily direct individuals' attention to appearance aspects of their body, hindering them in assessing how hungry or full they are and in adjusting their consumption accordingly.

Alongside health based motivations, people who try to lose or maintain weight are also often driven by appearance concerns (O'Brien et al., 2007; Putterman & Linden, 2004). If our hypothesis is correct, a focus on appearance of the body can entrap individuals in a vicious circle: A focus on one's appearance contributes to overconsumption, which may consequently feed back into more attention being devoted to how one looks. At a more general level, the current study contributes to a deeper understanding of whether and how external cues in the eating environment and internal hunger and satiety cues interact in affecting food consumption, fields which have been studied mostly in isolation of each other. We proceed to review evidence from research on internal cues in food consumption and perspectives on the body.

Influence of Physiological Hunger and Satiety Cues on Food Consumption

The human body is equipped with a complex homeostatic feedback system to inform the body and mind of its need for food. The ability to sense hunger and satiety cues and adjust food intake accordingly is considered an inborn skill that young children are generally quite good at but that deteriorates as children grow older (Birch, Fisher, & Davison, 2003; Cecil et al., 2005). Empirical evidence on the extent to which individuals adjust their food intake according to internal physiological cues is largely derived from so-called preload paradigms (Benelam, 2009). In this experimental paradigm participants are first served a "preload", often a milkshake, presented under the guise of a taste test. Unbeknown to participants, this milkshake is either high or low in calories, thus generating different levels of internal hunger and satiety signals. How much participants subsequently eat at a later point in time demonstrates how well they compensate for their previous intake. In

these types of paradigms the preloads differ only in their disguised caloric content, such that when compensation occurs this can be attributed to a higher awareness of and responding to the internal physiological satiety cues that these extra calories deliver, rather than to a more cognitive judgment of how much one should eat.

Assessing reliance on internal hunger and satiety cues by examining compensation behavior, rather than assessing absolute consumption at a single point in time, is important because it indicates how well individuals are able to balance consumption over time and can serve as a general marker for adaptive eating habits. For example, an individual's ability to sense feelings of satiety after a meal has been related to a lower overall food intake at another consumption moment (Drapeau et al., 2005) and to a lower susceptibility to gain weight (Cornier, Grunwald, Johnson, & Bessesen, 2004). Conversely, it was found that overweight individuals are less likely to rely on feelings of fullness to end a meal (Wansink, Payne, & Chandon, 2007; Tylka, 2006) and individuals who report weaker relationships between food consumption and experiences of hunger and fullness score higher on measures of disinhibited eating (uncontrolled eating) (Barkeling, King, Näsland, & Blundell, 2007).

Given the relationship between reliance on internal hunger and satiety cues and positive health outcomes, it is surprising that we know relatively little about the circumstances under which individuals might be better or worse at sensing internal hunger and satiety cues. Nutrition and physiological literatures have demonstrated that different properties of food, such as the food being in liquid or solid form (DiMeglio & Mattes, 2000) or macronutrient composition (Gerstein, Woodward-Lopez, Evans, Kelsey, Drewnowski, 2004), affect the satiating capacity of foods, but large interindividual differences exist in responses to these properties (Blundell et al., 2005). Some of the interindividual variance in reliance on internal hunger and satiety cues has

been related to personality differences, specifically restrained eating. Restrained eating, a personality trait characterized by a preoccupation with food and chronic but often unsuccessful dieting, has been repeatedly associated with a lack of awareness and responding to internal hunger and satiety cues, possibly due to ignoring and suppressing these cues over long periods of time (Heatherton, Polivy, & Herman, 1989; Herman & Mack, 1975). Generally, restrained eaters have been found to eat more rather than less following the serving of a preload, indicating counter-regulation rather than compensation for previous dietary intake (Herman & Mack, 1975).

Although reliance on internal hunger and satiety cues has thus usually been related to individual difference variables, recent studies have demonstrated that the extent to which individuals compensate for previous consumption can in fact be determined by the situation a person is in. Specifically, a distraction in the environment may shift attention away from the self and internal hunger and satiety cues. For example, eating while watching television or playing a computer game does not only contribute to overeating within the eating episode (Bellisle, Dalix, & Slama, 2004), but has been found to extend beyond the eating episode by increasing subsequent snack consumption (Higgs & Woodward, 2009; Mittal, Stevenson, Oaten, & Miller, 2010; Oldham-Cooper, Hardman, Nicoll, Rogers, & Brunstrom, 2011). Whereas these findings have mostly been attributed to an impaired memory for previous consumption, there is also initial evidence that distraction affects the awareness of hunger and satiety cues. Brunstrom and Mitchell (2006) found that participants who had been distracted during consumption experienced smaller changes in fullness following consumption than did non-distracted participants. Further evidence that the awareness of hunger and satiety cues is affected comes from a study by Bellissimo and colleagues (2007) showing that boys adjusted their consumption at lunch according to

whether they previously consumed a preload with glucose or a (covert) non-caloric substitute, but not when they were watching television during lunch. Taken together, these studies suggest that external cues in the eating environment can temporarily interfere with the reliance on internal hunger and satiety cues. Given that distraction may direct individuals' attention away from the body's internal hunger and satiety cues, directing attention to the self, or the body in particular, may seem like a good strategy to rely on hunger and satiety cues. Yet, based on research that has looked at different ways in which people relate to their bodies, we argue that not all attention that is directed at the body is beneficial.

Different Perspectives on the Body: How it Looks Versus How it Feels

Various lines of research that deal with how people process information about their bodies convey the central idea that when individuals focus attention on their bodies they can focus on how the body looks or on how the body feels (Avalos & Tylka, 2006; Fredrickson, Roberts, Noll, Quinn, & Twenge, 1998; Tsakiris et al., 2011). This distinction between directing attention towards outward appearance aspects of the body and internal functional aspects of the body has been termed public versus private body awareness (Miller, Murphy, & Buss, 1981), third versus first person perspectives on the body (Fredrickson et al., 1998), and body image versus interoception (Mehling et al., 2009). These constructs emphasize the extent to which individuals pay *attention* towards appearance aspects of the body rather than the *evaluation* of these appearance aspects of the body, setting it apart from constructs such as social comparison and body esteem (Franzoi & Shields, 1984; Richins, 1991; Rosa, Garbarino, & Malter, 2006; Tiggemann & McGill, 2004). Self-objectification

theory has argued that simply the attention paid to outward appearance affects individuals by taking away attention from internal body cues, regardless of how satisfied they are with their outward appearance. For example, compliments about one's appearance have been found to lead people to emphasize how the body looks over how the body feels and to experience similar negative consequences, such as increased body surveillance, as when negative information about the body is given (Calagero, Herbozo, & Thompson, 2009).

The idea that attending to how the body looks may reduce attention to how the body feels has often been put forward in the eating disorder literature, where a strong focus on appearance is frequently observed together with a reduced perception of not only hunger and satiety cues, but also other bodily cues such as heartbeat (Bruch, 1962; Pollatos et al., 2008). The field of self-objectification has addressed this relationship among non-clinical, mostly female populations. Self-objectification theory argues that due to the prevalence in (mostly Western) media of portraying (especially) young women as sexual objects, individuals learn to approach their bodies as an object to be evaluated only on the basis of appearance (Fredrickson et al., 1998) and that through such an appearance focus, attention is diverted away from how the body feels and functions. Self-objectification, or the extent to which individuals define their body in terms of how it looks, rather than in terms of how it feels, has been related to a range of negative outcomes such as body dissatisfaction, body shame, and eating disorders (for an overview see Moradi & Huang, 2008). Most important for our hypothesis, initial support for a negative relationship between a (self-reported) outward appearance focus and the awareness of internal body cues, including hunger and satiety, was found in survey studies (Daubenmier 2005; Myers & Crowther, 2008, but see also Bekker, Croon, & Vermaas, 2002; Spoor, Bekker, van Heck, Croon, & van

Strien, 2005). In a related vein, Miller et al. (1981) found that individuals who generally paid more attention to outward appearance aspects of the body could not distinguish between a caffeine drink and a placebo in the effects these had on inner body cues, whereas individuals who were generally more oriented towards internal aspects of their body could.

Recently, studies have been able to examine more fundamentally how individuals experience their body when focusing on outward appearance aspects of the body, by using the rubber hand illusion. This refers to a visual illusion involving the back of one's hand, a body part individuals usually do not have a strong aesthetic evaluation of. These studies demonstrate that focusing on appearance aspects of the body is related to a more general reliance on visual aspects of the body and provide initial support for the idea that such a focus overrides reliance on the body's internal cues (Eshkevari et al., 2012; Mussap & Salton, 2006). The rubber hand illusion consists of stroking a small paint brush across a fake rubber hand which is placed in the position of the participant's left hand and synchronously stroking the participants' real hand which is hidden from sight. The simultaneous visual input of seeing the rubber hand in the position of one's own hand being stroked and the sensory input of one's own hand being stroked, creates the illusion that the fake hand belongs to one's body (Botvinick & Cohen, 1998). Two recent studies have shown that the extent to which individuals experience the illusion, that is, rely on the visual information about the position of the hand over the sensory cues coming from their hand, is related to the extent to which individuals define their body in terms of appearance and place importance on Western beauty ideals (Eshkevari et al., 2012; Mussap & Salton, 2006). This suggests that focusing on appearance may be related to a more general mode of relying on visual information about the body. At the same time, the extent to which individuals experience the illusion

has also been related to a general lower sensitivity to inner bodily cues (Eshkevari et al., 2012; Tsakiris et al., 2011), suggesting that relying on visual cues of the body overrides the signaling power of internal body cues.

Even though studies on self-objectification and the rubber hand illusion provide initial evidence that a focus on appearance is indeed related to a reduced awareness of internal body cues, there are a number of limitations to the studies discussed so far. First of all, these studies are correlational, which makes it hard to rule out that an unknown personality factor underlies the relation between a focus on appearance and reduced awareness of body cues. Since a focus on appearance has only been studied as a trait, we cannot ascertain whether these effects occur in all individuals when they temporarily focus on appearance or whether these are limited to individuals who are more chronically oriented towards outward appearance aspects of their bodies. This is crucial as self-objectification literature has amply demonstrated that environmental cues can temporarily trigger individuals to focus on outward appearance aspects of their body. For example, situational cues such as full length mirrors (Tiggemann & Boundy, 2008), viewing magazine ads with models (Aubrey, 2010; Harper & Tiggemann, 2008), being exposed to self-objectifying words (Roberts & Gettman, 2004) or anticipating a male gaze (Calagero, 2004) have been found to lead women to define themselves in terms of their appearance. Many of the cues that lead people to adopt an appearance focus of their body are likely to be present in eating contexts, but to our knowledge no study has examined the impact these have on reliance on internal body cues, specifically hunger and satiety.

Another limitation of previous studies that have looked at awareness and reliance on internal body cues is that these have mostly relied on self-report measures of internal body cues. The reliance on internal body cues is particularly difficult for individuals to self report on, especially in a state of

rest when no (big) changes in their bodily states occur (cf. Herbert et al., 2012; Pollatos, Herbert, Kaufmann, Auer, & Schandry, 2007), which may lead to inaccurate measures. Additionally, some of these studies have not looked at hunger and satiety cues specifically, but have included these cues in a wider range of body cues (Daubenmier, 2005). Even though there is reason to believe that awareness and reliance on hunger and satiety cues is related to awareness of other inner body cues (Whitehead & Drescher, 1981; Herbert et al., 2012) this has not been examined directly. In sum, even though there is initial evidence that a focus on appearance aspects of the body overrides the perception of internal body cues, to our knowledge, no study has directly examined the causal link between a focus on appearance and reliance on internal hunger and satiety cues, nor examined reliance on internal physiological hunger and satiety cues in actual food consumption.

Overview of Experiments

Overall, we will test the relationship between appearance focus and individuals' reliance on internal hunger and satiety cues in food intake in two experiments, using two operationalizations of appearance focus. Experiment 1 manipulates appearance focus by exposing participants to their image in a mirror. Experiment 2 manipulates appearance focus by having participants evaluate a series of advertisements with models. In two pilot studies we test whether these manipulations indeed shift attention towards appearance based aspects of the body. Reliance on internal hunger and satiety cues is assessed by looking both at compensation in a preload paradigm (Experiment 1) and by manipulating time since previous consumption (Experiment 2). The hypothesis is that focusing on appearance reduces individuals' ability to rely on internal hunger and satiety cues.

Experiment 1

We propose that a mirror can elicit an appearance focus in individuals and test this assumption in a pilot study. The mirror has recently been used in manipulations of self-objectification (Tiggemann & Boundy, 2008) and also Hofmann and Heinrichs (2002) found that both positive and negative appearance aspects of the self become more salient after a mirror exposure. We expect that after being exposed to a mirror, individuals show an enhanced attention to outward appearance aspects of the body, and a decreased attention to internal aspects of the body. We test this in a pilot study by using the Body Consciousness Questionnaire (Miller et al., 1981) which has a public and private body consciousness subscale, and measures the extent to which individuals are aware of outward appearance and internal aspects of the body respectively. We adjusted it slightly to assess state body consciousness rather than trait body consciousness, and to examine attention paid to appearance and internal body aspects, rather than the evaluation or importance of these aspects.

A mirror has also been used to more generally focus attention on the self (Carver & Scheier, 1978), or on private aspects of the self (Goukens, DeWitte, & Warlop, 2009) but these tap into the tendency to examine one's private thoughts and into concerns about how other people might think of oneself, rather than the attention that is paid to private and public aspects of the body specifically. To compare the effects of outward appearance and internal aspects of the body with a more general self-awareness effect, also a public and private self-consciousness scale (Fenigstein, Scheier, & Buss, 1975) is administered. Furthermore we examine whether a mirror exposure induces a state of worrying in participants to rule this out as an alternative explanation. A final goal of this pilot study is to test whether a mirror induces

similar effects in both men and women. Although self-objectification theory has originally argued that the consequences of an outward appearance focus are specific to the situation in which girls and women find themselves, recent evidence (Hebl, King, & Lin 2004) shows that appearance focus has similar effects in both men and women of a diverse range of ethnic backgrounds.

Pilot Study 1

Method

Sixty-five students were recruited around campus. Nine participants were excluded from analyses because of a faulty administering of the mirror manipulation (e.g., not all mirrors removed in the no mirror condition) and one participant because of language problems in understanding the experimenters' instructions. This left a total of 55 participants (28 men, 27 women; mean age = 19.9 years) in the analyses. Participants were either exposed to their image in a mirror (appearance focus condition) or not (control condition) while filling out a series of short questionnaires including the Body Consciousness Questionnaire (Miller et al., 1981). We modified the Body Consciousness Questionnaire slightly to examine state body consciousness rather than trait body consciousness by asking participants about the attention they paid to different aspects of their body during the previous (neutral) questionnaire they filled out in a series of questionnaires. Five items of the Body Consciousness Questionnaire address the attention individuals pay to outward appearance aspects of the body (e.g., *"While I was filling out the previous questionnaire I paid attention to the characteristics of my face", 1* = not at all*, 7* = very much) and five items deal with the attention individuals devote to internal aspects of the body (e.g., *"While I was filling out*

the previous questionnaire I paid attention to an empty or full feeling in my stomach", 1 = not at all*, 7 =* very much). The item concerning '*posture*' related poorly to the other four of the public body consciousness dimension of the Body consciousness Questionnaire and seemed to tap less directly into outward appearance than the other four items. This item was consequently dropped from analyses. Internal reliabilities were α = .70 for the private (internal body aspects) and α = .72 for the public dimension (outward appearance aspects) of the Body Consciousness Questionnaire.

Participants also filled out an adapted state version of the Public Private Self Consciousness scale (Fenigstein et al., 1975) with seven items assessing private self-consciousness (e.g*., "At this moment I am alert to changes in my mood"* α = .80) and seven items assessing public self-consciousness (e.g., *"At this moment I am concerned about what other people think of me"* α = .76). Furthermore participants completed an adapted state version of the Penn State Worry Questionnaire (Meyer, Miller, Metzger, & Borkovec, 1990, e.g., *"I know I should not worry about things at this moment, but I just cannot help it."* α = .89), five items relating to state preference fluency (e.g., *"While filling out the previous questionnaire, I found it difficult to decide what I really think*" α = .70) and a measure of perspective taking (Nigro & Neisser, 1983).

Results and discussion

Condition and gender of participant were entered as independent variables in a MANOVA and focus on appearance aspects and internal aspects of the body served as dependent variables. Results show that exposure to a mirror induced a significant focus on outward appearance aspects of the body ($F(1, 51) = 5.57$, $p < .05$), but not on inner aspects of the body ($F(1, 51) = 1.36$, *ns*).

As expected, when participants were seated in front of the mirror, they indicated to pay more attention to aspects of their outward appearance (M = 1.79, SD = 1.09) than when they were not facing a mirror (M = 1.28, SD = .49). Gender of participant had no effect on focus on appearance (F(1, 51) = 1.16, *ns*) or internal aspects of the body (F(1, 51) = 2.26, *ns*), nor did it interact with the mirror manipulation (appearance aspects: F(1, 51) = 0.04, *ns*; internal aspects: F(1, 51) = 0.00, *ns*). No effects of the mirror manipulation were found on public or private self-awareness, worry scale, perspective taking, or preferences (all *F's* < 2.54, *ns*). There was a main effect of gender on public self-awareness (F(1, 50) = 10.03, p < .01) and private self-awareness (F(1, 50) = 9.04, p < .01), such that women were more publically and privately self-aware than men (public: M = 4.03, SD = .87 vs. M = 3.17, SD = 1.03; private: M = 4.38, SD = .97 vs. M = 3.46, SD = 1.20) but gender did not interact with the mirror manipulation on public and private self-awareness or any other measures.

These findings indicate that the use of a mirror indeed is a good manipulation of an outward appearance focus in both men and women. Also, these findings suggest that exposure to a mirror specifically directs attention to outward appearance aspects of the body, rather than more generally raising public or private self-awareness, or evoke a state of worry in participants. However, besides raising attention to outward appearance, we expected that the mirror would also decrease ratings on the private body consciousness subscale, which was not the case. One explanation for this is that it may be difficult to self-report on inner aspects of the body, especially over such a short period of time. Also, awareness of inner body cues may manifest itself better when changes in the state of the body take place.

In contrast to previous studies that have found an effect of the mirror manipulation on how well aware participants are of their attitudes and

thoughts (Goukens et al., 2009), we found no effect of our mirror manipulation on private self-awareness. One explanation for this could be the relatively large size of the mirror, whereas other studies have specifically used small mirrors to enhance participants' private self-awareness (e.g., Pham, Goukens, Lehman, & Stuart, 2010). With regard to public self-awareness, our findings suggest that a mirror may not so much enhance concern of how one looks to others, but rather increase the mere salience of particular aspects of appearance. This is in line with a study by Hofmann and Heinrichs (2002) who show that after a mirror exposure, individuals are more likely to describe themselves in terms of their appearance, using an equal amount of positive and negative statements.

Overall, this pilot study shows that a mirror enhances individuals' attention to appearance aspects of the body and in the main experiment we will therefore use the mirror manipulation to test the effect of an appearance focus on reliance on internal hunger and satiety cues. We will assess reliance on internal hunger and satiety cues by examining whether participants compensate for a covertly disguised preload of either a high or low caloric content in their subsequent consumption. Additionally, we describe both types of preloads as either high caloric or low caloric (independent of the actual content) to examine whether compensation in subsequent consumption is due to actual differences in the physiological cues these produce, or due to a more cognitive process of how the milkshakes are perceived.

Experiment 1

Method

Participants and design. One hundred and thirteen participants were assigned to a 2 (Caloric content of the milkshake preload: high vs. low) x 2 (Appearance focus condition: appearance focus vs. no appearance focus) x 2 (Label of the milkshake preload: high caloric vs. low caloric) between-subjects design. Three participants were excluded for not following instructions, two participants were excluded because they indicated a strong dislike for M&M's (rating of one on scale of seven), one outlier was identified because M&M consumption was above 3 SD of the mean. This left a total of 107 participants in the analysis (20 men and 87 women, mean age = 21.7 years, *SD* = 2.98). Participants received a small monetary compensation for participation.

Procedure. All sessions were run in the afternoon between 13:30 h. and 16:30 h. to minimize baseline differences in hunger levels. Participants were seated at individual desks and were informed that they would be participating in a series of unrelated experiments on "personality, taste and studying". In the appearance focus condition, a mirror was positioned in front of the participants' desks in such a way that participants could view their face and upper body part reflected in the mirror. In the no appearance focus condition, no mirrors were present in the research room. Participants started with a small questionnaire on 'lunch habits' and filled out questions about the time they had lunch and subjective feelings of hunger and satiety, in order to check baseline feelings of hunger and satiety and consumption prior to participation. Subsequently, participants filled out a measure of positive and negative affect (Watson, Clark, & Tellegen, 1988).

Next, participants took part in what was described to them as a taste test. Participants were served a 300 ml milkshake, described as either a light, low caloric milkshake (in the low caloric label condition) or as a full fat, high caloric milkshake (in the high caloric label condition), and were instructed to finish the milkshake completely. Depending on the experimental condition participants were in, they were served either a high caloric 300 ml milkshake (total caloric content: 534 kilocalories) or a low caloric 300 ml milkshake (total caloric content: 215 kilocalories), independently of how the milkshake was described to them (cf. Long, Hart, & Morgan 2002). Both milkshakes contained equal amounts of skimmed yoghurt, vanilla flavor and sugar. Both versions of the milkshake contained skimmed milk but in the high caloric milkshake part of the skimmed milk was replaced by full fat cream. Milkshakes were served in a carton container covered with a plastic lid and straw. Participants then rated the milkshake on a number of sensory properties (e.g., sweet, salt, bitter) as well as on a number of general characteristics (e.g., liking of the milkshake, perceived caloric content). Next, after a short filler task, they filled out the same questions about subjective hunger and satiety feelings as at the beginning of the study. To allow for satiation of the milkshake, participants consequently participated in a 15 minute filler task.

In line with the cover story that the study consisted of several unrelated studies, the experimenter then led the participants to a different research room, where they were to take part in a study on video fragments. Participants were seated behind computers where they could not see each other. In this research room, no mirrors were present. It was explained to participants that in order to study the evaluation of video fragments in a realistic setting, the experimenter had tried to simulate a home situation by placing a small candle, picture frame and a bowl of M&M's next to the

computers. The experimenter mentioned that participants were free to eat the M&M's as they liked. For the next 15 minutes, participants watched neutral video fragments and evaluated these. Finally, they filled out demographic questions, reported their height and weight, liking for M&M's and were probed for suspicion. Participants were thanked and paid. After participants left, the experimenter weighed the bowl of M&M's to calculate how much participants had consumed.

Measures. Consumption behavior was assessed by examining whether or not individuals started consuming (taking at least one M&M) and by examining the amount of M&M's in grams that were consumed once participants started consuming. To make sure previous consumption did not vary widely among participants, they were also asked whether they had lunch previous to participation in the experiment. Subjective feelings of hunger and satiety at the start of the experiment and after consumption of the milkshake were rated on 100 mm Visual Analogue scales using the following items: *How hungry are you at this moment?; How full are you at this moment?; To what extent would you like to eat something at this moment?; How much could you eat at this moment?* (α =.88) (cf. Flood & Rolls, 2007). Ratings of the milkshake were given on similar Visual Analogue scales on dimensions such as liking, creaminess, and perceptions of caloric content. State positive and negative affect was assessed on a seven point scale by the 20-item PANAS (Watson et al., 1988) and liking for M&M's was assessed on a seven point scale at the end of the experiment.

Results

Overall, 70.1 % of participants started consuming M&M's by taking at least one M&M out of the bowl. Of those who consumed M&M's (n = 75), participants ate an average of 29.77 grams (SD = 26.6). Because of the large proportion of zero's in the consumption data, the assumption of a normal distribution of our dependent variable was violated. To study the effects of caloric content, label, and appearance focus on consumption, we therefore separately examined the effects on the likelihood of starting to consume M&M's and the effects on the amount of M&M consumption (for individuals who consumed at least one M&M).

Baseline feelings of hunger and satiety. There were no differences in baseline feelings of hunger and satiety between the conditions at the beginning of the study (F (7, 98) = .97, *ns*), nor did the proportion of people who did not have lunch before the experiment differ across conditions (χ^2 (7) = 10.51, *ns*). Hunger feelings at the beginning of the study (marginally) affected the likelihood of consumption (b = 1.25, Wald = 3.68, p = .06) but did not change any of the findings and are therefore not included in any of the reported analyses.

Gender and BMI. Gender did not significantly influence either the likelihood of starting to eat (Wald = 1.19, *ns*) or the amount of consumption (F(1, 69) = 0.53, *ns*). As the total number of men in the sample was low (n = 20) interactions with any of the other manipulations were not assessed. Gender will not be included in any of the reported analyses. Also, correcting for BMI did not affect consumption or change any of the reported findings and will therefore not be included.

Effects of label of milkshake on M&M consumption. The label of the milkshake did not affect the likelihood of starting to consume M&M's, nor did it interact with the content and appearance focus conditions in predicting consumption likelihood (all Wald < 2.26, *ns*). In predicting amount of M&M consumption (for those who consumed M&Ms), label condition (coded as low caloric = -1, high caloric = 1), caloric content condition (coded as low caloric = -1 and high caloric = 1) and appearance focus condition (coded as no appearance focus = -1 and appearance focus = 1), as well as the interactions between these variables were entered as independent variables in an OLS regression. Whether the milkshake was labeled as low caloric or high caloric was found to have a marginally significant effect on amount of M&M consumption ($t(67) = -1.66$, $\beta = -.20$, $p = .10$), such that M&M consumption was marginally higher when participants priorly consumed a milkshake that was labeled as low caloric ($M = 35.03$, $SD = 26.78$) than when it was labeled as high caloric ($M = 25.64$, $SD = 26.03$). However, label did not interact with the appearance focus condition, caloric content condition or both in predicting consumption amount. Therefore the label condition will be taken up as a covariate in the analyses and we will focus our analyses on the effects of the appearance focus and caloric content conditions on M&M consumption.

Effects of caloric content and appearance focus on M&M consumption likelihood. To study effects on the likelihood of consuming M&M's, the caloric content and appearance focus conditions as well as the interaction between these variables were entered into a logistic regression, using the same coding as before. The label condition (coded as -1 = low caloric and 1 = high caloric) was taken up as a covariate. The factor caloric content appeared as a significant predictor of consumption likelihood (b = .58, Wald = 5.83, $p < .05$), indicating that the likelihood of starting to eat M&M's was significantly higher when

participants had previously been served a low caloric content milkshake (81.1%) than when they had been served a high caloric milkshake (59.3%). Appearance focus and the interaction between appearance focus and caloric content did not significantly affect consumption likelihood.

Effects of caloric content and appearance focus on amount of M&M consumption. To study the joint effects of caloric content and appearance focus on the *amounts* of M&M's that were consumed once participants had started consumption, an OLS regression analysis was performed on participants who had consumed one or more M&M's. Caloric content and appearance focus were entered as independent variables, as well as the interaction between these, using the same coding as before. The label condition was again taken up as a covariate. The amount of grams of M&M consumption served as the dependent variable. No main effects were found for neither appearance focus nor caloric content. As described before, a marginally significant main effect was found for the covariate label condition ($t(70) = -1.75$, $\beta = -.20$, $p = .09$). Importantly and consistent with our predictions, the interaction between the actual caloric content and appearance focus emerged as a significant predictor of the amount of M&M's that participants consumed ($t(70) = 2.39$, $\beta = .27$, $p < .05$).

Looking at the underlying simple effects, these showed that the effect of the caloric content of the milkshake within each of the appearance focus conditions tended in the predicted directions. Namely, participants in the no appearance focus condition consumed fewer M&M's after having previously consumed a high caloric milkshake ($M = 20.19$ grams, $SD = 15.98$) than after having previously consumed a low caloric milkshake ($M = 34.33$ grams, $SD = 30.41$, $F(1, 70) = 2.64$, $p = .11$), suggesting compensation. For participants that were subjected to the appearance focus manipulation, the pattern of means

went into the opposite direction: M&M consumption was higher for participants who had been previously served a high caloric milkshake (M = 39.31 grams, SD = 27.48) than a low caloric milkshake (M = 25.45 grams, SD = 26.66, $F(1, 70) = 3.07$, $p = .08$), suggesting counter-regulation. Means are also provided in Table 3.1.

We also examined the simple effects of the appearance focus condition within each of the caloric content conditions. These showed that the effect of appearance focus manifested itself mainly within the high caloric milkshake condition, such that participants in the appearance focus condition subsequently consumed more M&M's (M = 39.31 grams, SD = 27.48) compared to the control condition (M = 20.19 grams, SD = 15.98, $F(1, 70) = 5.28$, $p < .05$) after consumption of the high caloric milkshake. Within the low caloric milkshake condition there was no effect of appearance focus ($F(1, 70) = 0.94$, *ns*). These findings suggest that appearance focus especially hinders individuals in adjusting food intake after the consumption of a high caloric food.

Table 3.1. Amount of M&M's (grams) consumed as a function of appearance focus and caloric content of milkshake preload.

	Appearance focus	
Caloric content of milkshake	No appearance focus	Appearance focus
Low	34.33 (30.41) N = 21	25.45 (26.66) N = 22
High	20.19 (15.98) N = 16	39.31 (27.48) N = 16

Note. Values reported between parentheses are standard deviations.

Effects of caloric content and appearance focus on feelings of hunger and satiety. No effects were found for the label condition, caloric content condition, the appearance focus condition, or the interaction between these on participants' hunger and satiety feelings shortly after consumption (correcting for baseline feelings of hunger and satiety, all $F(1, 97) < 2.05$, *ns*). Thus, we found no support for the idea that participants in the no appearance condition were better aware of the hunger and satiety feelings produced by the different preloads shortly after consumption.

Perceptions of milkshakes. To check whether liking of the milkshake and perceptions of its caloric content and healthiness could explain our findings, we assessed how the milkshakes were perceived in the different conditions. Milkshakes were generally liked more in the no appearance focus condition ($M = 6.41$, $SD = 2.49$) than in the appearance focus condition ($M = 5.08$, $SD = 2.77$, $F(1, 99) = 7.27$, $p < .01$), especially high caloric milkshakes ($F(1, 99) = 4.76$, $p < .05$). The extent to which participants perceived the milkshake as healthy was affected marginally by the appearance focus condition (no appearance focus condition: $M = 3.21$, $SD = 1.21$, appearance focus condition: $M = 2.78$, $SD = 1.20$, $F(1, 99) = 2.96$, $p = .09$). There were also some differences in perceptions of the milkshakes in the different caloric content conditions and the different label conditions (see Appendix A). However, neither liking, healthiness, nor any of the perceptions affected subsequent consumption or changed our results when corrected for.

Effects of appearance focus on positive and negative affect. To check whether our observed findings could be explained by positive or negative affect, we examined the effect of the mirror on the PANAS scales. No significant effects were found on positive or negative affect ($F(1, 105)$'s < 1.02, *ns*).

Discussion

In line with our hypotheses, the results of Experiment 1 show that when people focus on their appearance by looking into a mirror, the extent to which they compensate for previous consumption is reduced. Participants that focused on appearance subsequently appeared to eat a higher amount of snacks when they had previously consumed a high caloric milkshake, whereas participants under control conditions adjusted their snack consumption to previous caloric intake. The results show that the mirror exposure did not elicit negative affect, and the reduced compensation after mirror exposure can thus not be explained by a negative mood participants might have had when focusing on their appearance.

Even though our predicted significant interaction between caloric content of the preload and appearance focus was found and the underlying effects went into the predicted direction, the underlying effects of caloric content of the preloads in each of the appearance focus conditions were rather small and did not reach significance levels. One possibility is that our manipulation of caloric difference was rather subtle and therefore it may be better to use a more natural situation in which people feel either full or hungry. The subtle difference in caloric content could also explain why individuals in the control condition could not explicitly report a higher awareness of the satiety cues that were produced by the milkshake, even though they did act on this in subsequent consumption. Although our findings could not be explained by different cognitions participants held about the milkshake regarding its caloric content, healthiness or taste, in Experiment 2, we will attempt to rule out that our findings are related to a specific characteristic of the preload.

Therefore, Experiment 2 will assess reliance on hunger and satiety cues in a more naturalistic situation in which people feel either hungry or full as a result of time since previous consumption. Furthermore, in Experiment 2 we wanted to examine whether general appearance related cues that are unrelated to one's own appearance can also lead individuals to focus on their own outward appearance and whether this would produce similar results. Therefore in Experiment 2 magazine advertisements are used that depict models and emphasize the western beauty ideals.

Experiment 2

Previous research has demonstrated that advertisements induce an appearance focus in individuals (Harper & Tiggemann, 2008). In a pilot study we aim to replicate the effect that advertisements depicting the western beauty ideal lead individuals to focus on their own appearance, even when their attention is not explicitly directed towards their own appearance as was the case in Experiment 1. To test this we use the same Body Consciousness scale (Miller et al., 1981) as in the pilot study of Experiment 1, measuring the attention individuals pay to appearance aspects and internal aspects of the body. Furthermore, we also want to examine whether these effects occur regardless of participants' body type and their motivation to change their body type through dieting. Because these advertisements are generally targeted at a female audience, we decided to only focus on women in Experiment 2.

Pilot Study 2

Method

Sixty-four female students were recruited through an email list to participate in an internet survey on advertisements. Nineteen participants were excluded because of having seen the advertisements in previous studies, and one participant was excluded because of taking an extremely long time to complete the survey (more than 3 SD from the mean, indicating the participant may have performed other tasks in between the survey). Fourty-four participants (mean age = 21.2 years) remained in the analyses. Participants were asked to view and evaluate 16 advertisements on attributes such as attractiveness and interest. In the appearance focus condition 10 of 16 advertisements depicted a thin female model and a focus on western beauty ideals in general. In the no appearance condition, the same advertisements were used but were manipulated using photo software so that they did not contain female models. In both conditions, six neutral advertisements without models or referring to beauty were included. After the ad evaluation task, participants proceeded to fill out a series of ostensibly unrelated questionnaires, including the Body Consciousness Questionnaire (Miller et al., 1981). Finally, participants filled out a measure of restrained eating (Van Strien, Frijters, Van Staveren, Defares, & Deurenberg, 1986), reported their weight and length, whether they were currently dieting, and demographics.

As in the pilot study of Experiment 1, the Body Consciousness Questionnaire was slightly modified to assess state body consciousness, and contained five items addressing attention to publically observable parts of the body and five items concerning attention to private internal parts of the body. As in the Pilot Study of Experiment 1, the item concerning 'posture' related

poorly to the other four items of the public body consciousness dimension and was consequently dropped. Internal reliabilities were alpha = .71 for the private and alpha = .86 for the public dimension of the Body Consciousness Questionnaire.

Results and discussion

Target ads with models (appearance focus condition) and without models (no appearance focus condition) were judged to be equally attractive ($F(1, 42) = 0.74$, *ns*) and interesting ($F(1, 42) = 0.03$, *ns*). Results show that the appearance focus condition induced a (marginally) significant focus on public observable parts of the body ($F(1, 42) = 3.39$, $p = .07$) but not on private parts of the body ($F(1, 42) = 0.29$, *ns*). When participants viewed the advertisements with models, they later indicated to be more aware of aspects of their outward appearance ($M = 4.36$, $SD = 1.41$) than when they were shown the same advertisements without models ($M = 3.55$, $SD = 1.49$). Neither BMI, restrained eating status, or dieting status affected awareness of outward appearance, nor did these variables interact with the condition participants were in.

In line with our expectations, the ads were successful in focusing participants on their outside appearance, albeit marginally significantly. This effect appeared regardless of participants' body type or dieting status, suggesting that evaluative processes did not play a role. Moreover, these results show that more implicit environmental cues can elicit in individuals a focus on their outside appearance, even when they are not directly confronted with their own appearance as was the case in Experiment 1. However, contrary to our expectation, but in line with the findings of Experiment 1, the ads did not reduce participants' focus on private body awareness. As in Experiment 1, we expect that it is difficult for participants to self-report on

such body cues within a small time frame. In the main experiment we use the advertisement manipulation to elicit a focus on outside appearance, and test its effect on participants' reliance on hunger and satiety cues.

Experiment 2

Method

Participants and design. Seventy-three female participants were assigned to a condition in a 2 (Satiety condition: Hungry vs. satiated) x 2 (Appearance focus condition: Appearance focus vs. no appearance focus) between-subjects design. Six participants were excluded because of not having had breakfast in the morning, three participants were excluded for not following the experimental instructions, one outlier was identified because snack consumption was above 3 SD above the mean and two participants were excluded because they expressed a strong dislike of savory snacks (defined as a score below 20 on a 100 point scale). Furthermore, two participants expressed suspicion of the true purpose of the study and were therefore also excluded from data analyses. This left a total of 59 participants (mean age = 20.5 years) in the analyses. In this experiment only female students were allowed to participate due to the fact that the advertisements that were used were specifically targeted to women. Participants were recruited via email and via flyers around campus.

Procedure. The study was described as a combined package of studies on the evaluation of advertisements and a taste test. Satiety was manipulated by varying the time at which the experiment was administered. Participants signed up for one of four sessions which took place either before lunch (11:30

or 12:00) or after lunch (13:00 or 13:30). At the time of signing up, participants were not aware that the time of the experimental session had any relation to the purpose of the study. The sessions before lunch comprised the hungry condition and the sessions after lunch comprised the satiety conditions. To make sure participants in the hungry conditions were indeed hungry and participants in the satiety conditions were satiated, participants received instructions one day before participating in the experiment. In an email that reminded participants of the time and location of their participation in the experiment, participants who were in the hungry condition (before lunch sessions) were asked not to eat anything three hours before the experiment, ostensibly because this was important for participation in the taste test. Participants in the satiety condition (after lunch sessions) were asked to have a filling lunch shortly before the start of the experiment, again explained as an important condition for a successful taste test. During the experiment, it was checked whether participants complied with these instructions.

Upon arrival at the lab, participants were seated at individual desks and started with the ad evaluation task. Participants were asked to carefully observe and evaluate ten A4 size, full color ads (the same ads as the target ads in the pretest). To make sure participants devoted their full attention to these ads, it was explained that later in the experiment participants would be asked to recall the advertisement they liked the best. The advertisements in the appearance focus condition were original advertisements for a variety of products such as perfume, water, or mp3 players, which depicted a strong focus on thin female models and western beauty ideals in general. In the no appearance focus condition, the same advertisements were used but were manipulated using photo software so as not to depict any female models. In

line with the cover story, participants evaluated each ad on a number of items such as originality and artistic quality.

After completing the ad evaluation task, participants proceeded to a second, ostensibly unrelated task, which was presented as a taste test. After filling out questions about previous consumption and hunger feelings ("*How hungry do you feel at this moment?*" *1*= not hungry at all, *7* = very hungry), participants were presented with two types of savory snacks. It was explained that participants could taste as many of the snacks as they wished. Participants were required to rate both snacks on a number of items such as 'saltiness', 'crispiness' and intentions to buy the snack. After filling out the taste test, participants proceeded to a filler task, which was set up to further stimulate consumption. Participants were required to read promotional texts about their university and were asked to what extent they could identify themselves with the information that was presented. The experimenter explained that she would just leave the snacks with the participants so that if they felt like having some snacks during this task they could still take some.

Finally, participants filled out whether they were currently on a diet, their weight, length and their age. Also some questions were asked to probe participants for suspicion regarding the true purpose of the study. Finally, participants were thanked and paid. After participants left, the experimenter weighed the bowls of savory snacks to assess how much participants had consumed.

Results

Manipulation check satiety condition. To assess whether the satiety manipulation was successful, hunger ratings of the two satiety conditions were compared. The results show that indeed participants in the hungry

condition indicated to be more hungry (M = 5.29, SD = .98) than participants in the satiety condition (M = 2.40, SD = 1.28; $F(1, 56) = 92.63$, $p < .001$).

Effects of satiety and appearance focus on snack consumption. To examine how satiety and appearance focus affect snack consumption, an ANOVA was carried out. Satiety and appearance focus were entered as independent variables and snack consumption served as the dependent variable. Means and standard deviations are shown in Table 3.2.

The results show no main effects of either the satiety condition or the appearance focus condition on participants' snack consumption. In line with our predictions and the results of Experiment 1, a significant interaction between satiety and appearance focus emerged ($F(1, 55) = 4.25$, $p < .05$). Simple effect analyses were performed to examine this interaction effect more closely. The results reveal that the satiety condition affected the amount of snacks that participants consumed when they had previously viewed neutral advertisements ($F(1, 56) = 3.89$, $p = .054$) but not when they had been exposed to advertisements that focused on outward appearance ($F(1, 56) = 1.03$, *ns*). More specifically, participants that had been exposed to neutral advertisements, consumed a smaller amount of snacks in the satiety condition (M = 17.38 grams, SD = 13.70) than in the hungry condition (M = 30.31 grams, SD = 18.46), while for participants in the appearance focus condition, there was no significant difference in consumption between the hungry (M = 25.38 grams, SD = 13.41) and satiety condition (M = 32.43 grams, SD = 26.04). Also, we examined the simple effects of appearance focus within each of the satiety conditions. These results show that appearance focus has a significant effect on the amount of consumption in the satiety condition ($F(1, 56) = 5.12$, $p < .05$), such that participants having viewed the advertisements that focused on outward appearance consumed more (M = 32.43 grams, SD = 26.04) than

participants who had viewed neutral advertisements (*M* = 17.38 grams, *SD* =13.70). Within the hungry condition, there was no effect of appearance focus condition ($F(1, 56) = .58$, *ns*).

To determine whether it is indeed reliance on hunger and satiety cues that is affected by the appearance focus condition, we also tested our hypothesis using the continuous scale of self-reported hunger feelings instead of the dichotomous hungry and satiety condition. In an OLS regression analysis, the continuous self-reported hunger scale, the appearance focus condition (coded 0 = no appearance focus, 1 = appearance focus) and the interaction between these two, were entered as independent variables, and consumption during the taste test as dependent variable. Confirming our findings above, the results show a significant interaction effect of appearance focus and hunger feelings on consumption ($t(54) = -2.40$, B = -6.39, $p < .05$) such that feelings of hunger had a significant positive effect on consumption in the no appearance focus condition ($t(54) = 2.40$, B = 4.26, $p < .05$), but no effect on later snack consumption in the appearance focus condition ($t(54) = -1.07$, B = -2.13, *ns*).

Effects of BMI and dieting status. The number of participants who reported to be currently dieting was low ($n = 4$). In separate analyses it was also checked whether the BMI of participants affected our findings. Taking BMI as a covariate did not affect food consumption, nor did it change our reported findings. BMI also did not interact with the self-objectification condition, the satiety condition or both, in affecting food intake.

Table 3.2. Amount of snack food (grams) consumed as a function of appearance focus and satiety condition.

Satiety condition	Appearance focus condition	
	No appearance focus	Appearance focus
Hungry	30.31 (18.46) *N* =16	25.38 (13.41) *N* = 13
Satiety	17.38 (13.70) *N* = 16	32.43 (26.04) *N* = 14

Note. Values reported between parentheses are standard deviations.

Discussion

In line with the findings of Experiment 1, the results of Experiment 2 show that exposure to Western beauty ideals interferes with individuals' reliance on internal hunger and satiety cues in deciding how much to eat. That is, individuals who were exposed to advertisements featuring models, did not adjust their subsequent food intake according to whether they previously had lunch or not, whereas individuals who saw neutral advertisements did adjust their food intake. As in Experiment 1, a focus on appearance particularly refrained individuals from eating less when satiated, indicating that focusing on appearance may particularly impair individuals' reliance on satiety feelings.

In Experiment 2, participants in the appearance focus condition ate the same amount regardless of whether they recently had lunch, whereas in Experiment 1 participants in the appearance focus condition even seemed to counter-regulate for previous consumption. Care should be taken in interpreting the counter-regulation findings of Experiment 1 and future

studies are needed to replicate these findings, as the underlying effects were small and only marginally significant. We argue that the same process of attention shifting away from internal hunger and satiety cues underlies our findings of compensation failure in both Experiment 1 and Experiment 2. However, it would be useful for future studies to further delineate the circumstances under which either counter-regulation or non-compensation is more likely to occur and further establish differences and similarities between these cases of failures to compensate.

In Experiment 2 different operationalizations of both appearance focus and reliance on hunger and satiety cues were used. This shows that the effects we found in Experiment 1 are not restricted to situations where individuals' attention is explicitly directed towards their own appearance, as is the case with a mirror. Rather, more common and subtle cues such as advertisements depicting the western beauty ideal, also shift people's attention to their outward appearance and have a similar effect on their reliance on hunger and satiety cues. Another difference with Experiment 1 is that instead of examining compensation after preloads differing in caloric contents, in Experiment 2 we assessed reliance on hunger and satiety cues as a result of time since previous consumption. This might reflect a more natural way of how people balance consumption over time.

General Discussion

Food consumption and body appearance are intrinsically linked: What and how much one eats in the long run affects how one looks. Regularly focusing on how one looks may thus seem like a good strategy to monitor and regulate the potential harmful consequences of food consumption on body appearance. In two studies we demonstrate that the effect may be just the opposite:

Individuals who are led to focus on their appearance through cues such as mirrors or model advertisements, do not rely on internal hunger and satiety cues in subsequent consumption (Experiment 2) and do not compensate for the consumption of a (covertly disguised) high caloric milkshake (Experiment 1).

Our findings corroborate previous findings from diverse research areas as self-objectification and neuroscience, that have suggested that attention devoted to appearance aspects comes at the cost of attention to internal aspects of the body (Eshkevari et al., 2012; Fredrickson et al., 1998; Tylka, 2006; Miller et al., 1981; Mussap & Salton, 2006; Tsakiris et al., 2011). The negative relationship between focusing on appearance and awareness of internal cues was one of the central predictions in the original formulation of self-objectification theory (Fredrickson & Roberts, 1997). However, to our knowledge this is the first study testing this relationship assessing actual behavior in an experimental design, rather than by self-report measures and correlations (Daubenmier, 2005; Myers & Crowther, 2008), and examining hunger and satiety cues specifically.

Our study extends previous studies that have examined the effects of focusing on outward appearance mostly in the context of how idealized images in the media cause people to compare their appearance with them (Richins, 1991) often leading to dissatisfaction with their own appearance (Grabe, Ward, & Hyde, 2008), especially for individuals who have pre-existing body image concerns (Groesz, Levine, & Murnen, 2002; Posavac, Posavac, & Posavac, 1998). We argue that our findings reflect a basic process of shifting attention towards appearance aspects of the body, rather than being driven by a body dissatisfaction process. Although we cannot completely rule out the possibility that evaluative thoughts about one's appearance did play a role, our findings show that we enhanced the attention towards outward

appearance without affecting worrying or concern of others' evaluation (Experiment 1) and that mirrors or model advertisements can shift individuals' attention to outward appearance and affect reliance on hunger and satiety cues, irrespective of weight concerns. Taken together, these findings suggest that cues such as mirrors and model advertisements can trigger more generally in individuals a basic process of shifting attention towards appearance aspects of the body, irrespective of body evaluation processes or pre-existing body image concerns. This idea is also in line with recent studies within the self-objectification literature, demonstrating that merely focusing on appearance can have similar consequences as traditional self-objectification manipulations that have focused more on the sexualization of appearance (Heflick & Goldenberg, 2009; Heflick, Goldenberg, Cooper, & Puvia, 2011).

The current study further contributes to the stream of literature on how cues in the food environment impact food consumption (cf. Wansink, 2004) in that we have examined how environmental cues can impact reliance on hunger and satiety cues (i.e. compensation) rather than affect absolute amounts of food intake. Reliance on hunger and satiety cues involves compensation for previous food intake across multiple consumption episodes and indicates whether people are able to balance consumption over time. The extent to which a person relies on hunger and satiety cues in food consumption has been related to a lower BMI (Kral et al., 2012; Tylka, 2006), healthier eating patterns (Cornier et al. 2004; Drapeau et al., 2005) and is therefore regularly referred to as a healthy alternative to more cognitive strategies of dieting (Avalos & Tylka, 2006; Bacon, Stern, Van Loan, & Keim, 2005). Given the role of reliance on internal hunger and satiety cues in a healthy eating pattern, insight into when people can and cannot regulate their eating through relying on internal hunger and satiety cues is essential. Our

findings further detail the type of contexts in which individuals are particularly likely to experience difficulties in regulating food intake, namely contexts where appearance aspects of the body are salient.

The failure to compensate for previous consumption or counter-regulation, eating even more rather than less after prior consumption, have previously been associated only with restrained eaters (Herman & Mack, 1975). The fact that restrained eaters overeat after a preload has been explained in terms of a 'what the hell effect': Consuming a caloric preload makes restrained eaters feel that they have broken their diet and therefore abandon it altogether (Polivy & Herman, 1985). Alternatively, it has also been argued that merely the exposure to a palatable food triggers in restrained eaters hedonic thoughts about enjoying food and at the same time suppresses their diet goals, which could result in overeating (Papies, Stroebe, & Aarts, 2007; Stroebe, Mensink, Aarts, Schut, & Kruglanski, 2008). The current study suggests that failure to compensate is not confined to restrained eaters, but rather that anyone can be led to abandon regulation through hunger and satiety cues. We propose that rather than a 'what the hell effect' or cognitive concerns around dieting, simply the process of shifting attention away from hunger and satiety cues is underlying our findings. In our second experiment, we examined consumption after participants did or did not have lunch, something which is unlikely to have triggered cognitions of breaking a diet. In our first experiment a similar volume of (what appeared to be) the same milkshake was served in both conditions, such that cognitions about breaking a diet should be equal across the conditions. What is more, the milkshakes were labeled as either caloric or not (independent of the content). If focusing on appearance would lead to counter-regulation through cognitions of calorie counting, we would expect that appearance focus would affect the impact of the label of the milkshake, rather than the impact of the (covert) content of the

milkshake.

Across two experiments, we have consistently demonstrated the effects of cues such as mirrors and model advertisements on reliance on internal hunger and satiety cues, and we have been able to rule out rival explanations such as negative affect or more general self-awareness. However, we have not been able to fully unravel the question of how exactly a focus on appearance reduces consumers' capacity to rely on physiological cues in eating behavior. In our view, reliance on internal hunger and satiety cues in food consumption entails two processes: becoming aware of the internal satiety cues that develop after food consumption and responding to them by adjusting subsequent food consumption. Based on previous research, we expected that cues such as mirrors and model advertisements, would reduce the awareness of internal body cues, but we found no evidence for this in our pilot studies. Also, in Experiment 1, participants in the control condition did not show enhanced awareness of internal hunger and satiety cues, even though they compensated according to the (covertly disguised) caloric content of the preload. One possibility is that our measures for the awareness of internal body cues were insufficiently sensitive, or that the extent to which individuals can consciously self report on this is limited. Another possibility is that our appearance focus manipulations did not affect the awareness of internal hunger and satiety cues, but rather the extent to which individuals respond or act on these cues. A similar mechanism has been proposed by some to explain the eating behavior of individuals with an eating disorder, arguing that these individuals sense internal hunger and satiety cues but actively repress them (Vitousek, Daly, & Heiser, 1991). In future studies it would be interesting to further unravel how exactly a focus on appearance aspects of the body affects reliance on internal hunger and satiety cues in food consumption.

Our findings have several practical implications, the most important message being that a preoccupation with how one looks seems to undermine rather than help achieving a healthy eating pattern. Being focused on what one is eating and how the inner body feels rather than focusing on how one looks may be more productive. However, commercials and other media often emphasize an appearance perspective, and even health magazines often frame their health messages in terms of its effects on appearance (Aubrey, 2010). The co-occurrence of an appearance focus in settings that are related to eating may make it hard for consumers to uncouple how one looks from food consumption. Cultural beauty ideals of thinness that are conveyed in diverse media outlets may trigger an appearance focus in people and affect consumption in contexts where eating is likely, such as during TV commercials, in shopping malls, or in cinemas.

Appendix A.

Significant differences between ratings of types of milkshakes (content) in Experiment 1

	Type of milkshake preload		
Attribute rating	Low caloric	High caloric	Statistics
Liking	5.03 (2.78)	6.40 (2.48)	$F(1, 107) = 8.33$**
Creamy	6.20 (2.24)	7.48 (2.02)	$F(1, 107) = 9.33$**
Caloric	6.04 (1.77)	6.69 (2.31)	$F(1, 107) = 3.06$+

Note. Values reported between parentheses are standard deviations. ** $p < .01$, + $p = .08$

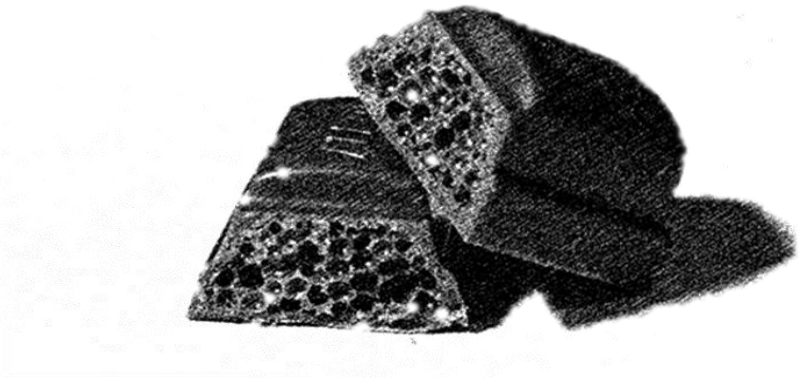
Significant differences between ratings of different labels of milkshakes in Experiment 1

	Type of label		
Attribute rating	Light	High fat	Statistics
Caloric	5.65 (1.93)	7.02 (2.00)	$F(1, 107) = 12.48$**
Healthy	3.31 (1.46)	2.54 (.96)	$F(1, 107) = 4.45$*
Satiating	6.57 (2.23)	7.33 (1.88)	$F(1, 107) = 3.87$+

Note. Values reported between parentheses are standard deviations. * $p < .05$, ** $p < .001$, + $p = .05$

Chapter 4

Body and Mind: How Mindfulness Enhances Consumers' Responsiveness to Physiological Cues in Food Consumption



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Abstract

External cues regularly override physiological cues in food consumption resulting in *mindless eating.* This study shows that *mindfulness*, an enhanced attention state, improves consumers' reliance on physiological cues. Consumers who are chronically high in mindfulness (Experiment 1) or who have received a short mindfulness training that focuses attention on the body (Experiment 2) compensate more for previous food intake in their subsequent consumption. After a mindful body meditation consumers are not affected by cues that indicate the amount or number of calories they have previously eaten (Experiment 4 and Experiment 5), rather they are more aware of the satiety cues that develop after consumption (Experiment 3). The current study shows that the focus of mindfulness matters: mindfulness trainings that focus attention on the environment or on the body similarly elicit state mindfulness, but only mindful attention with a focus on the body stimulates compensation for previous consumption and awareness of satiety cues. Finally, practicing mindfulness and specifically paying mindful attention to body sensations was related to a lower and more constant body weight across a student sample and a sample of the general population (Study 6a and Study 6b).

The human body is equipped with a complex homeostatic feedback system to regulate food intake. However, the number of people in Western societies that face weight problems suggests that this physiological system is often unsuccessful at maintaining a constant body weight. External cues in the eating environment regularly override physiological hunger and satiety cues. For example, consumers eat more when served bigger portions (Wansink & Park, 2001), when others eat more (Hetherington, Anderson, Norton, & Newton, 2006), and when food products have low-fat labels (Wansink & Chandon, 2006). These findings have led scholars to characterize food consumption as *mindless eating* and to conclude that paying attention to physiological cues of hunger and satiety is easily offset by cues in the environment (cf. Herman & Polivy, 2005; Wansink, 2010). Yet, whereas it is well known that consumers often fail to attend to physiological cues in their eating behavior, it is not known whether potential solutions exist to help consumers to be more attentive to these physiological cues. If *mindlessness* is related to consumers paying little attention to internal hunger and satiety cues, could *mindfulness* lead them to rely more on these internal physiological cues?

In the current study we propose that mindfulness indeed increases consumers' responsiveness to physiological cues and helps them to compensate for prior food intake. Mindfulness is defined as a state of "enhanced attention to and awareness of current experience or present reality" (Brown & Ryan, 2003, p. 822). Mindfulness can be trained and such trainings are offered at numerous centers worldwide, even the US army and police provide trainings in mindfulness to their employees (Center for Mindfulness and Justice, 2011; U.S. army, 2010). Mindfulness has been associated with various beneficial psychological health outcomes, but these findings are mostly based on clinical contexts and longer term intervention

studies (for an overview see Brown, Ryan, & Creswell, 2007). Even though recently some studies have been conducted within non-clinical samples, for example illustrating how mindfulness can aid organizational decision making (Fiol & O'Connor, 2003), mindfulness has received hardly any empirical attention within the consumer behaviour literature (Dong & Brunel, 2006). Based on mindfulness' ability to foster an enhanced state of attention (Jha, Krompunger, & Baime, 2007), we argue that mindfulness is beneficial for consumers in the eating context and in particular for improving responsiveness to internal hunger and satiety cues. We propose that even a short exposure to a mindfulness training can lead consumers to rely more on hunger and satiety cues through an enhanced access to these cues, and that this is not limited to clinical samples or individuals who are trying to lose weight, but that this is the case for consumers in general.

Furthermore, the current study distinguishes between different foci of mindful attention. In mindfulness research, a state of mindfulness has been manipulated in different ways, through different objects that attention is focused on. Also, trainings of mindfulness vary considerably in how they teach individuals to reach a state of mindfulness, through focusing attention on bodily sensations, stimuli in the environment or on both simultaneously (Bishop et al., 2004). As previous research has not distinguished between different foci of mindfulness, it is not clear whether observed effects should be attributed to a general mindfulness effect or whether the effects depend on the specific focus of the mindfulness training. We argue and show that, not mindful attention per se, but mindful attention to aspects of the body fosters responsiveness to hunger and satiety cues.

Internal hunger and satiety cues not only have the potential to affect within-meal consumption by signalling when to stop eating but also, and perhaps more importantly, can influence subsequent consumption by

signalling how much to eat at a later point in time. Responsiveness to these cues indicates how well consumers compensate for previous consumption. Compensating for previous food intake does not necessarily mean consuming less, but rather regulating food intake in such a way that previous consumption is taken into account. This is important because incidental overconsumption may not be harmful when consumers are able to compensate for this later. Compensating across meals could help consumers in attaining a constant energy intake and as a result maintain a healthy body weight. The current study shows that mindfulness facilitates the awareness of hunger and satiety cues, and enables consumers to compensate for previous food intake, both for mindfulness as a trait and for state induced mindfulness. It demonstrates that a short training of mindfulness is powerful enough to affect consumers' compensation for previous consumption and that chronically attending mindful attention to the body aids consumers in maintaining a healthy weight.

Internal Physiological Cues in Food Consumption

Recent consumer behavior research has compellingly shown that external cues can easily increase consumption (Coelho do Vale, Pieters, & Zeelenberg, 2008; Geyskens, de Witte, Pandelaere, & Warlop, 2008; Wansink, 2004). The accumulation of these findings has tended general thinking in this area to conclude that external cues are dominant in food consumption and that physiological hunger and satiety cues play only a minor role, except in more extreme cases of hunger or satiety (e.g., Herman & Polivy, 2005). However, these studies have examined consumption within a single meal whereas feedback loops involving hunger and satiety cues have a time delay. The extent to which consumers respond to hunger and satiety cues is therefore better

indexed by how well they compensate across consumption episodes, that is, how well they adjust food intake to previous consumption in order to maintain a constant energy intake. Indeed when looking across consumption episodes, physiologically based studies have shown that people compensate for previous consumption, indicating that satiety cues do affect consumption, albeit with substantial interindividual variance and with substantial differences in accuracy of compensation (Foltin, Fischman, Moran, Rolls, & Kelly, 1990; Rolls et al., 1991; Zandstra, Mathey, de Graaf, & van Staveren, 2000).

The extent to which individuals are able to respond to hunger and satiety cues has been identified as a critical determinant of their susceptibility to gain weight (Blundell et al., 2005; Cornier, Grunwald, Johnson, & Bessesen, 2004). To illustrate, Blundell et al. (2005) compared obese and normal weight individuals who regularly consume high fat meals. The obese group reported lower reductions in hunger after eating these high fat meals and also ate more snacks later in the evening, compared to the normal weight group. In general as well, overweight individuals have been found to be less likely to rely on feelings of fullness to end a meal than normal weight individuals (Wansink, Payne, & Chandon, 2007). Relying on internal cues and compensating for previous food compensation works in two directions; eating less when satiated, but also eating more when hungry. In the face of society's collective battle against overweight, a focus on how to respond to satiety cues may seem more advantageous than being able to respond to hunger cues. Yet, it has been suggested that ignoring hunger cues interferes with an effective energy regulation altogether (Herman & Polivy, 1980). In line with this, several studies have underlined the importance of giving children autonomy over how much they wish to eat, as children who are restricted in their food intake by their mothers, are less able to self-regulate energy intake (Johnson & Birch,

1994). However, whereas physiologically based studies have underlined the importance of responding to hunger and satiety cues, little is known on the psychological conditions under which consumers are better able to respond to physiological cues or the psychological traits that characterize "compensators" and "non-compensators" (e.g., Jebb et al., 2006). Two lines of research, on distraction and restrained eating, provide initial support that psychological states and traits can indeed affect how well consumers respond to physiological cues.

One state that can make individuals unsuccessful at compensating for previous consumption, is a state of distraction. Distraction during a meal can increase consumption within that meal (Bellisle, Dalix, & Slama, 2004), as well as consumption later during the day. For example, consumers who watch television or play computer games during a meal eat more snacks later on than non-distracted consumers (Higgs & Woodward, 2009; Mittal, Stevenson, Oaten, & Miller, 2011; Oldham-Cooper, Hardman, Nicoll, Rogers, & Brunstrom, 2011). These findings are mostly attributed to a reduced ability to remember previous consumption but could also indicate a lowered responsiveness to satiety cues. For example, distracted consumers are less able to compensate for the caloric content of a previously consumed drink that has been covertly manipulated to contain either few or a lot of calories (Bellissimo et al., 2007), suggesting that attention appears to play an important role in responsiveness to hunger and satiety cues.

Individuals may also chronically be more or less responsive to hunger and satiety cues. A personality trait that has frequently been associated with a failure to compensate is restrained eating, a form of constant but often unsuccessful dieting (Herman & Mack, 1975; Scott, Nowlis, Mandel, & Morales, 2008). Restrained eaters generally eat more rather than less after a prior consumption (Herman & Mack, 1975). In contrast, individuals who engage in

regular exercise are better at compensating for previous consumption, eating less after previously consuming a milkshake with a disguised high compared to low caloric content (Long, Hart, & Morgan, 2002). Whereas the precise mechanisms underlying restrained eaters' poor and exercisers' superior compensation for previous consumption are unclear, it is striking that these individual difference variables are related to different amounts of attention that these consumers pay to bodily cues. Restrained eaters, in order to keep with their dieting goal, actively try to ignore hunger cues. As mentioned previously, continuously overriding these cues makes restrained eaters less sensitive to hunger and satiety cues and body cues in general (Herman & Polivy, 1980). Indeed several types of disordered eating behavior have been shown to be related to paying little attention to the body (Spoor, Bekker, van Heck, Croon, & van Strien, 2005). In contrast, exercisers benefit from paying attention to internal body cues as this increases their performance (Masters & Ogles, 1998). During physical exercise, attention has been found to switch to internal body sensations, in particular during more vigorous exercise (Hutchinson & Tenenbaum, 2007). It is plausible then that for individuals who engage in regular exercise body cues are more often accessible.

Even though various lifestyle differences may account for differences in compensatory behavior of restrained eaters and exercisers, these findings indicate that not only attention per se, but paying attention to body sensations in particular could possibly help consumers to respond better to hunger and satiety cues, through an enhanced awareness of these cues. The area of mindfulness is concerned with both: Reaching a state of enhanced attention, often through focusing attention on the body.

Mindfulness

Mindfulness is conceptualized as an enhanced attention to and open non-judgemental awareness of what is going on at the present moment (Brown & Ryan, 2003) and is often described as a feeling of being fully present in the here and now. It has its roots in Buddhist traditions and it is most often trained through meditation practices. Mindfulness is also considered to vary among individuals naturally, irrespective of any form of training (Brown & Ryan, 2003). Mindfulness is conceptualized to consist of two core components: Mindfulness has been found to elicit a state of focused present-centered attention and is characterized by an open, non-judgemental stance towards thoughts or sensations that come into attention (Bishop et al., 2004). Mindfulness is distinct from constructs such as self-awareness and self-reflection in that mindfulness concerns the quality of perceptions, whereas self-awareness constructs center around self-knowledge and reflection. Measures of mindfulness have indeed been found to be unrelated to measures of self-awareness (Brown & Ryan, 2003).

Mindfulness has mostly been studied within clinical contexts where mindfulness trainings have been proven effective in treating various symptoms of anxiety disorders, pain and depression (for an overview see Brown et al., 2007). The exact mechanism through which mindfulness leads to this wide range of outcomes is still subject of debate. While a state of focused attention has in itself been related to higher psychological well-being (Brown & Ryan, 2003), within clinical contexts particularly the non-judgemental appraisal of - often painful - thoughts, may be relevant in explaining mindfulness‘ effects.

Mindfulness-based interventions for individuals with eating disorders or individuals who are trying to lose weight, have also focused particularly on

training this non-judgmental aspect of mindfulness, by attempting to affect individuals' attitudes towards the thoughts that they have about food. In support, mindfulness trainings have been found to lead to fewer intrusive thoughts about food (May, Andrade, Batey, Berry, & Kavanagh, 2010) and less cravings for food (Alberts, Mulkens, Smeets, & Thewissen, 2010). The current study proposes that the other aspect of mindfulness; its ability to foster a mental state of focused attention, is relevant for eating behavior and compensation in particular. This should not be limited to a clinical context or individuals who are trying to lose weight.

Recently, mindfulness has attracted considerable research interest outside clinical psychology. In line with mindfulness' claim, mindfulness training has indeed been found to lead to a more focused attention (Jha et al., 2007; Wenk-Sormaz, 2005). For example, Wenk-Sormaz (2005) showed that a brief exposure to a mindfulness training led to less interference in a Stroop task. Another aspect of attention, the duration with which individuals can sustain attention, was also found to be improved by mindfulness meditation (Valentine & Sweet, 1999). Finally, mindfulness has been related to an improved working memory (Jha, Stanley, Kiyonaga, Wong, & Gelfand, 2010). Additional evidence for the relationship between mindfulness and improved attention performance comes from neurological studies that showed that during meditative states, brain areas that are involved in attention processes are activated (Holzel et al., 2011). Besides effects on general attention performance, several studies suggest that mindfulness meditation is related to the activation of brain areas involved in the awareness of body sensations (Holzel et al., 2011).

Whereas reaching a focused state of attention is the overarching goal of all mindfulness trainings, these trainings vary considerably in how they attempt to achieve this. Some mindfulness trainings emphasize paying

attention to bodily sensations. For example, popular mindfulness meditation practices, such as the body scan and sitting meditation, guide individuals' attention specifically along different parts of the body and train them to focus attention on their breathing (Kabat-Zinn, 1990). The focus in these mindfulness trainings is specifically on internal body sensations, rather than on external aspects of body appearance, setting mindfulness apart from constructs such as self-consciousness (Lau-Gesk & Drolet, 2008), self-monitoring (Snyder & Gangestad, 1986), and self-objectification (Breines, Crocker, & Garcia, 2008). Other mindfulness trainings emphasize focusing on external objects in the environment or on both internal and external sensations at the same time (Bishop et al., 2004). It is not clear whether these different foci of attention are equally successful in reaching a focused state of attention. Furthermore, if this is the case, it has yet to be determined whether it is a general mindfulness effect that causes the range of observed beneficial outcomes, or whether the focus of mindful attention needs to be aligned with the desired outcome. This parallels a question in the research on responsiveness to hunger and satiety cues where both attention in general as well as attention to the body seem to play a role. In the current study we therefore not only examine whether mindfulness can improve responsiveness to internal cues in food consumption but also whether the object of mindful attention matters. Can mindful attention per se increase responsiveness to hunger and satiety cues, or does it matter where this attention is directed? In the current study we aim to answer this question by examining how mindfulness with different foci of attention impact consumers' compensation behavior and consumers' body weight in the long run.

Overview of experiments

Six studies examine how mindfulness affects individuals' compensation for previous food consumption, the awareness of hunger and satiety cues, and in the long run, individuals' body weight. Experiment 1 assesses whether chronic mindfulness, as a personality trait, leads to better compensation for the (covertly manipulated) caloric content of a milkshake. In Experiment 2 we examine the effects of state mindfulness elicited through short audio fragments of mindfulness meditations. In a pretest we assess whether mindfulness meditations which focus attention on either the body or the environment can similarly elicit state mindfulness, but with a different focus of attention. In Experiment 2 we then examine whether and which of these mindfulness meditations stimulates compensation for prior food consumption. In the experiments that follow we zoom in on the process of compensation: Experiment 3 tests the hypothesis that mindfulness acts on the accessibility of internal hunger and satiety cues, and Experiment 4 and 5 examine how consumers react to external cues in food consumption after a mindfulness manipulation. More specifically, Experiment 4 and 5 examine two alternative routes that could lead to enhanced compensation after mindfulness: an enhanced recall of previous consumption and enhanced sensitivity to health cues. Finally, in Study 6a and 6b we test the longer term effects of chronic mindfulness, as a personality trait and through mindfulness practice, on body weight and fluctuations in body weight, in both a student sample (Study 6a) and a sample of the general population (Study 6b).

Experiment 1

Method

Participants and design. Thirty-nine undergraduate students (14 men and 25 women, mean age = 20.7 years) were recruited at the beginning of three different lectures on campus. Participants first consumed a milkshake in the break of the lecture (the preload) and were served M&M's immediately after the lecture. Caloric content of the preload (high vs. low) was varied between subjects and trait mindfulness was assessed as a continuous factor. Participants received four Euros for participation.

Procedure and measures. All sessions took place in the afternoon between 2.15 pm and 4 pm to minimize baseline differences in hunger feelings. Participants were also asked to indicate hunger feelings (*1* = not at all hungry, *7* = very hungry). In the 15 minute break of the lecture participants took part in what was described as a taste test. They were served a 300 ml milkshake and asked to finish it completely. Unbeknown to them the milkshake was either high caloric (534 kilocalories) or low caloric (215 kilocalories) (cf. Long et al., 2002). Both milkshakes contained equal amounts of skimmed yoghurt, vanilla flavor and sugar. Also, both versions contained skimmed milk but in the high caloric milkshake part of the skimmed milk was replaced by full fat cream. Participants were asked to indicate on 7-point scales how much they liked the milkshake and the extent to which they thought it was healthy. Sensory properties (sweetness, caloric content, creaminess, ability to satiate) were rated on 10 cm visual analogue scales (anchored *'not at all'* on the left end, *'extremely'* at the right end). The MAAS scale (Brown & Ryan, 2003) was administered to assess trait mindfulness. This 15-item scale includes items

such as: "*I find it difficult to stay focused on what's happening in the present"* (α = .78). Participants indicated the frequency with which they encounter these experiences (*1* = almost always, *6* = almost never).

The second part of the experiment took place 45 minutes later at the end of the lecture, such that satiation of the milkshake could set in. Participants were seated behind individual computers and watched video fragments about studying at different universities. A bowl containing 200 grams of M&M's (515 kcal per 100 gram) stood next to each computer, ostensibly to match a home situation. Participants were free to take as many M&M's as they liked. The video fragments lasted 15 minutes, after which participants evaluated the fragments on several dimensions. Finally, they reported demographics and were probed for suspicion. At the end of the experiment participants were paid and debriefed. After participants had left, the experimenter weighed each bowl of M&M's to assess consumption amount.

Results and discussion

Baseline hunger. As expected, the two caloric content conditions did not differ in baseline hunger feelings at the outset of the study ($F(1, 37) = .002$, *ns*).

M&M consumption. To examine the joint effects of caloric content and dispositional mindfulness on the amount of M&M's that participants consumed, an OLS regression analysis was conducted. The caloric content of the preload milkshake (coded -1 = low caloric and 1 = high caloric), the score on the MAAS (centered around its mean) and the interaction between these two variables were entered as independent variables into the regression analysis. The gender of participant (-1 = male, 1 = female) was taken up as a

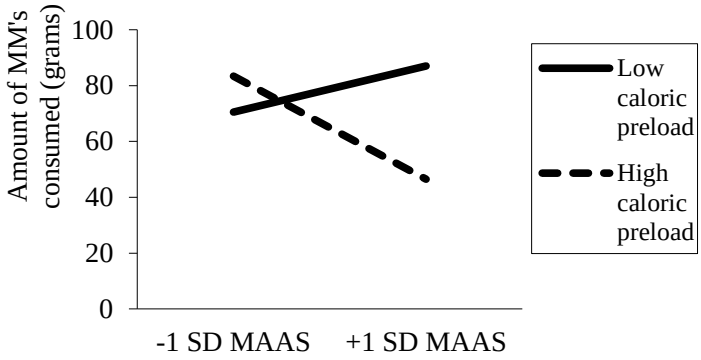
covariate to account for possible gender differences in consumption amounts. The amount of M&M's (in grams) that was consumed by participants served as the dependent variable.

The results show a main effect of gender on the amount of M&M's (in grams) that was consumed: Men consumed more M&M's than women (M = 100.86 grams vs. M = 44.76 grams, $t(34) = -4.29$, $\beta = -0.60$, $p < .01$). A separate analysis tested whether the interaction of gender with any of the other independent variables affected M&M consumption. This was not the case and these interaction terms were therefore not included in the final analysis. No main effects were found for either caloric content of preload ($t(34) = -1.00$, *ns*) or dispositional mindfulness ($t(34) = -0.69$, *ns*). More importantly, and in line with our predictions, the interaction between caloric content of the milkshake and dispositional mindfulness was a marginally significant predictor of the consumption amount ($t(34) = -1.85$, $\beta = -.38$, $p = .07$).

To examine this interaction in more detail, follow-up spotlight analyses were conducted. The results show that for high mindful participants (1 SD above the mean) the caloric content of the preload had an effect on the amount of M&M's they consumed later on ($t(34) = -2.13$, $\beta = -.40$, $p < .05$). More specifically, high mindful participants ate fewer M&M's when they had previously consumed a high caloric milkshake (M = 46.5 grams) than when they had previously consumed a low caloric milkshake (M = 87.1 grams, see figure 4.1). For low mindful participants (1 SD below the mean), the effect of the caloric content of the milkshake on M&M consumption was not significant ($t(34) = 0.62$, *ns*). Additional analyses examining consumption amounts of M&M's within each of the preload conditions, showed that the regression line of dispositional mindfulness was marginally significant and negative within the high caloric content condition, indicating that for participants who had been served a high caloric preload, a higher dispositional mindfulness was

related to a marginally significant lower M&M consumption ($t(34) = -1.87$, $\beta = -.36$, $p = .08$). Within the low caloric preload, dispositional mindfulness was not significantly related to M&M consumption ($t(34) = 0.77$, *ns*).

Figure 4.1. M&M consumption as a function of trait mindfulness (score on MAAS) and caloric content of preload.



Ratings of low and high caloric milkshakes. The low and high caloric milkshakes did not differ in the extent to which participants liked the milkshakes ($F(1, 36) = 2.46$, *ns*) but were rated differently on a number of sensory properties (see Appendix A). These ratings did not influence M&M consumption, nor did correcting for these ratings change the pattern of results. The perceived caloric content of the milkshakes, but none of the other ratings, was influenced by dispositional mindfulness and this effect was qualified by an interaction with the actual caloric content of the milkshakes ($t(34) = 2.87$, $\beta = .32$, $p < .01$). Participants high in dispositional mindfulness (1 SD above the mean) rated the high caloric milkshake as higher in calories than the low caloric milkshake ($M = 7.92$ vs. $M = 5.1$, $t(34) = 4.54$, $\beta = .70$, $p <$

.001) whereas this effect was not significant for participants low in mindfulness (1 SD below the mean; $t(34) = .16$, *ns*). Based on this, the reported interaction effect of caloric content of preload and dispositional mindfulness could possibly be mediated by the perceived caloric content of the preload. To test this explanation, we followed the procedures for assessing mediated moderation (Muller, Judd, & Yzerbyt, 2005). Results showed that, as perceived caloric content did not have a significant effect on M&M consumption ($t(36) = -1.14$, *ns*) (controlling for gender), mediated moderation could not be established. Thus, even though a higher dispositional mindfulness led participants to better perceive the caloric content of what they were consuming, this was not driving their enhanced compensation behavior and we thus found no support for this explanation.

Discussion. These findings show that high mindful individuals adjust their consumption to the caloric content of what they have previously eaten. This supports our prediction that mindfulness, as a trait, is related to a higher responsiveness to physiological cues. Low mindful individuals, even though they do not consume more calories overall, are more affected in their overall intake by the calories they were served in the preload, because they fail to compensate. This suggests that through their higher responsiveness to physiological cues, high mindful individuals are more resistant to the negative effects of high caloric foods.

Experiment 2

The goal of Experiment 2 is to assess whether short audio fragments of mindfulness meditations can also lead consumers to compensate better for previous consumption. We distinguish between two kinds of mindfulness

instructions – instructions that focus attention on the body and instructions that focus attention on the environment – and in a pretest we first assess whether these elicit similar levels of state mindfulness, but different foci of attention. This allows us to distinguish between the effects of a state of mindful attention in general and the focus of mindful attention on compensation behavior.

Pretest

Method

Participants and design. Sixty-six undergraduate students (53 women, 12 men, 1 unknown, mean age = 20.8 years) were recruited around campus. Participants were randomly assigned to one of three mindfulness instructions conditions (Attention to body vs. Attention to environment vs. Control condition) in a between-subjects design. Participants were given a snack product as a token of appreciation for their participation.

Procedure and measures. Upon arrival to the lab, participants were seated individually in cubicles. They were asked to evaluate an audio fragment, which was in fact the mindfulness manipulation, and to carry out the instructions as closely as possible (in the control condition: to listen as carefully as possible). Participants were seated on adjustable chairs and were asked to make sure their upper and lower legs made an angle of 90 degrees. Depending on the condition participants were in, they listened to an audio fragment on an individual mp3 player that consisted of instructions to focus attention on the body, to focus attention on the environment around them, or in the control condition they listened to a recorded short essay. In line with the coverstory,

participants evaluated the audio fragments on 7-point scales (*1* = not at all, *7* = very much) in terms of how much they liked the fragments, it caught their interest, the difficulty of the instructions and the length and pace of the fragments. Participants then filled out measures of state mindfulness and measures of whether they paid attention to their body and surroundings. State mindfulness was assessed by a state version of the MAAS scale (Brown & Ryan, 2003) which consisted of five items that assessed how mindful individuals were just before filling out the items (e.g., "*I was preoccupied with the past or the future", 1 =* not at all, *7*= very much). Awareness of body (e.g., "*I was aware of tensions in my body"*, α = .84) and awareness of environment (e.g., "*I noticed I paid a lot of attention to details in my surroundings",* α = .80) were assessed by four and five items respectively on the same 7-point scale. Finally, participants provided demographic information.

Mindfulness instructions. The audio fragments (all around four minutes) were prepared in close cooperation with an experienced and practicing yoga teacher, who read out the instructions for all three conditions. The attention to the body condition combined aspects of often used mindfulness exercises such as sitting meditation and the body scan (Kabat-Zinn, 1990). Participants were instructed to close their eyes and to put their hands on their upper legs. Their attention was slowly guided along different parts of their body starting with the toes and ending at the head. Throughout participants were also made aware of their breathing. To become aware of the different parts of their body, participants were instructed to focus attention on specific parts (e.g., "*…..Bring your attention to the spine…Become aware of your tailbone, in your thoughts go vertebra by vertebra upwards along your spine…*") and to perform several simple exercises (e.g., "*… While you inhale, lift your toes up from the floor and while exhaling, put them back again*"). In the attention to the environment

condition, participants were also instructed to put their hands on their upper legs. Their attention was slowly guided along different objects in their surroundings in a structured way, such as the chair they were sitting on, the objects on the table, ending with the partitioning between them and the next cubicle. Participants were instructed to become fully aware of objects in the surroundings and to focus their attention on specific details of these objects (e.g., "*Focus your attention on the structure of the wood, on the color...*"). To help participants focus their attention on aspects of the surroundings, they were also asked to perform certain exercises (e.g., "*Focus your attention on one stone of the wall, go up stone by stone*"... "*When you have reached the ceiling, go one stone to the right and go down again, stone by stone*"*)*. In the control condition, participants listened to a short essay on tourism that had been recorded by the yoga instructor for the purpose of the current study. The essay is written by a professional writer and has been broadcasted on radio.

Results and discussion

State mindfulness. An ANOVA analysis showed that the three audio fragments differed significantly in the extent to which these elicited state mindfulness ($F(2, 60) = 3.66$, $p < .05$). More specifically, LSD post hoc analyses indicated that reported state mindfulness was higher in the attention to body condition compared to the control condition, ($t(60) = -2.61$, $p < .05$). Also, state mindfulness was (marginally) higher in the attention to environment condition than in the control condition ($t(60) = -1.89$, $p = .06$). The attention to body condition and attention to environment condition did not differ in the state mindfulness they elicited ($t(60) = -.79$, *ns*). Means of conditions are reported in Table 4.1.

Awareness of body and surroundings. First, to ensure that the items of the awareness of body scale and awareness of environment scale did indeed tap into two different constructs, confirmatory factor analyses were performed. We assessed discriminant validity by comparing two models. A model that treated awareness of body and environment as two different constructs showed good fit ($\chi^2(26) = 29.86$, $p = .27$, RMSEA = .049, CFI = .985) while a model that treated these as one construct performed poorly ($\chi^2(27) = 162.23$, $p < .001$, RMSEA = .284, CFI = .464). A model comparison test indicated that the first model was superior to the second model ($\Delta\chi^2(1) = 132.37$, $p < .001$), thus supporting the existence of two different constructs.

Results of a MANOVA revealed that participants exposed to the attention to body condition indicated to be more aware of their body than participants in the control condition ($t(60) = 5.93$, $p < .001$) and the attention to environment condition ($t(60) = 4.11$, $p < .001$; $F(2, 60) = 18.21$, $p < .001$). In addition, participants in the attention to environment condition also indicated to be more aware of their body than participants in the control condition, even though this effect was only marginally significant ($t(60) = 1.89$, $p = .06$). For the environment awareness measure, participants who had been exposed to the attention to environment condition were more aware of their immediate environment than participants in the control condition ($t(60) = 6.11$, $p < .001$) or the attention to body condition ($t(60) = -6.95$, $p < .001$); $F(2, 60) = 29.10$, $p < .001$). No other differences between groups reached significance (For means of conditions see table 4.1.).

Ratings of audio fragments. The fragments were rated similar in terms of liking, pace and length (all *F's* < 2.01, *ns*). The attention to body and attention to environment fragments differed in the extent to which it caught participants' interest (Body: $M = 4.19$, Environment: $M = 2.97$, Control: $M =$

3.41; $F(2, 60) = 6.03$, $p < .01$). Furthermore, all rated the instructions in the attention to body and attention to environment conditions as easy but participants rated the instructions in the attention to body condition as relatively harder to perform than the instructions in the attention to environment condition (Body: $M = 2.85$, Environment: $M = 1.71$; $F(2, 54) = 4.71$, $p < .05$). These differences in interest and difficulty between focusing on the environment and the body are considered inherent to these types of instructions given that information about the self, in this case focusing on their own body, generally attracts attention (cf. Moray, 1959) but is also more subtle and therefore generally less accessible to participants than external stimuli.

Table 4.1. State mindfulness (score on MAAS) and awareness of body and environment as a function of mindfulness condition (Experiment 2) .

Measure	Mindfulness instructions		
	Attention to the body	Attention to the environment	Control
State mindfulness	4.60[a] (.88)	4.34[a] (1.01)	3.72[b] (1.29)
Body awareness	4.55[a] (.96)	3.17[b] (.94)	2.56[c] (1.26)
Environment awareness	3.22[a] (.58)	5.27[b] (.95)	3.54[a] (1.16)

Note. Scores on state mindfulness have been recoded such that higher scores denote higher values of mindfulness. Values reported between parentheses are standard deviations. Different superscripts indicate at least marginally significant differences ($p < .07$) between means (across conditions).

Discussion. These findings demonstrate that mindfulness instructions that focus attention on the body or on the environment can elicit similar levels of state mindfulness, but with foci of attention on the body and environment, respectively.

Experiment 2

The pretest has established that short audio fragments of two often used mindfulness trainings, one that focuses attention on the body and one that focuses attention on the environment, both elicit state mindfulness, but with different foci of attention. We now test the effects of these mindfulness manipulations on individuals' capability to compensate for previous consumption, allowing us to distinguish between a general effect of mindful attention and the focus of mindful attention. If the effect of mindfulness is due to enhanced attention in general, the focus of the mindfulness training should not matter. In contrast, if the focus of attention is critical, the two trainings should influence consumers' ability to compensate differently.

Method

Participants and design. One hundred and eighteen students were randomly assigned to a 2 (Portion size preload: Small vs. Large) x 3 (Mindfulness instructions: Attention focus on body vs. Attention focus on environment vs. Control condition) between-subjects design. One participant was excluded from analyses because he/she indicated to not have followed the experimenter's instructions regarding the mindfulness instructions (a score lower than 4 on a 7-point scale). This left a total of 117 participants in the

analyses (37 men and 80 women, mean age = 20.3 years). Participants received a five Euro gift voucher for participation.

Procedure. As in Experiment 1, participants were seated in individual cubicles. At the outset of the study, they were briefly asked about their current hunger feelings on a 7-point scale (*1* = not at all hungry, *7* = very hungry). Participants then started what was described as an evaluation task of an audio fragment, but was in fact the mindfulness manipulation. The instructions of the mindfulness conditions, the procedure and evaluation task were exactly similar to the pretest.

Next, participants proceeded with what was described to them as a taste test. Either a snack size Snickers (18 grams, 91 calories) or a full size Snickers (57 grams, 287 calories) was provided to them. In both conditions the snack was unwrapped. Participants were required to finish the whole chocolate snack and then to rate the snack on a number of dimensions (sweetness, taste, size, crunchiness, mouthfeel, aftertaste) on 7 point scales (*1* = does not describe product at all*,7* = describes product very well*)*. To allow for satiation to set in, participants then filled out unrelated filler tasks for twenty minutes before proceeding with the second taste test. Participants were served two bowls of two types of chocolate cookies (bite-size chocolate chip cookies and a type of very thin sliced chocolate covered sweet crisps) containing 60 grams and 40 grams of cookies, and were free to take as many as they would like. They rated the cookies on a number of dimensions, similar to the first taste test. Next, participants filled out neutral filler questionnaires for around ten minutes, to allow for more time for consuming cookies. In the end, participants filled out demographic information and were thanked and paid. After participants had left, the remaining cookies were weighed to assess cookie consumption.

Results and discussion

Baseline hunger. As expected, there were no differences in baseline feelings of hunger among conditions ($F(5, 107) = .60$, *ns*).

Audio fragments. As in the pretest, the attention to body condition was rated as more interesting than the other conditions (Attention to Body: $M = 4.25$, Attention to Environment: $M = 1.97$, Control: $M = 3.26$; $F(2, 114) = 23.30$, $p < .001$) and its instructions as harder to perform than the attention to environment condition (Attention to Body: $M = 2.28$, Attention to Environment: $M = 1.63$; $F(2, 114) = 23.67$, $p < .001$). These differences are in line with findings of the pretest and, as argued before, are inherent qualities of focusing on the body or on the environment. We will examine whether these differences between audio fragments affect cookie consumption, which we will comment on later.

Preload conditions. No differences were found in any ratings of the small and large portion size preload conditions (all $F(1,115) < 0.94$, *ns*), with the expected exception of size ($F(1, 115) = 117.8$, $p < .001$). We also tested whether participants in the different mindfulness conditions perceived the size of the chocolate snack differently, but this was not the case (mindfulness x portion size interaction; $F(2, 111) = .57$, *ns*).

Cookie consumption. An ANOVA was performed with mindfulness instructions and portion size of the preload as independent variables and cookie consumption as the dependent variable. Gender was taken up as a covariate. In separate analyses it was tested whether gender interacted with our manipulations, but this was not the case. The results show that neither the

portion size of the preload affected how many cookies participants subsequently consumed ($F(1,110) = 1.91$, *ns*) nor the mindfulness condition participants were in ($F(2, 110) = 1.89$, *ns*). Gender also did not affect subsequent cookie consumption ($F(1, 110) = 0.74$, *ns*).

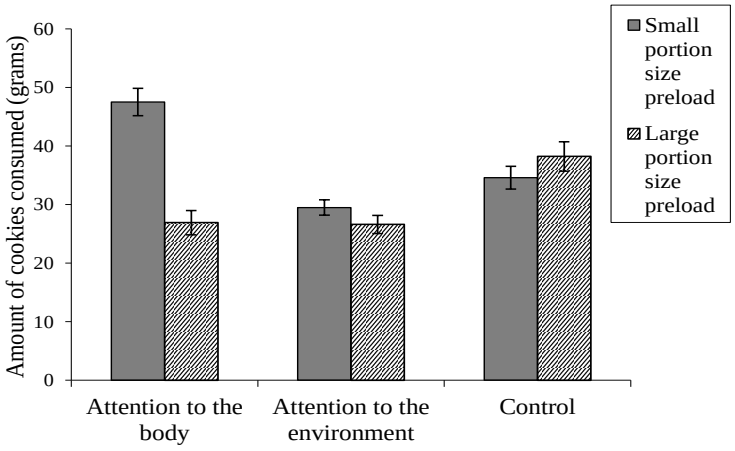
Most importantly, in line with our expectations and the results of Experiment 1, there was a significant portion size preload x mindfulness interaction ($F(2, 110) = 3.14$, $p < .05$). To examine this interaction effect more closely, simple effect analyses were conducted. These showed that the portion size of the preload had an effect on cookie consumption in the attention to body condition such that participants who had been served a large chocolate bar ate fewer cookies ($M = 26.9$ grams) than participants who had been served a small chocolate bar ($M = 47.5$ grams; $F(1, 110) = 7.77$, $p < .01$). Portion size of preload did not significantly affect cookie consumption in either the attention to environment condition ($F(1, 110) = 0.06$, *ns*) or in the control condition ($F(1, 110) = 0.34$, *ns*). Means are displayed in figure 4.2.

Furthermore, examining consumption within the small and large portion size preload conditions, revealed that after a small size preload, participants in the attention to body condition consumed more cookies than in the other two conditions (attention to body condition: $M = 47.5$ grams; attention to environment condition: $M = 29.5$ grams; control condition: $M = 34.6$ grams; $F(2, 110) = 3.35$, $p < .05$). In the large size preload condition, there were no differences in consumption across mindfulness conditions ($F(2, 110) = 1.66$, *ns*). Thus, participants in the mindful body condition compensated when having consumed a small size preload.

To rule out that differences between the fragments in either difficulty or interest were driving our effects, we conducted additional analyses, with difficulty of instructions and interest as covariates. The covariate difficulty of instructions positively affected cookie consumption but its inclusion did not

affect the interpretation of any other effects. Interest in the fragment marginally affected cookie consumption, but also did not change any results substantially. Thus, these differences between fragments do not drive our findings.

Figure 4.2. Amount of cookies consumed as a function of mindfulness condition and portion size of preload.



Note. Error bars represent standard error of means

Discussion. These results provide further support for our hypothesis that mindfulness improves an individual's reliance on internal cues in their subsequent consumption. In addition to the findings of Experiment 1, which showed that trait mindfulness is related to enhanced responsiveness to hunger and satiety cues, Experiment 2 shows that even a short mindfulness manipulation can improve compensation for previous consumption. Furthermore, these results show that it matters where this attention is directed, as only mindful attention to the body produces these results. Again, as in Experiment 1, mindful attention to the body led to compensation for

previous consumption, but did not lead consumers to uniformly consume less in all conditions, rendering it unlikely that improved self-control or mood were causing these effects.

A difference between the findings of Experiment 1 and Experiment 2 is that in experiment 1 mindful individuals compensated mainly by eating *less* after the *high* caloric preload whereas in Experiment 2 individuals compensated mainly by eating *more* after the *small* preload. The large preload in Experiment 2 was much lower in number of calories than the high caloric preload in Experiment 1, and this could provide an explanation for this pattern of results. Importantly, compensation entails responding to previous consumption, and this can mean both eating more after having consumed little and eating less after having consumed a lot, in order to achieve a constant food intake.

Experiment 3

Experiment 3 was designed to extend the findings of Experiment 2, using a different operationalization of the mindful attention to environment condition and to study hunger and satiety cues more directly. In Experiment 2 the mindful attention to environment condition focused participants' attention on their immediate surroundings of the lab they were in, which may have been rather boring compared to focusing attention on their bodies. In order to remove this potential confound, we modified the mindful attention to environment condition and test its effects in a pretest. We also more thoroughly study the effects of the two mindfulness conditions on measures of mood and arousal. In the experiment we then test the effects of the mindfulness conditions on feelings of hunger and satiety. In Experiment 1 and 2 we assessed the effects of mindfulness on the reliance on hunger and satiety

cues by examining how participants respond to preloads of different caloric content. We argued that the enhanced compensation in the mindful attention to body condition was due to consumers' improved awareness of the satiety cues produced by these preloads. We did not directly ask participants about their feelings of hunger and satiety because we were afraid that making participants explicitly aware of this would interfere with their subsequent consumption. Therefore, in Experiment 3 we specifically examine the effects of the different mindfulness conditions on the awareness of hunger and satiety feelings after different preloads.

Pretest

Method

Participants and design. Seventy-one students (57 women, 14 men, mean age = 20.9 years) were recruited around campus. Participants were randomly assigned to one of three mindfulness conditions (Attention to body vs. Attention to environment vs. Control condition) in a between-subjects design. Participants were given a snack product after participation.

Procedure and measures. The procedure and the mindful attention to body condition and the control condition were the same as in Experiment 2. However, a different mindful attention to environment condition was administered. The new fragment was equal in length to the audio fragments in the other two conditions (all around four minutes) and was recorded by the same yoga teacher. In the mindful attention to environment condition, a photo frame with a picture displaying an idyllic grass hillside landscape and a sunset was placed on the table of the participant. Participants were instructed to put

their hands on their upper legs, sit up straight and direct their attention towards the picture. Their attention was then slowly guided along different aspects of the landscape in the picture in a structured way. Participants were instructed to focus their attention on specific details of the pictures (e.g., "*Study the different tones of colors of the clouds ..","" Focus your attention on a small part of grass and study its structure"*) and to become fully aware of the landscape in the picture.

Participants then evaluated the audio fragments on 7-point scales (*1* = not at all, *7* = very much) in terms of how much they liked the fragments (nice, inspiring, catches interest, boring, annoying, α = .85), the difficulty of the instructions and pace of the fragments. Participants then filled out measures of state mindfulness and measures of whether they paid attention to their body and surroundings. State mindfulness was again assessed by a state version of the MAAS scale (α = .84, Brown & Ryan 2003) and awareness of body (e.g., "*I was aware of tensions in my body"*, α = .84) was assessed by the same five items as in Experiment 2, both on a 7-point scale. The five items that were used in Experiment 2 to assess awareness of environment were modified slightly in accordance with the modified manipulation (e.g., "*I noticed I paid a lot of attention to details in objects in my surroundings",* α = .75). In order to examine in more detail the effect of the different mindfulness fragments on arousal and affect, also an abbreviated version of the Pleasure Arousal Dominance scales (PAD) was administered (Mehrabian & Russel, 1974). Six semantic differentials were used to examine general positive or negative affect (e.g., happy, satisfied, α = .87), five semantic differentials assessed participants' arousal level (e.g., excited, relaxed, α = .65), and six semantic differentials measured the extent to which participants felt in control (e.g. dominant, in control, α = .66). The order in which mindfulness, body and environment awareness or the PAD scales were administered was

counterbalanced across participants. Finally, participants provided demographic information.

Results and discussion

State mindfulness. The mindfulness condition had the expected effect on state mindfulness, with a higher state mindfulness in both the mindful attention to body ($t(68) = -2.97$, $p < .01$) and mindful attention to environment conditions ($t(68) = -2.61$, $p < .05$, ($F(2, 68) = 5.22$, $p < .01$) than in the control condition. The two mindfulness conditions did not differ among each other in the state mindfulness they elicited ($t(68) = -0.36$, *ns*). For means of conditions see Table 4.2.

Awareness of body and surroundings. In line with expectations, participants in the mindful attention to body condition were more aware of their bodies than in either the mindful attention to environment condition ($t(68) = 5.75$, $p < .01$) or control condition ($t(68) = 6.85$, $p < .01$; $F(2, 68) = 27.16$, $p < .01$). There were no other differences in body awareness between conditions ($t(68) = 1.16$, *ns*). Furthermore, participants who were exposed to the new mindful attention to environment condition were indeed more aware of their surroundings than participants in either the mindful attention to body condition ($t(68) = 6.80$, $p < .01$) or the control condition ($t(68) = 4.95$, $p < .01$; $F(2, 68) = 24.77$, $p < .01$) . Participants in the control condition were marginally more aware of their surroundings than participants in the mindful attention to body condition ($t(68) = -1.77$, $p = .08$). For means of conditions see Table 4.2.

Table 4.2. State mindfulness (score on MAAS) and awareness of body and environment as a function of mindfulness condition.

Measure	Mindfulness instructions		
	Attention to the body	Attention to the environment	Control
State mindfulness	4.33[a] (0.92)	4.23[a] (0.73)	3.49[b] (1.20)
Body awareness	4.53[a] (0.86)	2.83[b] (1.24)	2.49[b] (0.91)
Environment awareness	1.96[a] (1.21)	4.39[b] (1.32)	2.60[c] (1.17)

Note. Scores on state mindfulness have been recoded such that higher scores denote higher values of mindfulness. Values reported between parentheses are standard deviations. Different superscripts indicate at least marginally significant differences ($p < .09$) between means (across conditions).

Pleasure, arousal, and dominance scales. Results of a MANOVA analysis revealed that the mindful attention to body and mindful attention to environment condition were similar in the extent to which these elicited feelings of pleasure ($t(68) = -0.70$, *ns*), arousal ($t(68) = -0.88$, *ns*), or dominance ($t(68) = -0.79$, *ns*). The control condition did differ from the two mindfulness conditions in that it elicited less pleasure ($F(2, 68) = 4.79$, $p < .05$), less arousal ($F(2, 68) = 3.85$, $p < .05$) and more dominance ($F(2, 68) = 4.67$, $p < .05$). For means of conditions see Appendix B.

Ratings of audio fragments. The fragments were rated similar in terms of general liking and pace ($F's < 1.95$, *ns*). Nor did the mindful attention to body and mindful attention to environment conditions differ on any of the

individual items of the scale such as whether it caught participants' interest ($t(68) = -1.64$, *ns*), or in how boring they rated the fragments ($t(68) = 1.49$, *ns*). The only difference between the attention to body condition and attention to environment condition was that the instructions of the body condition were rated as more difficult to perform (Mindful attention to body condition: $M = 3.83$; Mindful attention to environment condition: $M = 2.58$; $t(67) = 2.47$, $p < .05$), even though both conditions rated the instructions as relatively easy. The only difference between the control condition and the two mindfulness conditions was that the control condition was rated as more boring than the mindful attention to body condition (Mindful attention to body condition: $M = 3.63$; Control condition: $M = 4.74$; $t(68) = -2.31$, $p < .05$).

Discussion. These findings show that our altered manipulation of mindful attention to the environment is successful; it elicits similar levels of state mindfulness as the mindful attention to the body condition, and focuses attention on the environment specifically. Moreover, the mindful attention to the environment condition was similar to the mindful attention to the body condition in terms of the affective responses (such as arousal and pleasure) that were triggered. We will therefore use these manipulations to examine its effects on the awareness of hunger and satiety cues.

Experiment 3

Method

Participants and design. One hundred and thirty-one participants were assigned to a 3 (Mindfulness condition: mindful attention to the body vs. mindful attention to the environment vs. control) x 2 (Preload: low caloric vs.

high caloric content) between-subjects design. Eight participants did not completely consume the preload and six participants indicated not to have followed the instructions in the mindfulness conditions (a score lower than 4 on 7-point scale); these participants were therefore excluded from the analyses, which left a total of 117 participants in the analysis (28 men, 89 women, mean age = 21.0 years). Participants received a small monetary compensation for participation.

Procedure and measures. Participants were first asked to indicate their current hunger and satiety feelings on 100 mm VAS scales (e.g., "How hungry are you at this moment?","How much would you eat at this moment?", five items, α = .92) in order to assess baseline levels of hunger and satiety feelings. The mindfulness manipulation was, as in the previous experiment, described as an evaluation study of audio fragments and participants were asked to follow instructions as closely as possible. The mindfulness instructions focused and guided participants' attention on their body (mindful attention to the body), or on the landscape in a picture that was placed in front of them (mindful attention to the environment). In the control condition, participants were instructed to listen carefully to a recorded neutral story (for a more detailed description of the three mindfulness condition see Experiment 2 and pretest).

After rating the audio fragment, participants proceeded with what was described to them as a taste test. Participants were served chocolate milk and a typical Dutch winter treat, a type of spiced cookie, filled with a rich sugar and almond paste. Participants consumed 200 ml of a light version of chocolate milk that was based on skimmed milk and a small portion (31 grams) of the cookie in the low caloric content condition (total 233 kcal) or 200 ml of a full fat version of the same brand of chocolate milk together with a large portion of the same cookie (62.5 grams) in the high caloric condition

(total 448 kcal). Participants were unaware of the amount of calories in the chocolate milk or cookie. Participants were required to finish the chocolate milk and cookie completely and to rate both on a number of characteristics such as taste, sweetness, creaminess and aftertaste. Then, a neutral filler task of around 10-15 minutes followed, intended for satiation to set in. Afterwards, the same questions about hunger and satiety feelings as at the beginning of the experiment were asked (α = .91). Participants then provided some demographic information such as gender, age, and weight and height, were probed for suspicion and then finally filled out the restrained eating subscale of the DEBQ (van Strien, Frijters, Bergers, & Defares, 1986).

Results

Baseline differences in satiety feelings. Analyses show that despite random assignment to conditions, baseline levels of satiety were marginally significantly different across conditions ($F(5, 111) = 2.23$, $p = .06$). Baseline levels of satiety were therefore controlled for in the analyses.

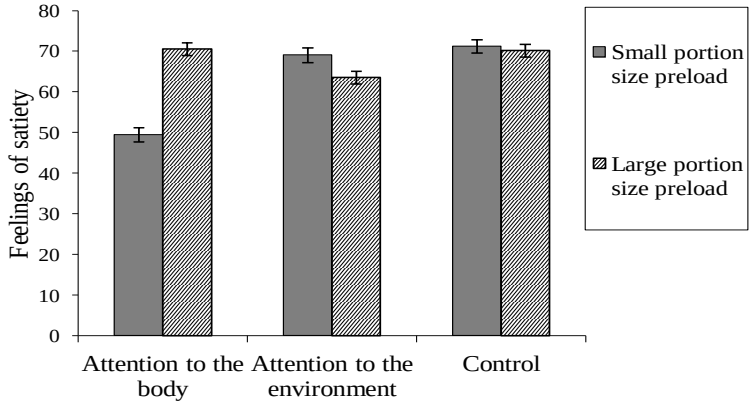
Effects of mindfulness condition and size of preload on satiety feelings after consumption of preload. In order to assess the joint effects of mindfulness condition and the preload condition on satiety feelings after consumption, an ANOVA analysis was performed with the mindfulness condition and preload condition as independent variables and satiety feelings after consumption as the dependent variable, controlling for baseline differences in satiety feelings at the start of the experiment. Gender was taken up as a covariate. The results show that the preload condition had a significant effect on feelings of satiety after consumption of the preload: Participants who had been served a small preload, subsequently reported to feel less full ($M = 62.44$, $SD = 21.06$) than

participants who had been served a large preload (*M* = 68.04, *SD* = 16.97; *F* (1,109) = 12.75, *p* < .01). The results also showed a significant effect of the covariate gender (*F*(1, 109) = 11.13, *p* <.01) with men feeling less full (*M* = 59.86, *SD* = 21.62) than women (*M* = 66.90, *SD* = 18.27). There was no main effect of mindfulness fragment on satiety feelings after consumption (*F* (2,109) = 1.17, *ns*).

In line with our predictions, the mindfulness condition and preload condition jointly predicted satiety feelings after consumption of the preload (*F* (2,109) = 3.56, *p* < .05). To further examine this interaction effect, simple effect analyses were performed which indicated that the size of the preload significantly predicted satiety feelings in the mindful attention to body condition (*F* (1, 109) = 19.40, *p* < .001) but not in the other two conditions (mindful attention to environment: *F* (1, 109) = 0.40, *ns*; control condition: *F* (1, 109) = 1.72, *ns*). More specifically, participants in the mindful to body condition felt less full after having consumed a small preload (*M* = 49.49 , *SD* = 19.40), compared to participants who had consumed a large preload (*M* = 70.55, *SD* = 16.56). (See Figure 4.3)

We also examined the simple effects of the mindfulness condition within each of the preload conditions. These findings revealed that mindfulness to the body had a marginally significant effect within the small preload condition (*F* (2, 109) = 2.90, *p* = .06), with participants feeling less full (*M* = 49.49, *SD* = 19.40) than participants in the mindful attention to environment condition (*M* = 69.08, *SD* = 19.31) or control condition (*M* = 71.24, *SD* = 17.45). Within the large preload condition there was no effect of the mindfulness condition on feelings of satiety after the preload (*F* (2, 109) = 1.80, *ns*).

Figure 4.3. Feelings of satiety as a function of mindfulness condition and portion size of preload.



Note. Error bars represent Standard error of means

Effects of mindfulness and preload condition on evaluations of the preload. Analyses showed that participants in the large preload condition perceived the preload as being larger (M = 5.36, SD = 1.42) than participants in the small preload condition (M = 3.28, SD = 1.58, F (1, 105) = 59.54, p < .001). Also, participants in the large preload condition who were served the high caloric chocolate milk perceived this as being sweeter (M = 5.43, SD = 1.08 vs. M = 4.44, SD = 1.38; F (1, 105) = 19.21, p < .001), more creamy (M = 5.88, SD = .97 vs. M = 5.26, SD = 1.20; F (1, 105) = 10.95, p < .01) and more tasty (M = 5.48, SD = 1.46 vs. M = 4.86, SD = 1.53; F (1, 105) = 4.57, p < .05) than participants in the small preload condition who were served the light version. Correcting for these ratings in our analyses did not change any of our main findings. The mindfulness condition or interaction between mindfulness condition and preload condition did not affect any evaluation of the preload.

Effects of BMI, restrained eating and dieting status on satiety feelings. In separate analyses it was tested whether controlling for restrained eating, BMI, or dieting status affected our findings. None of these covariates had an effect on satiety feelings after consumption of the preload (all *F*'s < 1.95, NS) nor did these affect our findings.

Discussion

These findings show that mindfulness affects the awareness of hunger and satiety cues: After mindful attention to the body, consumers are able to align their feelings of satiety to how much they have previously eaten. The results indicate that mindful consumers are better able to sense the physiological consequences of how much they have eaten, which is in line with our findings in Experiment 1 and Experiment 2 that mindfulness leads consumers to adjust their food intake according to previous consumption.

As in Experiment 2, it was only when participants directed mindful attention to their bodies that their feelings of satiety corresponded to the amount they had previously eaten. For participants who directed mindful attention to the environment or for participants in the control condition there were no differences in feelings of satiety after consuming either a small preload or a large preload. This suggests that mindful attention does not have a general effect, but that it matters where attention is focused.

As there is no absolute value of how full consumers 'should' feel after a specific consumption, we can only assess whether hunger and satiety feelings correspond to differences in the amount of calories consumed. Participants who were instructed to direct mindful attention to their bodies indeed reported differences in satiety feelings according to how much they had previously eaten, however, they specifically felt less full after having

consumed a small preload. A similar finding was observed in Experiment 2, where participants in the mindful attention to body condition compensated by eating more after having consumed a small preload, rather than eating less after a large preload. This raises the possibility that mindful attention to the body particularly enhances consumers' feelings of not being satiated, which could possibly have adverse effects on consumers' body weight, an issue which we will address in Study 6.

Experiment 4

In the previous experiments we have demonstrated that directing mindful attention to the body makes consumers more aware of internal hunger and satiety cues and leads them to rely more on internal cues in food consumption. In everyday life consumption episodes, however, also a variety of external cues influence consumption behavior (e.g., portion sizes or labels). In the following two experiments we test whether mindfulness affects how consumers respond to external cues in their eating behavior. In the previous experiments we have varied internal cues by providing participants with preloads of different caloric contents whereas we have kept external cues surrounding consumption constant. In the following two experiments we assess consumption after preloads that are similar in caloric content but we vary the presence of an external cue: a visual cue that affects salience of amount of previous consumption (Experiment 4) or a health cue that affects perceptions of healthiness (Experiment 5).

In Experiment 4 we assess whether mindful consumers react differently to a cue that makes previous consumption more visually salient. Visibility of food is known to have a powerful effect on food intake and as a result people are often characterized as eating with their eyes rather than

with their stomachs (Wansink, Painter, & North, 2005). Being able to see what you eat (compared to for example eating in the dark) has been found to facilitate the awareness of satiety feelings that develop after consumption and in this way reduce further food intake (Scheibehenne, Todd, & Wansink, 2010). Furthermore, visual cues that indicate how much one has already eaten also reduce further food intake. For example, consumers have been found to eat fewer chicken wings when the remaining bones stay on the table after consumption and to consume fewer pistachio nuts when the shells remain in sight compared to when such remainders of food are taken away (Kennedy-Hagan et al., 2011; Wansink & Payne, 2007). Presumably, a visual cue provides consumers with a cognitive short-cut of estimating previous consumption, as opposed to having to infer this from how full they feel.

In Experiment 4 we test whether focusing mindful attention on the body affects reliance on a visual cue by serving participants similar amounts of pistachio nuts, with or without a visual cue of previous consumption (i.e. with or without the shells of the nuts) and assessing subsequent food intake. Mindfulness may affect how consumers react to a visual cue of previous consumption in a number of ways. We have argued that mindfulness makes consumers compensate better because they rely on internal cues in consumption (i.e. "eat with their stomachs"). Based on this we expect that after our mindfulness manipulation consumption is not affected by whether a visual cue of previous consumption is present. Alternatively, it could be argued that mindfulness enhances compensation for previous consumption, because it makes consumers pay more attention to amount of previous consumption. If this were the case we would expect that a visual cue that makes the amount of previous consumption more salient would further facilitate this process and that participants would subsequently eat less when a visual cue was present, compared to when it was not.

As the previous experiments have found only mindful attention to the body (and not mindful attention to the environment) to facilitate awareness of body cues and enhance compensation, Experiment 4 and 5 will focus specifically on the effects of the mindful attention to body condition.

Method

Participants and design. Ninety-five students were recruited around campus through flyers. Participants were assigned to a 2 (Mindfulness condition: mindful attention to the body vs. control) x 2 (Visual cue of consumption: present vs. absent) between-subjects design. Seven participants were excluded for not completely finishing the preload and three participants because they indicated not to have followed the mindfulness instructions (score of lower than four on 7-point scale). This left a total of 85 participants in the analysis (14 men, 71 women, mean age = 20.8 years). Participants received a small monetary compensation in return for participation.

Procedure and measures. Upon arrival to the lab, participants were seated in individual cubicles and informed that they would participate in a series of unrelated studies. First, baseline feelings of hunger and satiety were assessed by two items on a 100 mm VAS scale ("*How hungry do you feel at this moment?*", "*How full do you feel at this moment?*" *1* = not at all hungry respectively full, *100* = very hungry respectively full) and combined in one satiety scale (α = 0.80). Then participants were asked to evaluate an audio fragment on an mp3 player, which constituted the mindfulness manipulation. Depending on the experimental condition participants were in, participants were asked to carry out instructions to focus attention on the body, or in the

control condition to listen carefully to a recorded neutral story (for a more detailed description of the mindfulness fragments see Experiment 2).

Next, a taste test of pistachio nuts followed. All participants were served a bowl of 55 shelled pistachio nuts and asked to completely finish the plate of nuts, ostensibly because the researchers were interested in how consumers experience the shelling of nuts. For participants in the no visual cue condition, participants were provided with a small bin with a lid and were instructed to dispose of the shells of the nuts in the bin. In the visual cue condition, participants were not provided with a bin and disposed of the pistachio shells on the plate. In line with the cover story, in both the visual cue and no visual cue condition, participants filled out several questions regarding the taste of the nuts and the experience of shelling the nuts. The experimenter checked whether participants had finished eating all of the pistachio nuts. In the no visual cue condition, the experimenter took away the bin and told the participants they could proceed to the next study. In the visual cue condition participants simply proceeded to the next part of the study and their plate with shells of pistachio nuts remained on their table, until the next taste test. Participants then filled out several neutral filler tasks on study evaluation. In between the filler tasks, participants were asked to give an estimation of how many pistachio nuts they had previously consumed. Participants were asked to estimate the absolute number and grams of nuts, and the total number of calories in the pistachio preload. Participants also rated the preload on a 7-point scale in terms of the amount of nuts (*1* = little, *7* = a lot) and the caloric content (*1* = low caloric content, *7* = high caloric content).

After another neutral filler task, participants were presented with a taste test of savoury snacks. Participants were served two bowls of savoury snacks (one bowl of 30 grams and one bowl of 40 grams) and were explained that they could consume as much as they would like. In the visual cue

condition, this was also the moment when the plate of pistachio shells was taken away by the experimenter. Participants were asked the same two questions about current hunger and satiety feelings as at the beginning of the experiment ($\alpha = 0.79$) and then rated both snacks on a number of dimensions such as saltiness, dryness and palatability on a 7-point scale. Participants then filled out another neutral filler task, in order to give participants more opportunity to consume the snacks. Finally, participants filled out demographics such as age, gender, weight and height, were probed for suspicion, and filled out the restrained eating subscale of the Dutch Eating Behavior Questionnaire (DEBQ) (van Strien et al., 1986). After participants left, the bowls of savoury snacks were weighed in order to assess amount of consumption.

Results

Baseline levels of hunger and satiety. Despite random assignment to conditions, baseline feelings of satiety were marginally significantly different across conditions ($F(3, 81) = 2.12$, $p = 0.10$). Baseline levels of hunger and satiety will therefore be controlled for in the reported analyses.

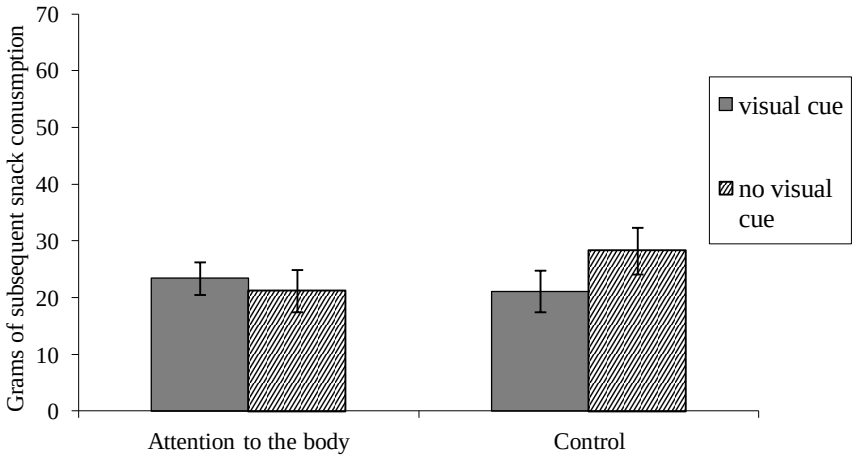
Effects of mindfulness and a visual cue of consumption on estimation of previous consumption. To test the effects of our manipulations on how well participants could remember their previous consumption, a MANOVA analysis was carried out with the visual cue condition, the mindfulness condition, and the interaction between these as factors, baseline levels of satiety and gender as covariates and the various estimates of previous consumption as dependent variables. There were no effects of the mindfulness condition on estimations of amount of previous consumption, or ratings of amount or caloric content

(all *F*'s < 0.88). Importantly, after the instructions to focus mindful attention on the body, participants were not more accurate in estimating their previous consumption (absolute difference between estimation of number of nuts consumed and actual number of nuts) than participants in the control condition ($F(1, 76) = 0.30$, *ns*). There was a marginally significant effect of the mindfulness condition on how many calories participants estimated to have consumed in the pistachio preload ($F(1, 76) = 2.80$, $p = .10$), with participants in the mindful condition having lower estimations ($M = 203.66$, $SD = 122.14$) than participants in the control condition ($M = 298.46$, $SD = 317.67$). No effects were found of the visual cue condition on estimations of number of nuts or number of calories, ratings of amount and caloric content of previous consumption, or accuracy in estimation (all *F*'s < 2.17, *ns*). There were no interaction effects of the mindfulness condition and visual cue on any of the estimation measures (all *F*'s < 2.10).

Effects of a visual cue of consumption and mindfulness on subsequent consumption. The visual cue condition, the mindfulness condition and the interaction between these two were entered as independent variables in an ANOVA with amount of subsequent consumption as a dependent variable. Baseline levels of satiety and gender were included as covariates. No main effects of the mindfulness condition ($F(1, 79) = 0.09$, *ns*) or whether participants had a visual cue of consumption ($F(1, 79) = 0.25$, *ns*) were found on subsequent consumption. Gender of participants did not affect later consumption ($F(1, 79) = 0.45$, *ns*). The covariate baseline levels of satiety did have an effect on subsequent consumption: The more satiated participants were at the outset of the study, the less snacks they ate later on ($F(1, 79) = 5.15$, $p < .05$).

A marginal significant interaction between the mindfulness condition and visual cue condition appeared ($F(1, 79) = 2.91$, $p = .09$). When looking at the underlying pattern (see also Figure 4.4), there was a trend towards participants in the control condition subsequently eating more when no visual cue of previous consumption had been available to them ($M = 28.27$ grams, $SD = 19.24$) compared to when they had been reminded of their consumption by the pistachio shells ($M = 21.10$ grams, $SD = 16.34$, $F(1,79) = 2.52$, $p = .12$). For participants in the mindfulness condition having a visual cue of previous consumption did not seem to affect subsequent consumption ($F(1, 79) = 0.74$, *ns*). Looking separately at the simple effects within the two visual cue conditions, no effect appeared of mindfulness within the visual cue condition ($F(1, 79) = 1.02$, *ns*) nor within the no visual cue condition ($F(1, 79) = 2.03$, *ns*).

Figure 4.4. Snack consumption as a function of the presence of a visual cue of previous consumption and mindfulness condition.



Note. Error bars represent standard error of means

Effects of BMI, restrained eating, and dieting status. In separate analyses we examined whether participants' BMI, restrained eating level, or dieting status affected our results. None of these covariates affected subsequent snack consumption (all *F*'s < 2.10, *ns*), nor did inclusion of these covariates significantly change our reported findings.

Discussion

These findings show that after focusing mindful attention on the body, participants were not affected by a visual cue of previous consumption in their later intake, and marginally less so than participants in the control condition. Participants who had performed a short training of focusing attention on the body did not eat more or less based on whether a visual cue of previous consumption was present, but ate similar amounts after the two preloads that were similar in caloric content. This is in line with our argumentation that a short training of mindful attention to the body leads consumer to rely on feelings of satiety in their subsequent consumption. The fact that a visual cue did not alter consumption in the mindfulness condition suggests that our previous compensation findings cannot be explained by a process of knowing how much one has already eaten, but rather by a process of feeling how much one has already eaten and adjusting consumption accordingly. It could still be argued that a visual cue of previous consumption did not affect participants in the mindful condition, because the mindfulness instruction in the first place enhanced their memory of previous consumption to such a degree, that a visual cue could not further affect this. However, the results show that overall, regardless of the presence of a visual cue, participants did not remember their previous consumption more accurately or differently after a mindfulness instruction, making this an unlikely mechanism underlying our findings.

Even though the finding that participants in the mindfulness condition were not affected by a visual cue in their subsequent consumption was in line with our argumentation and expectations, we expected participants in the control condition to be affected by a visual cue. Participants in the control condition indeed tended to eat more when no visual cue of previous consumption was available to them compared to when a visual cue of previous consumption was present, but the effect was not very strong. An explanation for this could be that the effect of a visual cues on consumption is not as strong when it manifests itself over multiple consumption episodes as within a single consumption episode, where it has been mostly studied.

Experiment 5

In Experiment 5 we test whether a mindfulness manipulation makes consumers react differently to a health cue. We follow the same procedure as in Experiment 4: We assess consumption after a preload that is similar in the internal satiety cues these produce but we vary the external cue that accompanies the preload. We make use of a health cue that distorts consumers' perception of caloric content, a bias known as the negative calorie illusion (Chernev, 2011). The negative calorie illusion refers to the erroneous belief that a healthy food item paired with an unhealthy caloric food will have a lower total caloric content than the unhealthy caloric food by itself.

In Experiment 5 we provide participants with an unhealthy preload either with or without the addition of three orange slices, thus comparing two preloads that are nearly identical in caloric content but *appear* to vary in terms of caloric content and health. Based on our previous findings we argue that participants who have performed a short mindfulness training focusing attention on their body rely on physiological satiety cues produced by the

preloads. When participants focus attention on the body, consumption should therefore be similar after the two preloads, as these are (nearly) similar in the internal signals these produce. Alternatively, if mindfulness makes consumers more sensitive to health information and adjust subsequent consumption according to their beliefs about caloric content rather than the physiological cues produced by the caloric content, we would expect that the health cue would influence subsequent consumption, increasing consumption when participants believe they have consumed fewer calories.

Method

Participants and design. Ninety-three participants were assigned to a 2 (Mindfulness condition: mindful attention to the body vs. control) x 2 (Health cue: orange slices present vs. orange slices absent) between-subjects design. Three participants were excluded for not completely finishing the preload and six participants because they indicated not to have taken the mindfulness instructions seriously (a score lower than 4 on a 7-point scale). We aimed to test whether participants would indulge themselves after a health cue and therefore chocolates served as the dependent variable. Our choice of the dependent variable was based on the premise that the chocolates were indeed perceived by participants as indulgent. Therefore, three participants who reported a strong dislike of both of the chocolates (mean rating of the two types of chocolates 3 or lower on a 7-point scale) were excluded. This left a total of 81 participants in the analysis (17 men, 64 women, mean age = 20.5 years, *SD* = 1.73). Participants received a small monetary compensation for participation.

Procedure and measures. Participants were first asked a few questions about their previous consumption and actual hunger and satiety feelings *("How hungry are you at this moment*?", "*How full do you feel at this moment?"*, transformed into a satiety scale, α = .90) and then carried out instructions to focus attention on the body (mindful attention to body condition), or to listen carefully to a recorded neutral story (control condition; for a more detailed description of the mindfulness conditions see Experiment 2). Participants then completed a taste test which was described as an evaluation of snacks that could be consumed at home. Participants were then asked to completely consume and evaluate a snack as if they would consume it at home. The snack consisted of a chocolate covered Belgian waffle (health cue absent condition), which was accompanied by three thin slices of fresh orange in the health cue condition. Participants rated the preload on a 7-point scale on dimensions such as its caloric content, taste, size, healthiness and gave estimations of number of calories and grams (in absolute numbers).

When participants completely finished consuming and rating the preload, the experimenter removed the empty plate and instructed participants to watch a 15 minute movie fragment about promoting universities through You Tube fragments, which was in fact a filler task in order for satiation of the preload to set in. After 15 minutes, participants proceeded to a second taste test and were served two bowls of chocolates (M&M's and a supermarket brand of chocolate snacks similar to Maltesers). Participants were asked to rate the chocolates on a number of dimensions (e.g., taste, sweetness, aftertaste) and were told that they were free to consume as many as they would like. Afterwards a small neutral filler task followed during which the chocolates were left on the participants' table. Finally, participants filled out a measure of trait self-control (Tangney, Baumeister, & Boone, 2004), restrained eating (subscale restrained eating of

DEBQ, van Strien et al., 1986) and provided some demographic information. After participants had left, the experimenter weighed each of the bowls containing the chocolates in order to assess the amount of consumption.

Preload snack. In a pretest we tested whether participants would indeed perceive a chocolate covered waffle presented together with slices of orange as less caloric than a chocolate covered waffle by itself, as predicted by previous research on the negative calorie illusion (Chernev, 2011). We showed 29 students (10 men, 19 women) a picture of a chocolate covered waffle (the same as was used in the experiment) either with or without three slices of orange and asked them to rate the snack on 7 point scales (*1*= not at all, *7* = very much). In line with predictions of the negative calorie illusion, participants rated the waffle in combination with the orange slices as less caloric (M = 4.86, SD = 1.10) than the chocolate waffle by itself (M = 5.80, SD = 0.77, $F(1, 27) = 7.21$, $p < .05$). Participants also rated the waffle with the orange as healthier (M = 3.5, SD = 1.61) than without (M = 2.00, SD = 0.76, $F(1, 27) = 10.60$, $p < .01$) and indicated to feel less like they had to control their subsequent consumption after consuming the chocolate waffle with orange (M = 2.50, SD = 1.45), than after the chocolate waffle by itself (M = 3.93, SD = 1.67, $F(1, 27) = 6.05$, $p < .05$). No differences were found between the waffle with or without orange in participants' estimates of the absolute number of calories or in the extent they would feel guilty after consumption of the snack (all F's < 0.64, *ns*).

Results

Baseline levels of satiety. ANOVA analyses revealed that conditions were similar with respect to baseline levels of satiety ($F(3, 77) = 1.02$, *ns*).

Effects of mindfulness and presence of health cue on perceptions of healthiness and caloric content of the preload. We examined how the preload was perceived in the presence or absence of a health cue and in the different mindfulness conditions. In line with the pretest, ANOVA analyses showed that the chocolate waffle was considered more healthy when it was presented together with the three orange slices (M = 2.98, SD = 1.41 vs. M = 1.56, SD = 0.60, $F(1, 77) = 32.37$, $p < .001$). Importantly, participants also perceived the chocolate waffle with the orange slices as less caloric than the chocolate waffle by itself (M = 6.26, SD = 0.77 vs. M = 6.62, SD = 0.59, $F(1, 77) = 5.17$, $p < .05$). This was similar across the two mindfulness conditions (F's < .07, *ns*), indicating that the negative caloric bias (adding something healthy to something unhealthy cannot reduce total calories) was present in both the mindfulness condition and the control condition.

Participants also gave estimates of the exact number of calories and grams that the preload contained. The estimated number of grams was higher when the waffle was accompanied with the orange (M = 149.29, SD = 98.19) than without (M =111.15, SD = 47.47, $F(1, 77) = 4.96$, $p < .05$), but not the estimated number of calories ($F(1, 77) = .07$, *ns*). Overall, participants in the mindful attention to body condition estimated the number of calories in the preload snack (with or without health cue) as higher (M = 299.73) than in the control condition (M = 241.30, $F(1, 77) = 5.26$, $p <.05$).

There were no differences between the waffle with and without orange in participants' rating of the preload's liking, attractiveness, size, or capacity to deliver energy (all $F(1, 77) < 2.22$, *ns*). Participants did find the preload without slices of orange easier to eat (With orange: M = 5.51, SD = 0.91 vs. without orange: M = 4.50, SD = 1.45, $F(1, 77) = 13.00$, $p < .01$) and more similar to something they would choose as a snack to eat at home (with orange: M = 3.55, SD = 1.66 vs. without orange: M = 4.49, SD = 1.71, $F(1, 77)$ =

6.24, $p < .05$). These ratings were similar across mindfulness conditions (all *F's* < 0.71), nor did the mindfulness condition have a main effect on how the preload was perceived (all *F*'s < .48).

Effects of mindfulness and health cue on subsequent consumption. In an ANOVA, we examined the effects of the mindfulness condition, the health cue and the interaction between these on subsequent consumption of chocolates. Gender of participant was taken up as a covariate. No main effects of mindfulness condition or health cue condition, nor the interaction, reached significance (all *F*'s < 0.54, *ns*). Only the covariate gender had a significant effect on subsequent consumption ($F(1, 76) = 4.30$, $p < .05$) with men consuming more chocolates ($M = 51.42$ grams, $SD = 26.67$) than women ($M = 37.59$ grams, $SD = 25.59$). As previous studies have shown that especially individuals who are concerned about their weight are susceptible to the presence of a healthy food item (Chernev, 2011), we have also conducted regression analyses including the restrained eating scale and its interaction with the independent variables. However, no main effects of restrained eating or interaction effects on subsequent consumption emerged. The same held for regression analyses in which the effects of trait self-control were examined.

BMI, restrained eating, and dieting status. Separate analyses showed that BMI or dieting status did not affect ratings of the preload or subsequent consumption of chocolates, nor did the inclusion of these variables as covariates change our findings. Restrained eating had a significant relation with participants' rating of the caloric content of the preload ($F(1, 75) = 8.56$, $p < .01$), with high restrained individuals rating the caloric content of the snack as higher. As stated before, restrained eating did not affect subsequent

consumption of chocolates nor did its inclusion as a covariate change any of our findings.

Discussion

The findings of Experiment 5 show that when directing mindful attention to the body, participants are also affected in their perception of foods by the negative calorie illusion, the misguided belief that adding a healthy food to an unhealthy food reduces the total number of calories. However, this bias did not affect their subsequent consumption. This is in line with our argumentation that paying attention to the body facilitates the reliance on hunger and satiety cues in consumption, as the caloric contents of both conditions were (nearly) equal. This also makes it unlikely that a mindful attention to the body manipulation makes consumers more sensitive to health information and that this could possibly explain their improved compensation.

At the same time, this pattern of findings was similar for participants in the control condition and we can therefore not conclude that attending mindful attention to the body makes consumers rely *less* on this bias in their subsequent consumption. Previous research on the negative calorie illusion has studied the effects of adding a health cue only for caloric estimations and consumption within a single consumption episode. Given that we do find the expected effects of adding a health cue on caloric estimation, we think that our failure to find an effect on subsequent consumption suggests that the effect is not as strong for explaining consumption across episodes as it is for consumption within a single episode.

Study 6

Up to this point, we have shown that directing mindful attention to the body helps consumers in compensating for the caloric content of previous consumption. Our findings show that mindfulness does not make consumers more sensitive to external cues with regard to amount of previous consumption or the perception of calories in previous consumption, if anything we found some limited evidence that they rely less on an external cue (only for a visual cue) in consumption. Rather, we found that mindfulness exercises directed at the body were shown to make consumers more aware of internal cues after consumption. However, the evidence that momentarily increasing mindfulness through incidental training enhances reliance on internal cues in food consumption raises the question whether chronic levels of mindfulness would also manifest themselves in more effective compensation in the long run, as evidenced by lower levels of body weight and lower fluctuations in body weight. In the current Study 6 we therefore examine how trait mindfulness and experience in mindfulness practice are related to body weight and fluctuations in body weight.

In both a student sample and a sample of the general population, we examine the correlates of both general trait mindfulness and mindful attention directed at the body, as well as individual's experience in mindfulness. In Study 6a we relate trait mindfulness measures to participants' self reported weight and their own perceptions of weight fluctuation in a student sample. In Study 6b we make use of weight measurements that were collected with the use of an internet connected scale over a period of 16 months, allowing us to study objective fluctuations in individuals' weight over a longer period of time in a sample of the general population.

Study 6a

Method

Participants and design. Participants were 167 students who were recruited through an email list for promoting research at the university. Even though the email list was intended for students, 17 participants indicated not to be a student (anymore). Two non-students and one student were excluded because they were outside the range of our target age group (> 35 years old). Also, seven participants were excluded because they indicated that the use of medicine or pregnancy had recently affected their weight. This left a total of 157 participants (21 men, 136 women, mean age = 22.1 years, SD = 2.61) in our analyses. Participants could enter a draw of several gift certificates as a reward for their participation.

Procedure. Participants were invited by e-mail to take part in an internet survey on "eating behavior and personality". Participants were told that the survey consisted of several unrelated studies and were asked to fill out the survey at a moment when they would not be distracted. Trait mindfulness was assessed by the Mindful Attention Awareness Scale (MAAS, Brown & Ryan, 2003), the observing subscale of the Kentucky Inventory of Mindfulness Skills (KIMS; Baer, Smith, & Allen, 2004) and by participants' experience in mindfulness. Next, the Dutch Eating Behavior Questionnaire (DEBQ, van Strien et al., 1986) and the weight fluctuation subscale of the Restraint scale (Herman & Polivy, 1980) were administered. Finally, participants answered some questions concerning their perceived health, noted their weight (kg) and height (cm), and provided demographics (gender, age). Below we will describe our measures in more detail.

Measures

KIMS observing subscale. In order to examine mindful attention with different foci of attention, the observing subscale of the Kentucky Inventory of Mindfulness Skills (KIMS; Baer et al., 2004) was administered. This subscale has six items that tap into the extent to which participants pay attention to their bodies (e.g., *"I notice changes in my body, such as whether my breathing slows down or speeds up.")*, three items that tap into whether participants pay attention to aspects of their environment (e.g., "*I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.")* and three items that assess the extent to which participants are aware of their feelings and emotions (e.g., "*I notice when my moods begin to change."*). Participants indicate the frequency with which these statements are true to their own experiences (*1* = almost never true/ never true, *7* = almost always true/always true).

We performed confirmatory factor analyses to assess whether these items tap into one construct "Observing", as formulated in the original research, or whether three different factors can be distinguished; "Attention to body", "Attention to environment" and "Attention to feelings and emotions", based on face validity of the items as described above. We assessed discriminant validity by comparing these two models. A model that treated all 12 items of the KIMS subscale as one construct performed poorly (χ^2 (54) = 190.04, $p < .001$, RMSEA = 0.13, CFI = 0.77), while a model that treated these as three different constructs performed reasonably (χ^2 (51) = 108.39, $p < .001$, RMSEA = 0.09, CFI = 0.91). A model comparison test indicated that the model with three separate constructs performed better than the model with one construct ($\Delta\chi^2$ (3) = 81.65, $p < .001$) and we therefore used the three different constructs in our analyses (Attention to body 6 items, $\alpha = .81$; attention to environment 3 items $\alpha = .63$, attention to feelings 3 items, $\alpha = .78$).

MAAS. In order to assess general trait mindfulness, the Mindful Attention Awareness Scale (MAAS, Brown & Ryan, 2003) was administered. The MAAS is a 15-item measure, with items that assess general trait mindful attention during everyday activities (e.g. *"I find it difficult to stay focused on what is happening in the present"*, *"I find myself listening to someone with one ear, doing something else at the same time"*). Participants indicate the frequency with which they encounter these experiences (*1* = almost never, *6* = almost always, the original response scale was reversed in order to match the response options to the other scales in the survey, scale was later recoded such that higher scores reflect higher mindfulness). Cronbach alpha in our sample was 0.78.

Experience in mindfulness. Participants' experience in mindfulness and/or meditation was assessed by the following item " *To what extent do you have experience in mindfulness and/or meditation?*" (*1* = no experience at all, *7* = a lot of experience).

DEBQ. The DEBQ was administered in order to assess eating styles. The DEBQ has three subscales; a 10- item subscale that assesses restrained eating (e.g., "*How often do you try not to eat over the course of an evening, because you are dieting?*") , a 13- item subscale that assessed emotional eating (e.g.*,"If you feel dejected or discouraged, does that make you feel like eating something?"*) and a 10-item subscale assessing external eating (e.g.*,"If you pass by a bakery, does that make you feel like buying something yummy?"*) (van Strien et al., 1986). Participants indicate the frequency with which these statements are true for them. (*1* = never, *5* = very often). In our current sample, internal consistency's (Cronbach alpha) were: $\alpha = 0.90$ for emotional eating, $\alpha = 0.77$ for external eating and $\alpha = 0.92$ for restrained eating.

Weight measures. Participants' BMI was calculated by dividing participants' (self- reported) weight by the square root of their (self-reported) height. Variance in weight was assessed by the weight fluctuation subscale of the Restraint scale (Herman & Polivy, 1980). This subscale consists of four items that assess instability in weight and a history of overweight (e.g. *"In a typical week, how much does your weight fluctuate?"*, *1* = 0-0.5 kg, *2* = 0.5 kg-1 kg, *3* = 1-1.5 kg, *4* = 1.5-2.5 kg, *5* = 2.5+ kg, *"How many pounds over your ideal weight were you at your maximum weight?"*, *1* = 0-0.5 kg, *2* = 0.5-3 kg, *3* = 3-5 kg, *4* = 5-10 kg, *5* = 10 + kg). Higher scores on the weight fluctuation scale denote higher fluctuation. Cronbach alpha for the weight fluctuation scale was α = .66.

Subjective health. Subjective health was assessed by the following question *"In general, how would you describe your health?"* (*1* = excellent, *2* = very good, *3* = good, *4* = mediocre, *5*= poor) and feelings of pain by the following item" *Looking back at the past four weeks, in how much pain were you?* (*1* = not at all, *2* = very slightly, *3* = slightly, *4* = considerably, *5* = serious pain, *6* = very serious pain).

Results

Relationship between mindful attention to body, mindful attention to environment, mindful attention to feelings (KIMS), BMI, and weight fluctuation. A regression analysis was conducted with BMI as a dependent variable, the mindful attention to body, mindful attention to environment, and mindful attention to feelings (KIMS) scales as predictor variables. Age, gender, subjective health, DEBQ-restrained eating, DEBQ-external eating and DEBQ-emotional eating were entered as control variables. The results show a significant negative relationship between mindful attention to the body and

BMI, such that participants who pay more mindful attention to their body have a lower BMI (t (146) = -2.26, β = -0.21, p < .05). Mindful attention to the environment, or mindful attention to feelings did not predict BMI. Collinearity diagnostics for all variables identified no problems with multicollinearity (all VIF < 1.65 and Tolerance > 0.61).

The same regression analysis was also conducted with the weight fluctuation scale as a dependent variable instead of BMI. In addition to the control variables mentioned above, we also controlled for BMI in these analyses as weight fluctuation is relative to body mass (individuals with higher body mass fluctuate more in absolute number of kilo's). The results show that mindful attention to body did not have a significant relationship with weight fluctuation (t(145) = 0.72, *ns*) nor did mindful attention to environment or feelings. Results of the regression analyses for BMI and weight fluctuation can be found in Table 4.3.

Relationship between mindful attention awareness scale (MAAS), BMI, and weight fluctuation. A regression analysis with BMI as dependent variable and MAAS as an independent variable was conducted, controlling for age, gender, subjective health and the three DEBQ subscales. The results of this regression analysis reveal that MAAS marginally significantly predicts BMI of participants (t(148) = 1.90, β = 0.78, p = .06). Contrary to expectations, higher mindfulness as measured by MAAS was related to a higher BMI. Collinearity diagnostics did not identify problems with multicollinearity (all VIF < 1.33 and Tolerance > 0.75). The same regression analysis as reported above was conducted, but with the weight fluctuation scale as a dependent variable and BMI as an additional control variable. The results show no relationship between MAAS and weight fluctuation (t(147) = -0.92, *ns*). Results of the regression analyses for BMI and weight fluctuation can be found in Table 4.3.

Experience in mindfulness/meditation, BMI, and weight fluctuation. We also assessed how participants' experience in mindfulness/meditation was related to their weight and weight fluctuation. Similar regression analyses as reported above were conducted with participants' self-reported experience as a predictor variable. The results show a significant and negative relationship between experience in mindfulness and BMI (t (148) = -3.31, β = -0.25, p <.01), that is, participants who reported to be more experienced in mindfulness/ meditation, had a lower BMI. Collinearity diagnostics did not identify problems with multicollinearity (all VIF < 1.36 and Tolerance > 0.74). A regression analysis with the weight fluctuation subscale as a dependent variable showed that experience in mindfulness was not related to weight fluctuation (t(147) = 1.46, *ns*). Results of the regression analyses for BMI and weight fluctuation can be found in Table 4.3.

Relations between mindfulness measures, eating style measures, weight measures, subjective health and demographics. Zero-order correlations between all measured variables can be found in Appendix C.

Table 4.3. Results of regression analyses predicting BMI and weight fluctuation from different measures of mindfulness.

	Outcome variable: BMI					Outcome variable: Weight fluctuation				
Predictor variable	B	β	t	*p*	R^2	B	β	t	*p*	R^2
Mindful attention to body (KIMS)	-0.61	-0.21	-2.26	.03		0.04	0.06	0.72	.47	
Mindful attention to environment (KIMS)	0.26	0.09	0.91	.37		0.09	0.12	1.48	.14	
Mindful attention to emotions (KIMS)	0.07	0.03	0.27	.79	.22	-0.04	-0.05	-0.67	.50	.41
MAAS	0.78	0.15	1.90	.06	.22	-0.08	-0.06	-0.91	.36	.39
Experience in mindfulness/meditation	-.44	-0.25	-3.31	.001	.25	0.04	.10	1.46	.15	.40

Note. Regression analyses controlled for age, gender, subjective health, DEBQ restrained eating, DEBQ external eating, and DEBQ emotional eating. Regression analyses with weight fluctuation as outcome variable additionally controlled for BMI.

Discussion

The current study shows that across a student sample, individuals who generally pay more mindful attention to body sensations, have a lower BMI. Even though this finding does not establish causality, it does suggest that chronically paying mindful attention to the body is beneficial for consumers. This is further supported by our finding that more experience in mindfulness/meditation is related to a lower BMI. We found that experience in mindfulness and meditation was related to the extent in which consumers pay mindful attention to their bodies, their environment and their feelings, but only mindful attention to the body was related to BMI. This coincides with our earlier findings that not general mindful attention but the focus of its attention is critical for its outcome. For general trait mindfulness as measured by MAAS, even an opposite relation was found, individuals who score higher on the MAAS have a higher BMI, something which we did not expect and will return to in the discussion of Study 6b. For none of the measures of mindfulness did we find a relationship with weight fluctuation. One possible explanation for this is that it is difficult for individuals to rate their own fluctuation in weight, specifically over a relatively short period of time, and especially for participants who do not regularly weigh themselves. Therefore in Study 6b we study weight fluctuations by using objective measures of weight over a period of 16 months. Also, in Study 6b we will study the same relations as in Study 6a but in a sample of the general population rather than in a student sample.

Study 6b

Method

Participants and design. For the current study we partly made use of secondary data and partly collected our own data, among the Longitudinal Internet studies for the Social Sciences panel (LISS panel), administered by CentERdata (Tilburg University, the Netherlands). The LISS panel is a representative sample of 8000 Dutch individuals (of 5000 Dutch households) participating in monthly internet surveys. Participants in the LISS panel are based on a true probability sample of households drawn from the population register, with the help of the Dutch Central Bureau of Statistics. Participants receive 7.50 Euro per half hour as financial compensation for participation. Households that do not have access to a computer and/or internet are provided with a computer and/or internet access. For more information on the LISS panel see www.lissdata.nl and Scherpenzeel and Das (2010).

1290 participants (960 households) of the LISS panel were selected to participate in a weighing project for which they received an internet-connected weighing scale at home. The minimum frequency with which participants were required to weigh themselves was randomly varied across households (once a day vs. once a week vs. unspecified). Also the feedback that participants received (feedback of their weight vs. feedback of their weight with their own target weight vs. feedback of their weight with recommended norm range) was randomly assigned per household. Combining these frequency and feedback conditions makes 9 experimental conditions.

The current research selected 514 participants in the weighing project on the basis of the following criteria: 1.) Participants were 18 years or older at the start of the weighing project 2.) Between March 2011 and June 2012,

participants had weighed themselves in at least 11 of the 16 months 3.) Participants had participated in a previous survey on eating styles in July 2010. In August 2012, the selected 514 participants were invited to participate in a survey on 'everyday experiences', of which 467 completed the survey (response rate 90.9%). Three participants were excluded because of measurement errors in the weight data. Fifty-seven participants were excluded because these participants indicated that during the weighing period, their weight was affected by either pregnancy (13 participants), an eating disorder (1 participant), or the use of medication (44 participants). This left a total of 407 participants in the analysis. Background variables of participants and how these compare to the Dutch population can be found in Table 4.4.

Procedure. Participants were invited to take part in a survey on 'everyday experiences'. Participants filled out the observing subscale of the Kentucky Inventory of Mindfulness Skills (KIMS; Baer et al., 2004) and the Mindful Attention Awareness Scale (MAAS, Brown & Ryan, 2003) in order to assess trait mindfulness. Participants were then asked to what extent they had experience in mindfulness or meditation and the extent to which they had experienced pain in the previous four weeks. On the basis of the participant's panel identification number, participants' responses in the mindfulness questionnaire were matched to measures in the weighing project, subjective health measures, their scores on the Dutch Eating Behavior Questionnaire (DEBQ) in a previous eating styles survey and demographic variables (e.g., age, education, income).

Table 4.4. Demographics of sample in Study 6b as compared to the Dutch population.

Demographic	Sample (%) N= 407	Dutch population[1] (%) N = 16655799
Gender		
Male	52.6 %	49.5 %
Female	47.4 %	50.5 %
Married		
Yes	71.0 %	41.2 %
No	29.0 %	58.8 %
Age (years)		
< 20	0.2 %	23.5 %
20-39	14.3 %	25 %
40-64	56 %	35.9 %
65-79	27.0 %	11.6 %
≥ 80	2.5 %	4.0 %
Education		
Primary	7.6 %	8.4 %
High school (vocational)	23.3 %	23.0 %
High school (general)	8.4 %	10.8 %
Vocational	27.5 %	29.3%
College	24.3 %	18.2%
University	8.8 %	9.4%
Degree of urbanization		
Low	38.4%	38.0 %
Moderate	25.6%	18.2 %
High	36.1%	43.8 %

[1] Based on demographics for 2011 provided by Statistics Netherlands (www.cbs.nl).

Measures

Mindfulness measures. As in Study 6A, the observing subscale of the Kentucky Inventory of Mindfulness Skills (KIMS; Baer et al., 2004) was administered in order to examine mindful attention with different foci of attention (see Study 6a). In line with Study 6a, confirmatory factor analyses showed that the three factor model (χ^2 (51) = 295.03, p < .001, RMSEA = 0.11, CFI = .91) outperformed the one construct model (χ^2 (54) = 511.5, p < .001, RMSEA = 0.15, CFI = .83; comparison test: $\Delta\chi^2$ (3) = 216.47, p < .001). We therefore used the three different constructs in our analyses (Attention to body 6 items, α = 0.87; attention to environment 3 items α = 0.79, attention to feelings 3 items α = 0.84). General mindfulness was assessed by the Mindful Attention Awareness Scale (MAAS, Brown & Ryan, 2003). For a description of the MAAS see Study 6a. Cronbach alpha in the current sample was 0.86. Experience in mindfulness/meditation was assessed by the same item as in Study 6a (" *To what extent do you have experience in mindfulness and/or meditation?*" (*1* = no experience at all, *7* = a lot of experience).

DEBQ. In July 2010, participants in the LISS panel were invited to participate in a survey about eating habits and attitudes towards snacks. Among other scales the DEBQ (van Strien et al., 1986) was administered (see Study 6a for a description of the DEBQ). Cronbach alpha's for the current sample were: Restrained eating: α = 0.91, External eating: α = 0.83, Emotional eating: α = 0.96.

Weight measurements. Participants logged in on the weighing scale and the weight of participants was registered. The weighing scale was connected to internet and their measures of weight were automatically saved with their

unique identification number. Thus, participants did not self-report their weight. BMI of participants was calculated using the weight as measured by the scale and height as reported by participants. BMI was calculated for participants each month (by taking the means of the first ten measurements each month) and means of these measures were calculated over the course of the 16 months. In order to examine weight fluctuation, we calculated the variance in the weight of participants over the sixteen months. We also computed scores for the number of times participants weighed themselves each month and the number of months they participated in the study.

Subjective health measures. In the survey participants were asked to rate the extent to which they had experienced pain in the previous four weeks (*1* = none, *7* = very serious pain). During the period of weighing participants were required to fill in several questions about their health each month. Participants indicated whether there were any circumstances that could have affected their weight (e.g. pregnancy, certain medicine that affect weight) and how they would characterize their health ("How would you describe your health in general? , *1* = poor, *5* = excellent"). This last item was averaged over the 16 months as a measure of subjective health.

Results

Relationship between mindful attention to body, mindful attention to environment, mindful attention to feelings (KIMS), BMI and weight fluctuation. A regression analysis was conducted in order to examine the association between mindful attention to the body, mindful attention to environment, mindful attention to feelings and BMI. These mindfulness measures were entered as predictor variables and participants' mean BMI across the 16

months served as the dependent variable. Gender of participant, age at the start of the weighing period, education level, the number of months participants weighed themselves, participants mean subjective health across the 16 months, and restrained eating measures (DEBQ-restrained, DEBQ-emotional, and DEBQ-external) were entered as control variables. Also, in order to check whether the experimental condition participants were assigned to had an effect on mean BMI, the mean number of times participants weighed themselves each month and the feedback condition participants were in (the three groups coded as two dummy variables), were included as control variables. Collinearity statistics for none of the explanatory variables surpassed critical levels (all VIF < 2.4, all Tolerance >.42). Results of the regression analysis revealed that mindful attention to the body did not predict BMI ($t(380) = -1.14$, *ns*), nor did mindful attention to environment or mindful attention to feelings. In separate regressions it was also checked whether our findings were different for BMI at the start or the end of the weighing period. This was not the case and will not be reported.

In order to assess whether there was a relationship between mindful attention to body, mindful attention to environment and mindful attention to feelings and weight fluctuation, regression analyses were conducted with the same predictor variables as in the above reported regressions, and variance across weight over 16 months as a dependent variable (for the monthly weight measures the average of the first 10 weight measures in that month was taken). Also, because individuals who have a higher BMI to start with are more likely to vary more in their weight, BMI at the start of the weighing period was also included as a control variable. The results show that mindful attention to the body has a negative significant relationship with variance in weight ($\beta = -0.25$, $t\ (296) = -3.18$, $p < .01$), such that individuals who indicated to pay attention to body sensations, varied less in their weight. The extent to

which individuals paid mindful attention to feelings, however, was found to have a positive relationship with variance in weight (β = 0.26, *t* (296) =3.18, *p* <.01), with participants who paid more attention to their feelings, having a higher variance in weight. Results of the regression analyses for mean BMI and variance in weight are reported in Table 4.5.

Relationship between mindful attention (MAAS), BMI, and weight fluctuation. Regression analyses were also performed with MAAS scores as a predictor variable. The dependent variable and control variables were similar to those in the regression analyses reported above. Collinearity diagnostics of none of the variables passed critical levels (all VIF < 1.78, all Tolerance >.56). The results of the regression analysis indicated that MAAS scores had a marginally significant relationship with participants' BMI, such that a higher MAAS score was related to a higher BMI (*t* (383) = 1.80, β = 0.09, *p* = .07). A regression analysis with variance across weight over 16 months as a dependent variable and MAAS as a predictor variable was also conducted. Control variables were similar as in previous analyses, with BMI at the start of the weighing period as an additional control variable. No relationship between scores on MAAS and variance in weight scores was found (β = -0.06, *t* (299) = -0.91, *ns*). Results of the regression analyses for mean BMI and variance in weight are reported in Table 4.5.

Experience in mindfulness, BMI, and weight fluctuation. We also assessed how participants' experience in mindfulness/meditation was related to the weight measures. A regression analysis with BMI as a dependent variable, experience in mindfulness as an independent variable and similar control variables as reported above, showed a significant and negative relationship between experience in mindfulness/meditation and BMI (*t* (382) = -2.12, β = -0.10, *p*

<.05). Participants with more experience in mindfulness had a lower BMI. A regression analysis with variance in weight across 16 months showed that experience in mindfulness was not related to weight fluctuation (t (298) = 0.81, *ns*, see Table 4.5).

Relations between mindfulness measures, eating style measures, weight measures, subjective health and demographics. Zero-order correlations between all measured variables can be found in Appendix D.

Table 4.5. Results of regression analyses predicting mean BMI and variance in weight over a period of 16 months from different measures of mindfulness.

	Outcome variable: Mean BMI across 16 months					Outcome variable: Variance in weight 16 months				
Predictor variable	B	β	t	*p*	R^2	B	β	t	*p*	R^2
Mindful attention to body (KIMS)	-0.23	-0.08	-1.14	.26		-1.23	-0.25	-3.18	.002	
Mindful attention to environment (KIMS)	0.00	0.00	0.00	1.00		0.15	0.03	0.40	0.69	
Mindful attention to emotions (KIMS)	-0.06	-0.02	-.28	.78	.19	1.32	0.26	3.18	0.002	.17
MAAS	0.58	0.09	1.80	0.07	.19	-0.58	-0.06	-0.91	.37	.14
Experience in mindfulness/meditation	-0.26	-0.10	-2.12	.03	.19	0.20	0.05	0.81	0.42	.14

Note. Regression analyses controlled for age, gender, subjective health, DEBQ restrained eating, DEBQ external eating, DEBQ emotional eating, education level, number of months weighed, average number of monthly weight measures, and feedback condition (three groups coded as two dummy variables). Regression analyses with variance in weight as outcome variable additionally controlled for BMI at the start of the weighing period.

Discussion

The findings of Study 6b provide additional support for our hypothesis that paying mindful attention to the body is related to positive weight outcomes. Relying on objective weight measures, we found that individuals who directed more mindful attention to their bodies varied less in their body weight over a period of sixteen months. This finding is in line with our argumentation that paying mindful attention to the body helps consumers to compensate for previous intake and maintain an overall constant food intake, and extending this logic, keep a constant body weight. In Study 6b, paying mindful attention to the body was not related to an overall lower BMI. Having more experience in mindfulness/meditation was found to be associated with a lower BMI. Finally, also in this sample general trait mindfulness as measured by MAAS appeared to be adversely related to BMI.

Across a student sample and a sample of the general population using both self report measures and objective measures of weight, we found that paying mindful attention to the body was related to positive health outcomes for individuals; a lower body weight (Study 6a) and a lower variance in body weight (Study 6b). Even though in Study 6b, in contrast to Study 6a, we did not find that paying mindful attention to the body was related to an overall lower BMI, in both samples we found that having more experience in mindfulness or meditation was related to a lower BMI.

We have argued that it is not mindfulness in general but rather directing mindful attention at the body that helps consumers to compensate for previous consumption and we found support for this in our experimental and survey studies. In both Study 6a and Study 6b general trait mindfulness (MAAS) was even found to have a positive relationship with BMI. This is something which we did not expect and is also not in line with our findings in

Experiment 1 where we found that a higher general trait mindfulness (using the same scale) was related to better compensation for previous consumption. One reason for the discrepancy in findings between Experiment 1 and our survey studies could be that general dispositional mindfulness has different effects in the short term and the long run. A higher awareness of the present moment may help short term compensation but mindful attention directed at the body is needed for longer term weight maintenance. There is little information available on the relationship between MAAS and BMI. A few (unpublished) studies have reported non-significant relationships between MAAS and BMI (Gilbert, 2010; Sopko, 2010) but to our knowledge no studies have reported significant positive relationships.

A second explanation for our findings concerns the MAAS scale we used for measuring general dispositional mindfulness. In the student sample we found no relationship between experience in mindfulness and trait mindfulness as measured by MAAS and in the sample of the general population we even found a negative relationship. This raises serious concerns about the construct validity of the scale, as experience in mindfulness and meditation provides a clear external referent to define mindfulness. Although studies have found meditation experience to be positively related to MAAS scores (Brown & Ryan, 2003) also several studies have failed to find such associations (e.g Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; MacKillop & Anderson, 2007). Recently, the MAAS scale has been criticized for measuring the absence of mindlessness rather than mindfulness (Grossman, 2011). Possibly, the MAAS scale measures enhanced attention more generally and is not able to tap into the more specific process of enhanced attention to the body that is related to positive weight outcomes.

General discussion

Over the last decades a wealth of research has convincingly shown that cues in the environment have the capacity of mindlessly driving our food consumption (Wansink, 2004). This has led scholars to label our eating environment as obesogenic and our eating behavior as mindless. The current research has examined the opposite side of the coin: By examining *mindful* eating as opposed to *mindless* eating and more broadly speaking, by looking at factors that improve rather than undermine healthy eating patterns. Our findings show that mindfulness leads consumers to be more aware of physiological cues and adjust further food consumption accordingly. This was found for consumers who are chronically more mindful but we also found that even a short mindfulness meditation that focuses attention on the body enhances consumers' awareness of hunger and satiety cues and increases compensation for previous food intake. Following a mindfulness manipulation, consumers were not more affected in their subsequent consumption by the salience of the amount of previous consumption or by the perceived healthiness of what they have eaten, making this unlikely explanations for our finding of enhanced compensation. Finally, we found that experience in mindfulness practice and chronically attending mindful attention to the body were related to a lower body weight and a more stable body weight, suggesting that also in the long run mindfulness, particularly mindful attention to the body, provides consumers with important health benefits.

Up till now, the concept of mindfulness has mostly been applied in clinical contexts to improve psychological well-being (Brown et al., 2007). Mindfulness-based interventions in the context of eating have mostly focused on interventions for individuals trying to lose weight and aim at changing

individuals' maladaptive thoughts towards food (Alberts et al., 2010; May et al., 2010). The current study shows that also among a non-clinical population, mindfulness is a relevant predictor of individual's body weight and fluctuation in body weight. Moreover, our findings illustrate mindfulness' applicability to food consumption for consumers in general, demonstrating that even a very short manipulation can alter responsiveness to physiological cues.

We have argued that paying mindful attention to the body, enables individuals to attend more closely to physiological cues of hunger and satiety, and that this drives their later compensation behavior. One possible alternative explanation underlying our finding of improved compensation is that through an enhanced attention, mindful individuals can better register how much they eat. In line with this, the effects of distraction on compensation in eating behavior have mostly been attributed to an interference with the cognitive encoding of how much is consumed (Higgs & Woodward, 2009). However, if mindfulness, through an enhanced attention, would lead individuals to better encode how much they eat, we would expect that both mindfulness conditions, rather than only the mindful attention to the body condition would show enhanced compensation. When testing this alternative explanation more directly we found that an individual's recall of the amount of previous consumption was not affected by the mindfulness manipulation, indicating that consumption amount was not encoded or remembered differently. Finally, making the amount or the number of calories in their previous consumption more salient did not affect consumers that had followed a short mindfulness meditation, rendering it unlikely that consumers followed a cognitive strategy of compensation.

We think that a more plausible explanation for our finding of improved compensation is that mindfulness facilitates consumers' awareness of internal hunger and satiety cues and leads consumers to adjust subsequent

consumption accordingly. Our finding that only paying mindful attention to the body, but not mindful attention to the environment, led to enhanced compensation also lends support to the idea that an improved access to hunger and satiety cues was the driving mechanism. In a more direct test of this hypothesis we have indeed found that paying mindful attention to the body led individuals to become more aware of the satiety cues that developed after preloads of different caloric contents. One limitation of our study is that the effects of mindfulness on the awareness of hunger and satiety cues and on compensation behavior were studied in separate studies, and we can therefore not draw a direct causal pathway for our hypothesis. In our view, relying on hunger and satiety cues in food consumption entails two processes: consumers must first of all be aware of their physiological hunger and satiety cues, but they must also respond to them by adjusting their food intake accordingly. In order to respond to physiological hunger and satiety cues, consumers must first become aware of these cues, something which we found becomes easier for individuals after a mindfulness meditation focusing on the body. In our compensation paradigms, the processes of becoming aware of physiological cues and responding to them are intertwined and in our studies we have treated them as one process. However, we cannot rule out that mindfulness not only affects the awareness of internal hunger and satiety cues but also the extent to which consumers respond to them. Future research should test this more directly in order to disentangle how these processes lead to enhanced compensation for previous consumption.

The distinction we made in the current research between different foci of attention has implications for both the food consumption and mindfulness literature. Whereas several studies on food consumption have demonstrated that a lack of attention undermines compensation behavior (Bellissimo et al., 2007; Higgs & Woodward, 2009; Mittal et al., 2011; Oldham-Cooper et al.,

2011), our findings suggest that in order to improve responsiveness to hunger and satiety cues, it is not enough to enhance attention in general but this attention should be directed to (internal sensations of) the body. This is further supported by the finding that being chronically more mindful of the body's sensations is related to a lower body weight and less fluctuation in weight, whereas a higher dispositional mindfulness with different foci of attention is not. It should be noted that our mindful attention meditation did not direct individuals' attention directly to their stomach, nor were hunger and satiety cues explicitly mentioned. It appears that focusing on feeling different parts of the body and experiencing sensation such as breathing, makes a whole system of body sensations more accessible. This is in line with recent findings that suggest that the awareness of different body sensations, such as heart beat, breathing, and feelings of satiety are related (Herbert, Muth, Pollatos, & Herbert, 2012). Up till now the diverse range of effects of mindfulness have all been attributed to a general mindfulness effect. Distinguishing between different foci of attention in mindfulness and its effects in different applications, could shed more light on the mechanisms underlying mindfulness.

Relying on internal physiological cues in food consumption entails eating when hungry and stopping to eat when satiated. However, in two of our experiments we found that mindful participants particularly felt less full after a small preload and compensated by eating more after a small preload. This raises the concern whether paying attention to the body is beneficial for consumers or could instead make consumers particularly sensitive to feelings of hunger. Even though being able to notice feelings of hunger is an important determinant of an effective energy regulation altogether (Herman & Polivy, 1980), there is a possibility that an exaggerated attention to feelings of hunger leads to overeating. However, we found that paying mindful attention to the

body was related to a lower body weight in the student sample and a more constant body weight over a period of sixteen months in a sample of the general population. Even though these results are cross-sectional and do not allow for causal inferences, together with our experimental findings this suggests that paying mindful attention to the body is an effective strategy to maintain a healthy and stable body weight.

Having said this, an opposite relationship with body weight appeared for our measure of general dispositional mindfulness (MAAS), with more mindful individuals having a higher BMI. Even though our experimental findings indicate that particularly mindful attention to the body rather than mindful attention directed elsewhere facilitates compensation, we did not expect an inverse relationship. Also, this is inconsistent with our first experiment in which we found that individuals with a higher score on the same measure of dispositional general mindfulness, compensated better for the caloric content of a preload. As mentioned before, we suspect that the overall enhanced attention state as measured by the MAAS may not generalize to an enhanced attention to the body. This is also evidenced by the failure to find a relationship between MAAS and experience in yoga and meditation practice, in which attention to the body is an important element. Perhaps general enhanced attention as measured by MAAS, or rather the lack of absent mindedness as has been suggested by some authors (Grossman, 2011) may enhance compensation in the short term, but lacks the specific attention to the body that is vital to maintain a healthy body weight in the long run. Our finding that two measures of mindfulness were related to very different outcomes is also interesting in the light of a discussion among mindfulness scholars of whether mindfulness should be considered as a single construct (as in the case of MAAS) or whether mindfulness encompasses a range of specific skills (Baer et al., 2006; Bishop et al., 2004; Grossman, 2011). In order

to gain a clearer picture of what qualities various measures of mindfulness tap into and how they relate to each other, future studies should compare more directly how general dispositional mindfulness and more specific elements of mindfulness relate to eating behavior.

Numerous findings in consumer research have shown how external cues influence what and how much consumers eat (for an overview see Bublitz, Peracchio, & Block, 2010), and as a result it has been suggested that internal physiological cues play a relatively small role in food consumption (e.g., Herman & Polivy, 2005). However, most studies could not assess the effects of internal physiological cues, because these studies assessed consumption only at a single point in time or did not manipulate physiological cues. Using a preload paradigm, we have been able to examine the effects of physiological internal cues more directly and demonstrate that mindfulness can alter responsiveness to these internal cues. We also examined whether mindfulness may alter reliance on external cues in food consumption. We found that after a mindfulness manipulation, individuals were not affected by an external cue of the amount or calories of previous consumption, making strategic compensation on the basis of amount or calories of previous compensation an implausible explanation for our findings. However a limitation of our study is that these external cues also did not have a strong effect (in the case of a visual cue of previous consumption) or any effect (in the case of a health cue) in the control condition, which makes it hard to make any comparisons with the mindfulness condition. One possible explanation we can provide for the lack of strong findings for these external cues, is that the effects of these cues manifest themselves mostly within one eating episode, as they have been mostly studied, rather than across eating episodes. This highlights the need to study how the effects of external cues manifest themselves over multiple eating episodes.

Amidst an abundance of insights into factors that undermine consumers' eating behaviors and lead to mindless eating, the current study provides consumers with a positive perspective showing how they can improve their eating patterns. Rather than simply advising consumers to rely on hunger and satiety cues, which is something people often struggle with, our findings give consumers more guidance on how responsiveness to hunger and satiety cues can be achieved. Simply focusing on several general and more accessible aspects of the body, such as breathing and posture, can improve a consumer's eating patterns.

Appendix A

Significant differences between low and high caloric milkshakes (Experiment 1).

Rating	Milkshake		Test statistics
	High caloric	Low caloric	
Sweetness	7.54 (2.08)	5.99 (2.41)	$F(1, 36) = 4.48$, $p < .05$
Caloric content	8.09 (1.40)	6.36 (2.26)	$F(1, 36) = 7.88$, $p < .01$
Creaminess	8.11 (0.94)	6.15 (2.50)	$F(1, 36) = 9.72$, $p < .01$
Healthiness	2.67 (0.97)	4.00 (1.65)	$F(1, 36) = 8.92$, $p < .01$
Satiating	8.34 (1.67)	5.20 (2.63)	$F(1, 36) = 18.76$, $p < .001$

Note. Values reported between parentheses are standard deviations.

Appendix B

Scores on pleasure, arousal, dominance scales (PAD scales) as a function of mindfulness condition (Pretest Experiment 3).

Measure	Mindfulness instructions		
	Attention to the body	Attention to the environment	Control
Pleasure	4.78^{a} (0.89)	4.58^{a} (0.97)	3.96^{b} (0.97)
Arousal	4.90^{a} (0.58)	4.73^{a} (0.80)	5.27^{b} (0.66)
Dominance	3.73^{a} (0.63)	3.72^{a} (0.61)	4.20^{b} (0.60)

Note. Values reported between parentheses are standard deviations. Different superscripts indicate significant differences ($p < .05$) between means(across conditions).

Appendix C

Zero-order correlations between measures (Study 6a).

Measure		1	2	3	4	5	6	7	8	9	10	11	12	13
1.	KIMS- body	-												
2.	KIMS- environment	.52**	-											
3.	KIMS- feelings	.48**	.44**	-										
4.	MAAS	.09	.13	.13	-									
5.	Experience mindfulness	.29**	.22**	.23**	-.12	-								
6.	BMI	-.15+	-.04	.04	.04	-.18*	-							
7.	Weight fluctuation	-.00	.09	.09	-.10	-.01	.57**	-						
8.	DEBQ- restrained	-.04	-.19*	.22**	-.11	-.03	.31**	.29**	-					
9.	DEBQ- emotional	.12	-.03	.15+	-.24*	.13	.17*	.11	.24**	-				
10.	DEBQ- external	-.05	-.02	-.00	-.27**	-.18*	.07	.16*	-.05	.35**	-			
11.	Subjective health	-.02	.02	.08	-.15+	.13	.11	.21**	.07	.15	.12	-		
12.	Pain	.05	-.01	-.06	-.23**	.19*	-.09	.04	.06	.00	.03	.36**	-	
13.	Age	.07	.14+	.01	.04	.21**	.22**	.17*	-.05	.04	-.22**	.02	.04	-

*$p < .05$, **$p < .01$, + $p < .10$

Appendix D. Zero-order correlations between measures (Study 6b).

Measure		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	KIMS- body	-														
2.	KIMS- environment	.61**	-													
3.	KIMS- feelings	.68**	.66**	-												
4.	MAAS	-.12*	.02	-.10+	-											
5.	Experience mindfulness	.40**	.23*	.32**	-.13**	-										
6.	Mean BMI	-.06	-.08	-.08	.08	-.09+	-									
7.	Variance in Weight	-.07	-.01	.07	-.04	-.01	.25**	-								
8.	DEBQ- restrained	.28**	.18**	.23**	-.04	.17**	.20**	.03	-							
9.	DEBQ- emotional	.21**	.09	.12*	-.34**	.22**	.11*	-.001	.25**	-						
10.	DEBQ- external	.11*	.03	.11*	-.39**	.16**	.05	.06	.05	.58**	-					
11.	Subjective health	-.02	.02	.05	.04	.02	-.18*	-.02	.05	-.13**	-.02	-				
12.	Age	-.01	.07	-.09	.22*	-.14**	.12*	-.08	.15**	-.22**	-.37**	-.16**	-			
13.	Education	.12*	.07	.12*	-.22**	.18**	-.17*	-.04	.02	.10*	.15**	.12*	-.28*	-		
14.	Months weighed	-.04	.02	-.01	-.05	-.04	-.06	.004	.04	-.05	-.09+	-.06	.15*	.02	-	
15.	Monthly weighing moments	-.03	-.06	-.03	.07	-.02	.09+	.10*	.09	-.08	-.07	.13*	.15**	.01	.19**	-

*$p < .05$, **$p < .01$, + $p < .10$

Chapter 5

General Discussion

The aim of this thesis was to identify how one consumption episode affects the amount of food that consumers eat during a subsequent consumption episode. The thesis focused on two key questions related to consumption sequences: (i) *when* do people rely on internal hunger and satiety cues in sequential consumption episodes, and (ii) how does social context in terms of with whom one consumes affect later consumption. We have argued that the amount of resources that individuals have available is crucial for how consumers balance the amount of consumption across episodes. First of all, we examined how the social context affects later consumption through self-control resources. Furthermore, we have explored whether attentional resources are necessary for an awareness and reliance on the body's hunger and satiety cues, and have shown that particularly the focus of attention -on the body's internal sensations or the body's external appearance- moderates the extent to which consumers are able to compensate for previous consumption. The next section gives an overview of the main findings of this thesis.

Overview of main findings

The findings show that the social context during a meal- specifically whether consumers eat with someone they know or with someone they don't know- affects how much consumers snack afterwards (**chapter 2**). Our prediction was based on previous research that has suggested that less smoothly flowing conversations use up self-control resources (Finkel et al., 2006) and that resisting cookie consumption relies on such resources (Baumeister et al., 1998). We thus expected that meals shared with familiar others would be accompanied by smoother conversations and would lead to less snacking after the meal. Indeed, the results show that when participants shared dinner with

someone they knew, they experienced the mealtime conversation as smoother and subsequently ate fewer snacks when they were by themselves, compared to participants who had dinner with a stranger. However, there was no evidence that smoothness of conversations underlied the effect of familiarity with eating companion on later snack consumption. Thus although we confirmed the hypothesised effect, the underlying mechanism could not be confirmed. In the same study, we also explored the effects of seating arrangement on smoothness of conversations and later snack consumption. The findings show that how individuals are seated towards each other affects how smoothly they experience mealtime conversations: When seated directly opposite each other, conversations were experienced as less smooth than when seated next to each other, or diagonally around the corner of a table. Seating did not affect later cookie consumption, neither directly nor through smoothness of conversation.

Whereas chapter 2 focuses on how the social context of an eating episode affects later snacking through self-control, **chapters 3 and 4** examine how attentional resources affect the extent to which consumers balance amounts of consumption across consumption episodes. Specifically, we argue that the extent to which consumers adjust for previous consumption by relying on how full they feel, depends on where consumers direct attentional resources. **Chapter 3** demonstrates that environmental cues such as mirrors and advertisements can direct individuals' attention to appearance aspects of their body. Furthermore, the results show that when individuals direct attention to external, appearance based aspects of their body, they are less successful in compensating for "hidden" additional calories in a milkshake in their later intake as well as in adjusting consumption according to whether they previously had lunch. Also, an appearance focus on the body has an effect on whether participants compensate for the actual content of the preload,

rather than on how it is labelled, suggesting that an appearance focus on the body interferes with the awareness of internal satiety cues rather than with memory for previous consumption.

As directing attentional resources towards appearance aspects of the body appeared to distract away from hunger and satiety cues, in **chapter 4** we extend our finding by examining the other side of the coin. That is, would directing attentional resources towards internal body sensations facilitate the awareness of internal hunger and satiety cues and enhance compensation in consumption behavior? Awareness of body sensations plays a central role in mindfulness, a state of enhanced attention of the present moment, often practiced through yoga or meditation (Holzel et al., 2011; Mehling et al., 2012). A series of experiments in chapter 4 therefore examine the role of mindfulness in the awareness of hunger and satiety feelings and compensation in consumption behavior. We find that individuals who are chronically more mindful are better able to compensate for a milkshake that is covertly manipulated to contain more calories. Also, the findings show that short mindfulness exercises focusing attention on the body, enhance compensation for amount of previous consumption. The direction of attention is crucial: Exercises that direct mindful attention on the body or on the environment both lead to a state of enhanced attention, but only mindful attention directed at the body facilitates compensation for previous consumption. Furthermore, after mindful attention to the body exercises, individuals were not affected in subsequent consumption by cues that indicated the amount of calories or amount of consumption, but participants were more aware of the satiety cues that developed after consumption. This suggests that mindfulness enhances compensation by facilitating the awareness of internal hunger and satiety cues rather than by enhancing cognitions about previous consumption. Finally, chapter 4 explores how the

extent to which individuals pay mindful attention to internal body cues in everyday life is related to measures of BMI and body weight fluctuation, among a student sample and a sample of the general population. Overall, the findings show that paying attention to internal body cues in general, as well as practicing yoga or mindfulness, is related to beneficial weight outcomes. The relationship between mindful attention to the body and beneficial weight outcomes was not reflected in a measure of general mindfulness.

Implications: Contributions to theory

By examining consumption sequences rather than single consumption episodes we have contributed to insights in consumers' eating behavior in a number of ways. First, our findings on the social context of eating extend previous research that has almost exclusively focused on the effect of social context within single eating occasions. The main finding of this latter body of research is that eating with more people and in a more pleasant social context increases food intake (de Castro, 1994; Herman, Roth, & Polivy, 2003). Our focus on consumption sequences provides a complementary perspective in showing that eating with friends and familiar people may not be as detrimental as research on single eating episodes suggests. To our knowledge, this is the first study that has examined the delayed effects of social contexts on later food intake. Although we find our hypothesized effects, our findings need to be interpreted with care because we fail to find empirical support for the theoretically reasoned underlying process.

The second important contribution of our research comes from the integration and bridging of two research traditions. Whereas previous research has tended to focus on whether compensation is due to internal signals or external cues, our research links the two by asking the question:

when rather than *whether* consumers rely on internal cues. An extensive body of work in the consumer research literature has studied the effects of environmental cues and psychological states on food intake, but the focus has been on single shot consumption episodes. General thinking in this area has tended to conclude that internal physiological cues play but a minor role in predicting consumption (cf. Herman & Polivy, 2005; Wansink, 2010). On the other hand, the nutrition and eating behavior literature has extensively studied compensation for previous consumption according to internal cues, but has focused primarily on the types of foods or personality traits that are related to (in)effective compensation. Recently, a number of studies within the nutrition and eating behavior literature has also examined how a psychological state, particularly distraction, can momentarily affect compensation in consumption (e.g., Brunstrom et al., 2012; Higgs & Woodward, 2009; Oldham-Cooper, Hardman, Nicoll, Rogers, & Brunstrom, 2011). The findings of this thesis add to this line of research. In combining the consumer behavior and nutrition literatures and their corresponding research paradigms we have gained more insight into *when* consumers *do* compensate for previous consumption. This is important as our findings suggest that relying on hunger and satiety cues is not a fixed personality trait, as has previously been assumed, but also has state aspects that can be altered momentarily through environmental influences that shift individuals' attentional resources to different aspects of their bodies.

Related to that "*when*" question of compensation we identify attentional resources as an important moderator for the extent to which consumers rely on internal signals. Several studies have demonstrated that attentional resources affect compensation by influencing the extent to which consumers can cognitively remember their consumption (for an overview see Robinson et al., 2013). Our findings suggest that attentional resources can also

affect compensation by impacting consumers' awareness of the hunger and satiety cues that develop after eating. This is in line with initial findings that distraction can temporarily interfere with the awareness of hunger and satiety cues (Bellisimo et al., 2007; Ogden et al., 2013). We further add to this literature on attentional resources by showing that not only attention per se, but rather the focus of attention is crucial. Our findings suggest that attention focused on inner body sensations and attention focused on outer body appearance have very different effects on compensation in consumption. Furthermore, only directing attention at the body, but not a general level of increased attention, was found to enhance compensation.

The findings on directing attentional resources towards internal sensations of the body also contribute to a growing literature on body awareness in general, which assumes that the awareness of several body cues are related (Herbert et al., 2012; Mehling et al., 2009). The extent to which individuals are aware of subtle internal body cues, has been assessed primarily by heartbeat monitoring tasks, where individuals' perception of their number of heartbeats within a certain time frame is compared to their actual number of heartbeats (Mehling et al., 2012). The extent to which individuals are able to sense their heartbeats has indeed been related to the awareness of a range of different internal body sensations such as pain perception, emotional experience or sensitivity for gastric feedback (Herbert et al., 2012). Also, the awareness of several body signals has been related to activation in specific brain areas, specifically the right anterior insula (Critchley, Wiens, Rotshtein, Öhman, & Dolan, 2004). Our findings add to the evidence that the awareness of several internal body cues may be related, as a short training of focusing on different body cues, such as focusing on breathing, led consumers to be more aware of hunger and satiety cues.

Finally, our research adds to the growing body of research on the popular concept of mindfulness in relation to food intake. Although mindfulness trainings are popular and linked to a range of (psychological) health benefits (Brown & Ryan, 2003; Brown et al. 2007) not all of these benefits are founded on emperical research or are applied to non-clinical populations. With regard to eating behavior, mindfulness has been associated with more adaptive eating styles but this has been studied primarily in clinical samples where mindfulness techniques were embedded in broader intervention programs (e.g., Kristeller & Wolever, 2011). Also, these studies did not focus primarily on being aware of hunger and satiety cues but directed specific attention at changing the way individuals dealt with disturbing thoughts about eating (e.g., May et al., 2010). The current study adds to the mindfulness literature in that a crucial component of mindfulness, being aware of internal body sensations, can aid consumers in compensating for previous food intake and that this is not restricted to clinical populations, dieters, or individuals with eating disorders but applies to individuals more generally. Furthermore, the distinction we made in the different foci of mindful attention suggests that there may not be a 'general' mindfulness effect but that its effects also depend on the object of attention.

Limitations and future research

Despite these contributions, the research has also raised a number of new questions and suggestions for future research. Complementing the limitations already discussed in the individual empirical chapters, there are four issues that deserve special attention overall.

Time interval between consumption episodes

In this thesis we have examined consumption episodes that follow shortly after each other in order to study the basic processes of how such episodes may affect each other and the factors that moderate compensation of food intake across consumption episodes. We examined short term compensation by assessing food intake in a time range of 15-45 minutes after consumption of the preload. This time frame is in line with several preload studies assessing short-term energy regulation, as most studies have used a time interval of around 20- 30 minutes (Birch et al., 1989, Benelam, 2009). This time frame therefore allowed us to study the basic process of compensation and situations when individuals are better or worse at detecting and responding to physiological cues[3]. Such sequences of consumption episodes reflect situations such as a dessert following a meal and are relevant for studying modern eating patterns where several smaller meals and snacks have started to replace traditions of three larger meals a day (Popkin & Duffey, 2010; Samuelson, 2000). However, this short time span and our focus on adjustment in food intake after snack consumption rather than after meals, also limits the extent to which our findings can be generalized to longer time intervals between consumption episodes and this is something that should be examined in further research. It is to be expected that with meals that have larger energy contents, the time that such meals are able to generally suppress further

[3] Different time frames may reflect responses to different kinds of physiological cues. In very short term intermeal intervals, compensation may primarily measure responses to the weight and volume of foods, whereas a longer time frame may be needed to study responses to energy content and different kinds of macronutrients (Zandstra, Mathey, de Graaf, & van Staveren, 2000).

intake is longer and we expect that directing attentional resources towards either appearance aspects of the body or internal sensations of the body has similar effects in these situations. On the other hand, previous findings suggest that as the time between consumption episodes increases, it becomes increasingly hard for individuals to adjust their food intake according to previous intake (Rolls et al., 1991). Recent findings suggest that as time progresses cognitions about previous food intake rather than actual intake determine subsequent intake (Brunstrom et al., 2012). Brunstrom and colleagues (2012) show that in consumption shortly after the preload, participants compensated for the actual amount of energy intake regardless of how much the researchers told them they had consumed, but after about two hours, the amount they thought they had consumed became more decisive in their later food intake. In this light, attentional resources directed at body cues may then have limited effect. Future research should establish whether our findings on the basic processes of compensation generalize to longer intervals between consumption episodes and generalize to meals rather than snacks.

Repeated exposure and learning effects

A longer time perspective on our findings also entails the question of how consumers react to repeated exposures of directing attention toward appearance aspects of the body or internal body cues. Our findings have demonstrated that incidental cues such as mirrors or beauty advertisements, and short mindfulness exercises can affect the extent to which consumers are able to compensate for previous consumption. It is possible that with repeated exposure, attention to these cues decreases and likewise their effect on consumption behavior. On the other hand, in the case of mindfulness exercises, a learning effect may lead individuals to become better at these

exercises and at sensing the physiological effects of foods. Future research should address the issue of whether after repeatedly directing attentional resources towards outer body appearance or inner body sensations over time its effects remain, or become stronger or weaker. In this respect an interesting possibility to pursue is whether a learning effect in mindfulness also initiates a learning effect in the perceived satiety value of foods. A number of studies have shown that expectations of the satiety value of a food are learned through the experiences consumers have with these foods (Brunstrom, Shakeshaft, & Alexander, 2010; Brunstrom, Shakeshaft, & Scott-Samuel, 2008). However, the expectations that consumers have about the satiety values of foods often do not match the actual energy content of foods (Brunstrom et al., 2008). Repeatedly being more aware of satiety feelings that develop after consumption of a food could potentially increase the accuracy of how satiating consumers expect a food to be at a subsequent moment of consumption. As the perceived fillingness of a food has been identified as an important predictor of how much consumers serve themselves (Brunstrom & Rogers, 2009; Brunstrom & Shakeshaft, 2009), directing attentional resources to the body could in this way produce a positive reinforcing cycle.

Longer term effects

Taking an even longer time perspective, it is relevant to reflect on how our findings may contribute to achieving and maintaining a healthy body weight. Our findings on mindfulness indicate that chronically directing mindful attention to the body is related to positive weight outcomes. This indicates that directing mindful attention to the body is beneficial in the long term, but these findings were based on correlational evidence and personality measures. Future studies should examine whether instructing people to direct

attentional resources towards body cues helps consumers to achieve and maintain a constant and healthy weight in the long term. In particular, it is relevant for future studies to examine in greater detail how directing attentional resources at body cues does not only affect compensation but particularly accuracy of compensation. A potential negative side effect of focusing on body cues is that more attention is paid to hunger feelings than to satiety feelings. Along with the finding that upward compensation for "missing" calories is easier than downward compensation for "additional" calories (Mattes, Pierce, & Friedman, 1988) directing attentional resources to body cues poses the risk of overcompensation. Correlational findings in our study however, have found no indication that focusing on body cues, including hunger cues, leads to overcompensation.

Also relevant for studying the longer term potential of mindfulness in maintaining a constant body weight is to examine in greater detail whether the findings of enhanced compensation hold when external pressures to consume increase. The current studies did test compensation when people were confronted with relatively large portions of tempting food products and the mindfulness findings thus provide an indication that compensation is enhanced even in the face of temptation. Relying on hunger and satiety cues could in this way provide consumers with a kind of buffer to resist the effect of environmental cues on food intake. However in consumption situations outside the laboratory, environmental cues, such as the variety of food products or perceptions of others eating, are likely to be much stronger. Future research should examine in greater detail whether the effects of focusing on hunger and satiety cues uphold amidst greater external pressures to eat and may even form a buffer against these effects.

Related to the question of how our findings contribute to a constant and healthy body weight in the long term, is the question of whether our

effects generalize to individuals who are specifically concerned with achieving or maintaining a constant weight, which was not the case in our sample. In this respect it might also be useful for future research to distinguish between being aware of hunger and satiety cues and responding to them. In our findings directing attentional resources to the body led individuals to being aware of hunger and satiety cues and relying on these in consumption. However, awareness and responding to hunger and satiety cues is not necessarily the same process and this distinction may be particularly relevant for studying compensation behavior of restrained eaters or dieters.

Underlying mechanisms

An important limitation of this thesis is that we have not been able to pinpoint exactly the mechanism for our observed findings. Future studies should examine in more detail the underlying mechanisms of our effects, as well as replicate our research in order to test the robustness of our findings. The first study on the effects of social context on later consumption measured smoothness of conversation as a proxy for the level of self- control resources but did not find any evidence for the hypothesized mechanism. In the studies that looked at directing attentional resources on outer body appearance and inner body sensations, a direct test of our hypothesis would have been that a differential awareness of hunger and satiety cues explained the effects of our manipulations on later food intake. However, one of the difficulties of measuring awareness of hunger and satiety is that the measurement in itself raises the awareness of hunger and satiety cues. By asking individuals about their levels of hunger and satiety, attention is automatically directed towards these cues, which makes it difficult to find any differences in awareness as a result of our manipulation.We therefore chose to study our hypothesized

mechanism in a series of studies and found converging evidence for our hypothesis. Nevertheless, it would be useful to pursue this further in future research. One possibility is to explore whether more implicit measures of the awareness of hunger and satiety could be developed that reliably measure awareness of these cues without specifically directing attention to hunger and satiety.

Practical relevance

Despite these limitations, the current findings also have several practical implications. Whereas a substantial body of research has emphasized the many ways in which consumers are led to overeat (Bublitz, Peracchio, & Block, 2010; Bellisle, Dalix, & Slama, 2004; Rolls, Morris, & Roe, 2002; Wansink, 2004), our findings give some direction on how consumers can improve their eating patterns. First of all, the findings show that mindfulness trainings may be an adaptive strategy to become aware of hunger and satiety cues that develop after consumption and to compensate for previous consumption. In practice, mindfulness trainings differ substantially in the object that attention is focused on; the body, an object in the environment or both simultaneously. Our findings show that the focus of attention matters: only attention that was focused on the body led consumers to become aware of hunger and satiety cues and to compensate for previous consumption. Also, our study that looked at weight measures in the general population over a longer period of time showed that chronically directing mindful attention to the body was related to a lower variance in weight but directing attention elsewhere was not. Thus, rather than assuming a general mindfulness effect of various mindfulness trainings, it would be useful for mindfulness practitioners to distinguish

between different kinds of foci of attention in the aims that the trainings wish to accomplish.

Our findings on the effects of mindfulness were based on very short mindfulness exercises that guided attention along different aspects of internal body sensations. Instead of a more rigorous mindfulness training, these findings suggest that taking just a few moments before eating to become aware of how you feel could be a useful strategy to become more aware of the body's signals. This would also argue for allowing sufficient time to consume meals, rather than rushing them or combining them with work or distracting activities.

Our findings on the effects of appearance focus show that focusing on appearance is not a useful strategy for consumers. Although for many consumers food intake and appearance are closely linked, our findings indicate that decoupling this relationship could benefit consumers. Such a relationship between eating and appearance is also maintained in food environments and media where eating and appearance are often simultaneously salient. Based on our findings that subtle cues such as mirrors or advertisements with models already trigger an appearance focus, care should be taken when structuring food environments. The presence of mirrors, images of beauty ideals and food in settings such as shopping malls or cinema's seems an unfortunate combination. Even though our study did not focus on consumers who were specifically trying to lose weight, our findings could also be relevant for dieting behavior where the link between appearance and eating behavior is likely to be especially strong and where our observed mechanism could entrap consumers in a vicious circle. This is also in line with studies that have shown that dieting for appearance based reasons is less likely to be successful than dieting for health based reasons (e.g., Putterman & Linden, 2004).

To conclude, this research on food consumption across sequential consumption episodes has opened up a new direction for future research with both theoretical and practical relevance for understanding food consumption. The findings of this thesis offer a good starting point to further examine how directing attentional resources to different aspects of the body affects reliance on hunger and satiety cues, and in particular to further study the promising role of mindfulness in enhancing reliance on hunger and satiety cues in food consumption.

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Summary

Consumers eat at various sequential occasions throughout the day. The current thesis addresses the question of how one consumption episode can affect the amount of consumption at a subsequent episode. The thesis focuses specifically on how the social context during a consumption episode affects subsequent consumption, and on when consumers rely on hunger and satiety cues in sequential consumption episodes.

Understanding consumption sequences relates to the broader question of how consumers regulate their food intake. If consumers are able to compensate for previous consumption in the amount they eat later on, incidental overeating may not be that problematic. However, prior studies on consumers' ability to compensate for previous food intake have produced mixed results, some showing that consumers adjust their intake to previous consumption, others showing that only certain people are good at this, and yet other studies demonstrate that consumers' compensation mechanisms are weak all together. One of the reasons why consumers may often fail to compensate for previous food consumption is that environmental food cues, such as the availability and portion sizes of food, may override compensation mechanisms. With the recent emphasis on how such external cues impact food intake within a single consumption episode, in our view, the question of when consumers *do* compensate for previous consumption has received insufficient attention. Although previous research has studied which individuals are more likely to compensate for previous compensation and how the form and macronutrients of the food may affect compensation, the current thesis studies *when* consumers are more or less likely to compensate for previous consumption.

The thesis consists of five chapters. **Chapter 1,** the general introduction, distinguishes three routes through which one consumption

episode can affect amount of consumption at a subsequent episode. First, consumers can compensate for previous food intake by relying on physiological cues produced by consumption, which come into awareness as subjective feelings of hunger and fullness. The feeling of fullness that persists some time after consumption, serving to suppress subsequent food intake, is referred to as *satiety.* An alternative route of compensation is through the cognitions or memories that people have about previous consumption. For both of these routes the attentional resources that consumers have available are crucial for the extent to which they can compensate for previous consumption. Although attentional resources have mostly been associated with a cognitive route of compensation, we argue that attentional resources are also necessary for consumers to become aware and rely on internal physiological cues in consumption. Finally, the social context of a consumption episode may also affect later consumption. Again, we argue that resources that consumers have available are a crucial factor, but in this case it concerns the amount of resources that consumers have available for resisting food intake. Consumption episodes may deplete self-control resources, and this can affect the amount of consumption at a later point in time.

Chapter 2 addresses the question of how the social context during a consumption episode, particularly whether eating companions know each other, affects how much consumers snack later on when they are by themselves. The effect of seating arrangement is also explored. Findings show that the social context during a shared meal affects how much consumers snack later on when they are by themselves. In a naturalistic dinner setting, participants had dinner with a same-sex participant who was either familiar or unfamiliar to them, sitting either next to each other, facing each other, or around the corners of a table. After the dinner, participants individually took part in what was described as a taste test and their cookie consumption was

assessed. The results show that when sharing a meal with a familiar dinner partner, subsequent solitary snacking was lower than when participants shared dinner with an unfamiliar other. Also, mealtime conversations were perceived as smoother during dinners with familiar others than during dinners with unfamiliar others, but smoothness of conversations did not mediate the effect on later snacking. Participants who were seated directly facing their eating companion perceived the conversation as less smooth, but seating did not affect later cookie consumption. Overall, these findings suggest that the social context during a consumption episode affects how much consumers eat later on by themselves, even though the mechanism is not yet clear.

Chapters 3 and 4 examine how consumers balance the amount they eat across consumption episodes, addressing the question of when consumers are more or less able to compensate for previous consumption through the awareness of hunger and satiety cues. Rather than focusing on individual difference variables or properties of the food as has previously been studied, these chapters examine how directing attention at either external appearance aspects of the body or internal body sensations affects the extent to which consumers are able to adjust their amount of consumption according to their earlier food intake. Whereas previous research has argued that focusing attention on appearance aspects of the body comes at the cost of attention that can be paid to internal body cues, this has been based on correlational evidence. **Chapter 3** describes two pilot studies and two experiments that test the relationship between focusing on appearance and relying on internal cues in food consumption. The findings demonstrate that cues in the environment, in particular mirrors or advertisements depicting models and Western beauty ideals, can focus consumers' attention on outward appearance aspects of their bodies and interfere with compensating for additional calories in a covertly

manipulated milkshake and with adjusting food consumption according to previous food intake.

Chapter 4 builds on these findings by examining the opposite side of the coin: Does directing attentional resources towards internal body sensations enhance compensation for previous consumption? Six studies address this question by examining the role of mindfulness in compensation for previous consumption. Awareness of body sensations plays a central role in mindfulness, a state of enhanced attention of the present moment, and is often practiced through yoga or meditation. The first experiment shows that individuals who are chronically more mindful are better able to compensate for a milkshake that is covertly manipulated to contain more calories. Awareness of body sensations is also something that can be trained. In a number of experiments participants were required to perform short mindfulness exercises, that focused attention either on their breathing and internal body sensations or on an external object in the surroundings, or they listened to a recorded story as a control condition. The findings show that these short mindfulness exercises that focus attention on the body enhance compensation for amount of previous consumption. Exercises that direct mindful attention on the environment were also found to lead to a state of enhanced attention, but only mindful attention directed at the body facilitated compensation for previous consumption. Furthermore, the results indicate that after mindful attention to the body exercises, individuals are not affected in subsequent consumption by cues that indicate the amount of calories or amount of consumption, but participants are more aware of the satiety cues that develop after consumption. This suggests that mindfulness enhances compensation by facilitating the awareness of internal hunger and satiety cues rather than by enhancing cognitions about previous consumption. Finally, this chapter also explores how the extent to which individuals pay mindful

attention to internal body cues in everyday life is related to measures of BMI and body weight fluctuation, among a student sample and a sample of the general population. Overall, the findings indicate that paying attention to internal body cues in general, as well as practicing yoga or mindfulness, is related to beneficial weight outcomes.

Finally, **Chapter 5** provides an overview of the main findings of this thesis and provides an outlook on how the findings contribute towards theory, focusing on their contribution to mindfulness research and on the added value of bridging insights and paradigms from psychology, consumer research and nutrition. Also, the limitations of the current research are discussed and an outlook is provided on how the findings of this thesis are expected to unfold over longer time periods. Finally, this chapter addresses practical implications of the findings of this thesis for consumers. Consumers are advised to avoid focusing attention on appearance aspects of their bodies in eating situations, but to pay attention to internal body sensations instead, for example through mindfulness.

Samenvatting

Gedurende de dag eten consumenten op verschillende opeenvolgende momenten. Dit proefschrift richt zich op de vraag hoe een consumptie episode de hoeveelheid consumptie op een later moment kan beïnvloeden. Specifiek richt dit proefschrift zich op de vraag hoe de sociale context van een consumptie episode latere consumptie beïnvloedt en op de vraag wanneer consumenten zich laten leiden door honger en verzadigingssignalen in opeenvolgende consumptiemomenten.

Inzicht in opeenvolgende consumptiemomenten is gerelateerd aan de algemenere vraag hoe consumenten hun voedselinname reguleren. Incidenteel overeten hoeft niet problematisch te zijn als consumenten hiervoor compenseren door de hoeveelheid die men later eet aan te passen. Echter, eerdere studies naar de mate waarin consumenten in staat zijn te compenseren voor voedselinname hebben wisselende bevindingen opgeleverd. Sommige studies laten zien dat consumenten hun voedselinname aanpassen aan eerdere consumptie, andere studies laten zien dat alleen bepaalde mensen hier goed in zijn en weer andere studies laten zien dat de compensatie mechanismes van consumenten over het geheel genomen zwak zijn. Een van de redenen waarom consumenten vaak niet compenseren voor eerdere voedselinname is dat voedsel cues in de omgeving, zoals de aanwezigheid en portiegroottes van eten, compensatie mechanismes verstoren. Recentelijk is er veel aandacht geweest voor hoe zulke omgevingscues voedselinname binnen een consumptie episode kunnen beïnvloeden. Daarmee is, naar ons idee, de vraag naar wanneer consumenten *wel* compenseren voor eerdere consumptie, teveel naar de achtergrond verdwenen. Terwijl eerder onderzoek heeft bestudeerd welke individuen meer geneigd zijn te compenseren voor eerdere consumptie en hoe voedselkenmerken en voedingsstoffen compensatie beïnvloeden, bestudeert

dit proefschrift *wanneer* consumenten in meer of mindere mate compenseren voor eerdere consumptie.

Dit proefschrift bestaat uit vijf hoofdstukken. **Hoofdstuk 1**, de algemene introductie, onderscheidt drie routes die aangeven hoe een consumptie episode de hoeveelheid voedselinname tijdens een volgende consumptie episode kan beïnvloeden. Ten eerste, consumenten kunnen compenseren voor eerdere voedselinname door af te gaan op fysiologische signalen die ontstaan na consumptie en die waargenomen worden als subjectieve gevoelens van honger en verzadiging. Een 'vol' gevoel dat enige tijd na consumptie aanhoudt en dat ertoe dient om latere voedselinname te onderdrukken wordt aangeduid met het begrip 'verzadiging'. Een alternatieve route van compensatie is via de cognities of herinneringen die mensen overhouden aan eerdere consumptie. Voor deze beide routes van compensatie is de hoeveelheid aandacht die mensen beschikbaar hebben cruciaal voor de mate waarin consumenten in staat zijn te compenseren voor eerdere voedselinname. Hoewel de rol van aandacht tot nu toe vooral in verband is gebracht met een cognitieve route van compensatie, beargumenteren wij dat aandacht ook van belang is voor consumenten om zich bewust te worden en af te kunnen gaan op interne fysiologische signalen in consumptie. Ten slotte, ook de sociale context waarin een consumptie episode plaatsvindt kan latere consumptie beïnvloeden. Wij beargumenteren dat de capaciteit die mensen beschikbaar hebben voor het weerstaan van (verleidelijk) eten een cruciale factor is. Consumptie episodes kunnen de capaciteit voor het uitoefenen van zelfbeheersing uitputten en dit kan de hoeveelheid voedselinname op een volgend moment beïnvloeden.

Hoofdstuk 2 richt zich op de vraag hoe de sociale context gedurende een consumptie episode, met name of tafelgenoten elkaar kennen, invloed heeft op hoeveel consumenten later eten wanneer ze op zichzelf zijn. Ook is

gekeken naar het effect van de wijze waarop tafelgenoten zitten ten opzichte van elkaar. De bevindingen laten zien dat de sociale context gedurende een gezamenlijke maaltijd van invloed is op hoeveel mensen later snacken wanneer ze op zichzelf zijn. Tijdens het experiment aten deelnemers een avondmaaltijd in een natuurlijke setting, met een andere deelnemer van hetzelfde geslacht die ze wel of niet kenden, en waar ze ofwel naast, recht tegenover of schuin tegenover zaten. Na de maaltijd namen deelnemers individueel deel aan een zogenaamde smaaktest waarin de hoeveelheid koekjes die ze aten gewogen werd. De resultaten laten zien dat wanneer een maaltijd gegeten werd in het bijzijn van een bekende, de hoeveelheid geconsumeerde snacks vervolgens lager was dan wanneer deelnemers een maaltijd hadden gegeten met iemand die ze niet kenden. Het gesprek dat deelnemers hadden tijdens de maaltijd werd als soepeler ervaren wanneer deelnemers aten met een bekende dan met een onbekende, maar dit medieerde niet het effect op latere snack consumptie. Deelnemers die recht tegenover elkaar zaten aan tafel ervoeren de conversatie tijdens het eten als minder soepel, maar hoe men zat had geen effect op de hoeveelheid later gegeten koekjes. Over het geheel genomen laten deze bevindingen zien dat de sociale context tijdens een consumptie episode effect heeft op hoeveel consumenten later eten wanneer ze alleen zijn, ook al is het onderliggende mechanisme nog niet duidelijk.

De hoofdstukken 3 en 4 onderzoeken hoe consumenten de hoeveelheid voedselinname over meerdere consumptie episodes in evenwicht brengen, en richten zich op de vraag wanneer consumenten meer of minder in staat zijn te compenseren voor eerdere consumptie door het bewustzijn van honger en verzadigingssignalen. In plaats van ons te richten op individuele verschillen of kenmerken van het voedsel, zoals eerder uitvoerig is bestudeerd, bestuderen deze hoofdstukken hoe het richten van de aandacht

op ofwel de uiterlijke kenmerken van het lichaam of op de interne lichaamssignalen van invloed is op de mate waarin consumenten in staat zijn de hoeveelheid voedselinname aan te passen aan eerdere consumptie. Eerder onderzoek heeft beargumenteerd dat het richten van aandacht op het uiterlijk van het lichaam ten koste gaat van aandacht aan interne lichaamssignalen, maar dit was gebaseerd op correlationeel bewijs. **Hoofdstuk 3** beschrijft twee pilot studies en twee experimenten die de relatie toetsen tussen het focussen op uiterlijk en het afgaan op interne fysiologische cues in voedsel consumptie. De bevindingen laten zien dat spiegels of advertenties met modellen en Westerse schoonheidsidealen de aandacht van consumenten verschuiven naar uiterlijke aspecten van het lichaam. Deze cues verstoren vervolgens de compensatie voor additionele 'verborgen' calorieën in een milkshake en het aanpassen van consumptie aan eerdere voedselinname.

Hoofdstuk 4 bouwt voort op deze bevindingen door het bestuderen van de andere kant van de medaille: Leidt het richten van de aandacht op interne lichaamssignalen tot een verbetering in compensatie voor eerdere consumptie? Zes studies gaan in op deze vraag door het bestuderen van de rol van mindfulness bij compensatie voor eerdere consumptie. Het bewustzijn van lichaamssignalen speelt een centrale rol in mindfulness, een staat van verhoogde aandacht voor het huidige moment, en wordt vaak geoefend door middel van yoga of meditatie. Het eerste experiment laat zien dat individuen die chronisch meer mindful zijn, beter in staat zijn te compenseren in hun latere consumptie voor het drinken van een milkshake die extra 'verborgen' calorieën bevat. Het bewustzijn van lichaamssignalen is ook iets dat getraind kan worden. In een aantal experimenten werden deelnemers gevraagd korte mindfulness oefeningen uit te voeren. Deze oefeningen richtten de aandacht ofwel op de ademhaling en interne lichaamssensaties, of op een object in de omgeving, of deelnemers luisterden naar een opgenomen verhaal bij wijze van

controle conditie. De resultaten laten zien dat korte mindfulness oefeningen die de aandacht richten op het lichaam de mate van compensatie voor eerdere consumptie verhogen. De mindfulness oefeningen die de aandacht richtten op de omgeving leidden ook tot een verhoogde staat van aandacht, maar alleen de aandacht die op het lichaam gericht was verhoogde compensatie voor eerdere consumptie. De resultaten laten daarnaast zien dat na de mindfulness oefeningen die de aandacht op het lichaam richtten, deelnemers niet beïnvloed werden in hun latere consumptie door cues die een indicatie gaven van de hoeveelheid of de hoeveelheid calorieën die ze eerder hadden geconsumeerd maar deelnemers waren zich meer bewust van verzadigingsgevoelens die ontstonden na eerdere consumptie. Dit suggereert dat mindfulness compensatie in voedselinname kan verhogen door het bewustzijn van interne honger en verzadigingssignalen te vergemakkelijken in plaats van door het bewuster maken van gedachten aan eerdere consumptie.

Ten slotte geeft **hoofdstuk 5** een overzicht van de belangrijkste bevindingen van dit proefschrift. Ook bespreekt dit hoofdstuk hoe de bevindingen bijdragen aan de bestaande theorie, met name de bijdrage aan mindfulness onderzoek en de toegevoegde waarde van het verbinden van inzichten en paradigma's uit de psychologie, consumentengedrag, en voedingswetenschappen. Verder gaat het hoofdstuk in op de beperkingen van het onderzoek en de verwachte lange termijn effecten. Tot slot worden de praktische implicaties van de bevindingen besproken. Consumenten worden geadviseerd om in eetsituaties het focusen op uiterlijke kenmerken van hun lichaam te vermijden en in plaats daarvan aandacht te schenken aan interne lichaamssignalen, bijvoorbeeld door middel van mindfulness.

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About the Author

Evelien van de Veer studied psychology at the Vrije Universiteit Amsterdam and graduated in 2006 with a (research) master degree in social psychology. She then worked for the police department of Amsterdam where she conducted research on citizens' feelings of safety and was part of a multidisciplinary advice group. A publication based on this research at the police recently received attention in several media outlets, including the Wall Street Journal. In 2008 Evelien started working at the Marketing and Consumer Behavior group at Wageningen University, which resulted in the current PhD thesis. In 2010 Evelien visited the Food and Brand lab at Cornell University for a four month stay as a visiting scholar. Currently, Evelien works at the Marketing and Consumer Behavior group at Wageningen University as a post-doctoral researcher on an EU funded project on health claims and symbols.

Evelien van de Veer

Wageningen School of Social Sciences (WASS)
Completed Training and Supervision Plan

Name of the course	Department/Institute	Year	ECTS (=28 hrs)
I. General part			
Techniques for writing and presenting a scientific paper	WGS	2011	1.2
Writing grant proposals	Wageningen Language services	2011	2
Member MG3S PhD council	MG3S	2008-2010	2
Writing research proposal	MG3S	2008-2009	2
Organization PhD career event 2010	MG3S	2010	0.5
II. Mansholt-specific part			
Mansholt Introduction course	MG3S	2008	1.5
Mansholt Multidisciplinary Seminar	MG3S	2011	1
'Distracted by the Man in the Mirror: Focusing Attention on the Outside Body Reduces Responsiveness to Internal Signals in Food Intake'	ACR, Jacksonville, USA	2010	1
'Body and mind: How mindfulness enhances consumers' responsiveness to physiological cues in food consumption.'	ACR, St. Louis, USA	2011	1
Bi-annual presentations IPOP meetings: Satiety & satisfaction	Wageningen	2008-2012	2

III. Discipline-specific part

Sensory perception & food preference	VLAG	2011	1
BSI workshop on influence of sensory and normative cues on human food intake	Behavioral science institute Nijmegen	2008	0.5
KLI workshop: Controlling the uncontrollable; on regulation of automatic processes	Kurt Lewin Institute	2008	0.6
International Research Seminar: The neuroscience of eating behavior- what psychologists should know	Research institute for Psychology and Health	2009	0.5
KLI workshop: Applying psychophysiological measures to social psychology research	Kurt Lewin Institute	2009	0.6
KLI workshop: Workshop evolutionary social and organizational psychology	Kurt Lewin Institute	2011	0.5
KLI symposium Embodied Cognition Utrecht	Kurt Lewin Institute	2009	0.5
Eden doctoral seminar on research methods in marketing	EIASM	2009	4
Eden doctoral seminar on consumer behaviour	EIASM	2010	4
MCB: PhD series: Marketing	MCB	2009	1
MCB: PhD series: Methodology in Marketing and Consumer behaviour	MCB	2009	1
MCB: PhD series: Consumer behaviour	MCB	2009	1

IV. Teaching and supervising activities

Social psychology	MCB	2009-2010	2
Supervising Bachelor upgrade (1) and Msc theses (2)	MCB	2010-2011	2
TOTAL			**33.4**

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