Claiming satiety:

consumer perception, interpretation

& subsequent food intake

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Chapter 1

General introduction

Introduction

Over the past decades, the prevalence of overweight and obesity has increased tremendously. In 2008, worldwide an estimated 1.46 billion adults were overweight (Body Mass Index 25-30 kg/m^2) and an additional 502 million adults were obese (BMI > 30 kg/m^2) (Swinburn et al., 2011). Being overweight or obese can have serious health consequences, as high BMI is an important riskfactor for cardiovascular diseases, different types of cancer and type 2 diabetes (Wang, McPherson, Marsh, Gortmaker, & Brown, 2011). At the most basic level, overweight is the result of an imbalance in energy intake and energy expenditure: over time more calories are consumed than energy is expended.

Adequate management of food intake is a crucial factor in the development and prevention of overweight. Such food intake management constitutes a complex process involving concious and unconscious decisions on when to start, what to eat, how much to consume and when to stop. To support adequate food intake management, the human body is equipped with a sophisticated physiological system that provides a variety of internal signals, resulting in subjective feelings of hunger and satiety. This appetite control system has proven to be highly important in human evolution and has improved survival through periods of unstable food environments where shortages were altered with abundance (Bellisari, 2008).

However, the current high prevalence of overweight and obesity suggests that the appetite control system may be less effective in situations where food is always in abundance (Popkin & Gordon-Larsen, 2004). In such environments the appetite control system is challenged and potentially overpowered by habits, routines and cues in the external environment as (additional) determinants of the regulation of food intake. External cues from the food consumption environment exert their effect on subjective feelings of hunger and satiety through psychological processes as an addition to the internal signals from physiological processes (Mela, 2006; van Kleef, van Trijp, van den Borne, & Zondervan, 2012). External, environmental cues tend to be strong, salient and seductive, and are believed to undermine the process of self regulation necesary to the accurate management of food intake (Wansink, 2010; Wansink, Just, & Payne, 2009). Thus, subjective feelings of hunger and satiety are under the joint control of internal physiological signals and signals from the food consumption

environment. These two types of signals may be aligned in that external cues possibly enhance and strengthen internal signals of hunger and satiety, but in many instances external cues signaling when to start, what to eat, how much to consume and when to stop, may override the internal signals of "start and stop" any consumption event, potentially leading to overconsumption.

The two interrated processes of satiation and satiety are crucial for accurate food intake management (Bellisle, 2008). Satiation, sometimes referred to as within-meal satiety (Benelam, 2009) is the process that leads to the termination of eating (Blundell et al., 2010). Satiety, sometimes referred to as between-meal satiety, is the feeling of fullness after a meal and serves as a signal for the timing and size of the next consumption moment (Benelam, 2009; Blundell, et al., 2010). For human food consumption, with more or less structured eating occasions, satiety is the more strategic process in food intake management as food intake decisions are made in an anticipatory fashion. That is, how much to consume at any discrete consumption occasion to ensure that the next eating occasion can be reached comfortably without a lack of energy or unpleasant feelings of hunger that may undermine the self-control to resist temptations to (over-) consume in between.

Taking as a starting point that food intake management is under the joint control of internal signals and external cues, we review scientific evidence on how external cues can support or undermine an individuals' responsiveness to internal signals.

Internal signals from the appetite control system

An influential theoretical framework outlining the various internal signals affecting feelings of satiety and satiation over time is the satiety cascade proposed by Blundell over 25 years ago (Blundell & Burley, 1987) that has been further updated by Mela (e.g. Mela, 2006). The satiety cascade (see Figure 1.1) details out the sensory, cognitive, post-ingestive and post-absorptive influences on feelings of satiation and satiety over time.

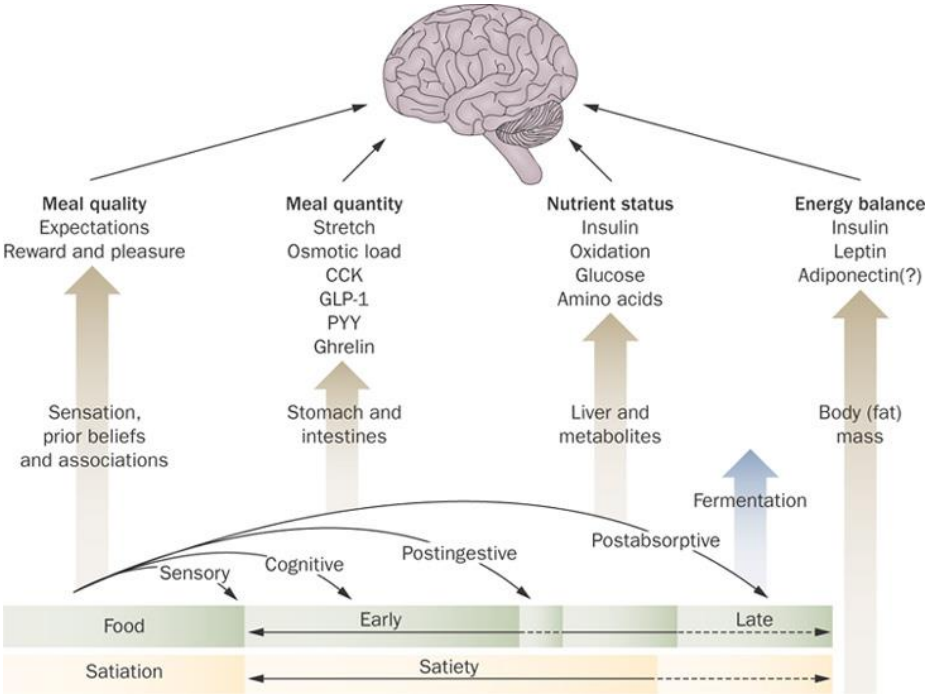

Figure 1.1. Satiety cascade from Blundell modified by Mela. Permission obtained from John Wiley and Sons, Blundell et al. (2010).

Following the satiety cascade, the start of a consumption moment is determined by a combination of internal hunger signals and cognitive factors. Just after the start of a consumption episode and prior of any post-ingestive or post-absorptive signals, meal quality (e.g. expectations, reward and pleasure) is an important factor in the development of satiation feelings.

When consumed food reaches the stomach, post-ingestive and post-absorptive processes take over and meal quantity becomes important. The increase in gastric volume, the 'stomach stretch' is communicated to the brain and gastrointestinal hormones are released (Benelam, 2009). In combination with the cognitive perceptions of the food and drink consumed this makes that satiation is stimulated.

When nutrients are absorbed by the intestines, satiety signals are released from the digestive track signalling to neurons in the brain in the post-ingestive phase

of the satiety cascade (Blundell, Rogers, & Hill, 1987) and satiety hormones are released. On the long term, the stimulation of satiety is based on the availability of nutrients sensed by the hypothalamus. When deviations from normal adiposity levels are detected, insulin and leptin are mobilized to induce satiety (Berthoud, 2007).

External cues challenging the internal system

It might be expected that, over time, this internal appetite control system leads to appropriate timing and portion sizes of meals to avoid uncomfortable feelings of hunger or satiety (Booth, Lee, & McAleavey, 1976). But external cues from today's food environment seem to override and/or undermine these internal signals and make it more difficult to regulate food intake. In this chapter we discuss external cues that challenge signals from the appetite control system in the following five phases: meal initiation, meal planning, consumption phase, end of eating episode and time till next meal (Figure 1.2).

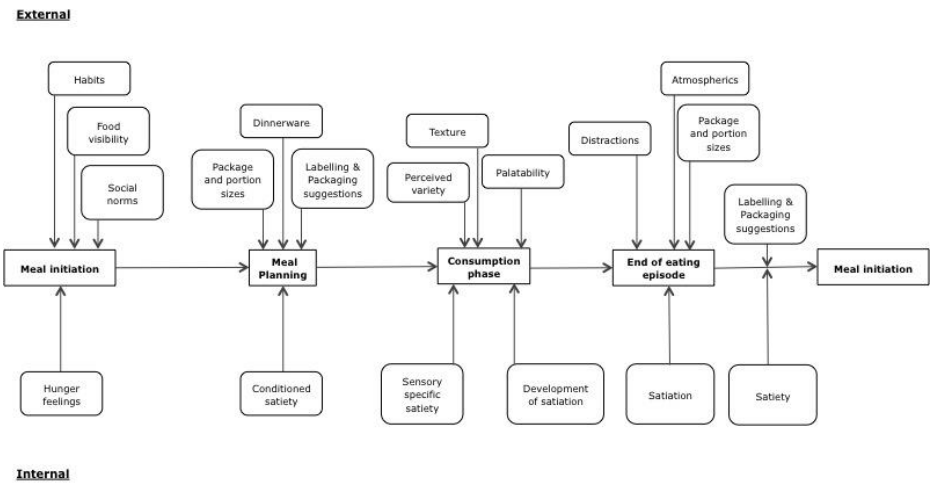

Figure 1.2. External cues challenging the internal appetite control

Meal initiation

The subjective feeling of hunger provided by the appetite control system is an important signal for meal initiation. However, in some instances external cues

and not internal hunger signals induce the start of a consumption episode. For meal initiation, the external cue "eating by the clock" and other eating habits are important influencers. Eating by the clock is a fixed pattern of meals and snacks during the day (e.g. 7.30 breakfast, 12.20 lunch, 18.00 dinner) that many people develop over the years and comply with, regardless of hunger and satiety feelings. The development of eating habits is an effective strategy to save up cognitive capacity for other tasks and decisions since food intake is a reoccurring activity during the day (Marteau, Hollands, & Fletcher, 2012). Eating habits are the result of conscious decisions that have evolved in automatic behaviour. It can therefore be assumed that, although habits can overrule internal signals, there is still some sort of relationship between eating habits and internal signals. For satisfactory daily food consumption it is important to find a delicate balance between avoiding unpleasant hunger feelings and preventing abnormal fullness. Through our experience with the intake of food we try to find this balance and discover the optimum timing between two consumption moments. Over time, the repetitive use of this interval becomes a habit that will be predictive for future meal initiation. These habits are often so strong that they manage to be predictive even in the absence of hunger feelings (van't Riet, Sijtsema, Dagevos, & de Bruijn, 2011).

Also the existence of food cues in the environment can initiate food consumption. A food cue can be the sight or smell of a food product but can also be the visibility of foods in an advertisement on TV or in a magazine (Cornell, Rodin, & Weingarten, 1989; Chandon & Wansink, 2002; Chandon, 2012; Painter, Wansink, & Hieggelke, 2002; Harris, Bargh, & Brownell, 2009). These food cues influence meal initiation by altering physiological responses via two distinct routes. Schüssler et al. (2012) argues that food cues in the environment increase feelings of hunger. As soon as food cues as the smell of freshly baked cookies or the sight of a chocolate bar are perceived, the stomach stimulates ghrelin secretion. Ghrelin is a neuropeptide that induces appetite of which the levels normally increase before meals and decrease after consumption. Perceiving a food cue thus actually increases hunger feelings. At the same time, the sight and smell of foods affect the level of dopamine transmission in the brain (Volkow, Wang, & Baler, 2011; Volkow et al., 2002). The neurotransmitter dopamine plays a major role in reward-driven learning. When consuming a food for the first time, the level of dopamine transmission in the brain is increased and causes a feeling of enjoyment. When exposed to

the food more often, the dopamine response transfers onto cues that are associated with food reward, for example the sight or smell of the particular food. Already the smell of a food can induce a dopamine response in the brain and becomes a predictor of reward. This response increases the desire to consume the food, inhibits cravings and is associated with 'wanting' of a food instead of 'liking' the food (Finlayson, King, & Blundell, 2008; Finlayson, King, & Blundell, 2007; Mela, 2006; Volkow, et al., 2011). When food cues similarly trigger hunger feelings and food 'wanting', it is easy to imagine that resisting food intake is extremely difficult. Especially when cognitive capacity is low, it is a challenge to resist attractive food temptations and the initiation of (snack food) consumption increases (Ruhm, 2012).

In addition, cultural determined social norms are important influencers of meal initiation. Often, consuming food is more than simply ingesting nutrients and it plays an important role in our daily social life. A logical consequence is the development of social norms that can initiate a meal in the absence of hunger feelings. For example, in many cultures it will be considered impolite to refuse a meal (Power & Schulkin, 2009). Most people will accept and initiate the meal, even when they just ate and are not at all hungry, to not offend their host.

Meal planning

Once the onset of an eating episode is determined, the meal planning process starts. A suitable consumption volume is often already selected before the first bite (Fay et al., 2011). An important physiological mechanism in the pre-meal planning process is being able to learn from previous ingestions. Through post ingestive learning, we learn to associate the physiological consequences of food intake with different sensory food cues. One of the possible physiological consequences of food intake is the experienced level of satiety after consumption. Booth (1972) formulated the term 'conditioned satiety' to describe the association between sensory aspects of a food, as a sweet taste or creaminess, and the internal feeling of fullness afterwards. With the help of those associations we build expectations and we learn how much we need to eat to feel comfortably full. Recent research suggests that these expectations affect meal-size selection before the start of a meal (Brunstrom, 2007; Brunstrom, 2011; Brunstrom, Brown, Hinton, Rogers, & Fay, 2011; Brunstrom, Rogers, Pothos, Calitri, & Tapper, 2008; Brunstrom & Shakeshaft, 2009; Brunstrom, Shakeshaft, & Scott-Samuel, 2008). Some external cues undermine this learning

process of conditioned satiety by influencing norms, perceptions and expectations and with that affect the meal planning process.

Packaging and portion sizes undermine conditioned satiety by suggesting that the restaurant portion or the pre-packaged or served food presented is the normal amount to consume. These packaging and portion sizes set a norm for the appropriate amount to eat and therefore make pre-meal planning based on own experiences unnecessary. People tend to eat the main part of the food that is presented or served to them. Studies show that intake from different packaging and portion sizes mirrors the amount of food presented: more food is consumed from larger portions compared to smaller ones without a significant difference in feelings of fullness afterwards (Rolls, Roe, Kral, Meengs, & Wall, 2004; Rolls, Roe, & Meengs, 2006a, 2006b; Wansink, 2010). The unit size of food (i.e. the number of units in which a portion of food is divided) also influences consumption as people tend to eat many foods in units (e.g. slices, pieces). Typically, people eat more when food is presented in larger compared to small units (Geier, Rozin, & Doros, 2006)

The serving behaviour of others affects the meal planning process in a similar manner. Participants in modelling studies tend to serve a similar amount (or somewhat less) than the confederate who has been instructed to eat a lot or a little (Herman & Polivy, 2005). This shows that in these social situations we rather use norms set by others than our own experiences and expectations.

The amount of food selected during the meal planning process is also affected by the size of dinnerware, including plates, spoons, bowls and glasses. People tend to over serve when it comes to larger plates and bowls and under serve when confronted with smaller dinnerware. This effect can be explained by the Delboeuf illusion (Van Ittersum & Wansink, 2012). This illusion illustrates that a same size circle (as food on a plate) appears smaller when surrounded by a slightly larger circle and with that biases serving size perceptions and consumption. Van Ittersum and Wansink (2012) suggest that using smaller plates leads to an decrease in food intake without affecting feelings of fullness after consumption.

Labelling and packaging cues can influence the amount of food selected during the meal planning process by altering product expectations that have been built

through conditioned satiety. Low fat, organic and fair trade claims on packaging make that consumers expect a healthier food product than it actually is, the so called 'health halo' effect and therefore consume more (Schuldt, Muller, & Schwarz, 2012; Schuldt & Schwarz, 2010; Wansink & Chandon, 2006). The effect seems to be robust, Wansink and Chandon (2006) showed that low fat labels increased food intake independently of the type of snack, age of consumers, consumption setting, being an nutrition expert or not and whether people served themselves (Wansink & Chandon, 2006). It might be that healthy food is perceived as less filling compared to other foods and therefore needs to be consumed in a larger amount to be equally satisfying (Finkelstein & Fishbach, 2010). Another explanation is that consumers' anticipated consumption guilt is reduced because the food is perceived to be healthier (Chandon, 2012).

In addition, labelling and packaging cues affect the meal planning process by influencing a food's expected satiety. Expected satiety is the cognitive belief on the satiety value of food products, which partly finds its basis in learning from previous consumption experiences and the effects different products have on satiety (De Graaf, 1995). However, recent research shows that in addition to learning from experienced satiety, expected satiety also seems to be influenced by packaging cues. Piqueras-Fiszman & Spence (2012) showed that the weight of a package is a subtle cue to influence satiety expectations. Products in heavier containers are expected to be more satiating and dense, both before and after tasting the food, compared to the same content presented in a visually identical but lighter container.

Consumption phase

An important process in meal termination that develops during the course of eating is satiation. In this phase of food consumption, a food's sensory features make that the body signals nutrient intake and with that increases feelings of satiation. A internal mechanism that stimulates the development of satiation feelings is sensory specific satiety: the decrease in pleasantness of the food that has been consumed generalizing to other foods that would deliver similar sensory features, such as taste or textures (Hetherington, 1996; Rolls, 1986; Snoek, Huntjens, Van Gemert, De Graaf, & Weenen, 2004). Meal variety is an external cue that has the potential to overrule the process of sensory specific satiety. Meals that offer more variety in sensory features have less effect on the

decrease in pleasantness to eat and therefore stimulate consumption (Brondel et al., 2009).

A food's texture is another influential external cue in the development of satiation feelings. Most probably, texture influences satiation through its effect on oral exposure time in the mouth. Taste receptors in the mouth inform the brain that food is being processed and nutrients enter the body. This makes that satiation feelings are stimulated. Because of a shorter oro-sensory exposure time, more liquid substances lead to a lower satiation response and therefore later meal termination in comparison to solid foods (De Graaf, 2012).
Also a food's palatability influences the development of satiation feelings during the course of a meal. Some argue (Berthoud, 2007; Erlanson-Albertsson, 2005) that when a 'standard food' is ingested, information on its energy content and taste are transmitted to the hypothalamus leading to the release of various satiety peptides and a decrease in appetite. But when a highly palatable food is consumed, taste sensing is different in comparison with a standard food. Information on the food is transmitted to the reward centre leading to an increased release from reward mediators as dopamine and serotonin from the reward centre. This reward centre has connections with appetite controlling neurons in the hypothalamus that induce hunger signals and suppresses satiety signalling, which may lead to overeating and increased levels of adiposity (Berthoud, 2007; Erlanson-Albertsson, 2005). Several studies indeed show that more food is consumed when it is palatable compared to less palatable food with similar caloric content (Sørensen, Møller, Flint, Martens, & Raben, 2003; De Castro, Bellisle, & Dalix, 2000; De Castro, Bellisle, Dalix, & Pearcey, 2000).

End of consumption episode

Towards the end of a consumption episode, the developed feelings of satiation lead to meal termination. Although bodily signals might signal to stop eating, the decision to actually end a consumption moment needs to be made actively. Some external cues extend this decision and drive food consumption beyond the point that internal satiation signals would suggest. A distraction during an eating episode is such a factor and seems to reduce the monitoring capacity. The presence of others, TV viewing or playing a computer game during consumption makes that less attention is paid to the meal that is therefore not encoded properly in memory (Higgs & Woodward, 2009). Distractions also make a person less perceptive of internal satiation signals, which leads to a

longer meal duration and increases intake (Conger, Conger, Costanzo, Wright, & Matter, 1980; Goldman, Herman, & Polivy, 1991; Hermans, Larsen, Herman, & Engels, 2008; Hermans, Larsen, Peter Herman, & Engels, 2012; Higgs & Woodward, 2009; Mittal, Stevenson, Oaten, & Miller, 2011; Oldham-Cooper, Hardman, Nicoll, Rogers, & Brunstrom, 2011). Similarly, atmospherics (e.g. music, lightning) during consumption influence food intake. Preferred or soft music and dimmed lightening encourage a slower rate of eating and longer meal duration. The pleasant ambience and the fact that leftover foods are available for a longer period of time make that it is more difficult to actively stop the consumption moment (Caldwell & Hibbert, 2002; Wansink, 2004; Wansink & van Ittersum, 2012). Also packaging and portion sizes have the potential to drive food consumption beyond the point internal signals would suggest. The so called 'completion compulsion' makes that plates are cleaned and packages are emptied even when feelings of fullness would indicate to stop eating (Siegel, 1957; Fay, et al., 2011; Wansink, 2010).

Time till next meal

The time till the next eating occasion is largely determined by the presence or absence of satiety feelings. Most probably, these satiety feelings have a physiological and a cognitive component. At the end of a consumption moment, when nutrients are absorbed by the intestines, satiety signals are released from the digestive track signalling to neurons in the brain in the post-ingestive phase of the satiety cascade (Blundell, et al., 1987) and satiety hormones are released. Furthermore, satiety feelings can be influenced by labelling and packaging cues through altering satiety expectations. Both early work from Wooley (1972) and a more recent study from Crum and colleagues (2011) showed that beliefs and expectations can be important influencers in the process of satiety development and meal termination. Wooley (1972) found that people tend to report feelings of hunger and fullness in accordance with their beliefs on what they ate rather than the actual caloric content. Participant's food intake was reduced and feelings of fullness 20 minutes after consuming a meal were increased when the test food was positioned as 'high calorie'. Crum et al. (2011) extended these findings by measuring the level of the satiety hormone ghrelin in response to the intake of differently labelled milkshakes. They showed that the level of ghrelin had a steeper decline when a milkshake was labelled as "indulgent" than when the same milkshake was labelled as "sensible", indicating that participants' internal feelings of satiety were in line

with what they believed they were consuming. This finding indicates that the perception of what has been eaten not only has a cognitive effect but also mediates internal physiological processes.

When hunger feelings return or habits, food visibility or social norms indicate that it is time to eat, a new consumption episode starts.

Aim and scope of this thesis

Most research on the influence of external cues on food intake is directed at cues that hamper internal signals and increase food consumption. However, external cues can also be used to emphasize internal feelings of satiation and satiety and influence people to delay meal initiation or to consume smaller quantities of food.

The present thesis focuses on satiation and satiety expectations and inferences as a guide for food intake, both with and across consumption episodes. It focuses on three types of factors: physiological cues, claims on food packages and packaging design, and their role in satiation/ satiety expectations and food intake. In that sense, this thesis recognizes that satiation and satiety experiences are largely based on relevant feedback from previous consumption moments. However, next to learning from personal experiences, satiation and satiety expectations may also be inferred 'on the spot', either explicitly (as from satiety claims), but potential also implicitly and more intuitively (as from packaging design and other factors in the eating context). In the past, external cues in food intake decisions have received considerable attention. This thesis extends that research by explicitly taking satiety and satiation expectations as central concepts. This fits current time frame, where the body of research on consumers' satiety expectations from cues such as volume (Brunstrom, Collingwood, & Rogers, 2010), unit size (Van Kleef, Kavvouris, & Van Trijp, submitted) and product inferences (Piqueras-Fiszman & Spence, 2012) is quickly growing.

Chapter 2 can be regarded as the baseline chapter of this thesis. It focuses on product related satiation and satiety beliefs of different snacks and the extent to which consumers include these considerations in the management of their food choices. *Chapter 3* builds on these results by exploring the potential of satiety-related health claims to increase product differentiation. It specifically examined how different claim formulations may lead to different levels of satiety and

satiation inferences, ranging from what the product is believed to contain (content-related inferences), to deliver (satiety related benefits), and leads to (satiety related consequences). *Chapter 4* extends these findings in two directions. First, it explores how sheer packaging design may serve as a cue for satiation and satiety related expectations and inferences, next to, and potentially in interaction with the presence of a satiation-related health claims. Additionally this study extends the previous studies in moving beyond expectations and hypothetical choices, with a focus on how expectations impact on actual food intake. *Chapter 5* builds further on this coherence in satiety-related signals and also uses an actual food intake paradigm. In the studies presented in *chapter 5*, presence or absence of a satiety-related claim ("This muesli contains added fibre, therefore you will feel full for longer period of time") was combined with a disguised caloric content (300 vs. 600 kcal) of a breakfast, resulting in either match or mismatch of the satiety claim information with the physiological cues for satiety and satiation. *Chapter 6* concludes this thesis and provides a general discussion and suggestions for future research.

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Chapter 2

Consumer perceptions of satiety-related snack food decision making

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Abstract

The aim of this study is to gain more insight into how consumers' perceptions of the satiety value of snack products influence their choice of such products and to get a better understanding of consumer terminology and perceptions about product-related satiety. Participants were asked to indicate their individual product choice in response to a scenario. Scenarios varied as a between-subject factor in terms of whether information on the time gap till the next meal occasion (favourite main dish) was provided or not, and whether this meal would be eaten after one hour or four hours. To get a better understanding of consumer terminology a repertory grid task was used to elicit consumer attributes relating to satiety. This research shows that, when consumers are confronted with situations that vary in satiety requirements, they do not make significantly different snack products choices. But they do have specific ideas about the product features that influence the perceived satiety level of a product. Products perceived as fat, high in protein, with a savoury taste and in one piece are expected to have a higher level of satiety compared to sweet products and products that exist of multiple small items.

Introduction

In many Western societies, a more individualized consumption pattern is replacing the traditional structure of eating three meals a day at fixed times and places (Bisogni et al., 2007; Jastran, Bisogni, Sobal, Blake, & Devine, 2009). Work roles, family organization, and lifestyle changes are causing food intake to become more irregular, often without fixed meal times, away from home, and between meals (Mestdag, 2005; Poulain, 2002). This irregularity can result in large time gaps between meals, whereas the human body requires a regular energy supply. Consumers frequently bridge this energy need by eating between meals, often outside the home environment. Consumption outside the home is on the rise, (Kant & Graubard, 2004; Le Francios et al., 1996; Lin & Frazao, 1997; Orfanos et al., 2007; Ribas-Barba et al., 2007) not only in terms of actual meals but also in terms of snacking (Vandevijvere, Lachat, Kolsteren, & Van Oyen, 2009).

Snacking can be defined as the consumption of food and drinks between the three main meals of the day (De Graaf, 2006; Savige, MacFarlane, Ball, Worsley, & Crawford, 2007) and occurs most often in the afternoon (Anderson, Macintyre, & West, 1993; Cross, Babicz, & Cushman, 1994; Savige, et al., 2007). Recent research has shown that snack products contribute to approximately 40% of the daily energy intake (Bell, Kremer, Magarey, & Swinburn, 2005; Rangan, Randall, Hector, Gill, & Webb, 2008; Rangan, Schindeler, Hector, Gill, & Webb, 2009). Some authors (Bhutani & Varady, 2009; De Groot & van Staveren, 2002; Titan et al., 2001) have argued that increasing the number of eating occasions across the day could actually be beneficial to weight management. However, this of course is only the case if additional caloric intake *between* meals (from snacking) is effectively compensated for in caloric intake *within* meals. Unfortunately, other studies demonstrate that consumers are not particularly effective in this process of energy compensation after eating a snack (Marmonier, Chapelot, Fantino, & Louis-Sylvestre, 2002; Whybrow, Mayer, Kirk, & Stubbs, 2007; Zandstra, Stubenitsky, De Graaf, & Mela, 2002)

Snacking is a complex, poorly understood and under-researched phenomenon. From a caloric intake perspective, effective snacking requires consumers to predict their future caloric needs and preferences – a process that consumers

are not particularly good at (Kahneman & Snell, 1992) – and to select a snack product that can fulfil these satiety preferences. There is limited reason to believe that consumers' snack categorizations are organized around the satiety properties of foods. Rather, these goal-derived categories are organized around appropriateness for specific eating situations (Ratneshwar & Shocker, 1991; Ratneswar, Pechmann, & Shocker, 1996) making them potentially habitual in nature. This does not exclude these categorizations from containing a level of learning (Higgs, 2008) and hence appropriateness for specific situations that can include satiety considerations (Morwitz, 1997), but to our knowledge this has not been specifically addressed in previous studies. It is known that consumers adjust their appropriateness judgments about snacks depending on their health goals (Ratneswar, et al., 1996), but to the best of our knowledge no previous studies have specifically explored snack consumption in relation to appropriateness for satiety-related consumer goals.

Snacking behaviour is initiated by feelings of hunger, or at least a desire to eat. Adequate snacking behaviour thus requires a delicate balance between the direct reward of reducing feelings of hunger (satiation) versus the more temporal goal of bridging the time span until the next meal (satiety) (Bellisle, 2008; Benelam, 2009; Blundell, Hill, & Rogers, 2004). From a nutritional point of view, the macro and micronutrient composition of food products is known to have a differential effect on the satiety properties of foods (van Kleef, van Trijp, van den Borne, & Zondervan, 2012). For example, proteins are more satiating than carbohydrates, carbohydrates are in turn more satiating than fat, which is more satiating than alcohol (Skidmore, 2007). However, it is questionable whether consumers´ snacking behaviour is guided by such nutritional knowledge. Rather, consumers are more likely to base their snacking decisions on lay beliefs based on perceived appropriateness for the situation than on detailed nutritional knowledge (Wansink, Payne, & Shimizu, 2010). Recently, increased research attention has been paid to consumers´ tacit knowledge regarding satiety and satiation properties of foods. Murray and Vickers (2009) in a qualitative study have shown that consumer perceptions of fullness and hunger are affected not only by the physiological properties of the food but also by more psychological factors relating to the method of consumption. For example, in the Murray–Vickers' study, warmer foods made the participants feel fuller, whereas after consuming oranges for breakfast, participants felt physically full but still mentally hungry. Apparently, the oranges

had not satisfied them completely. This research is important as it shows that consumer perception of satiety and satiation depends on a combination of the nutritional quality of the food and lay knowledge about food and food consumption. However, this research fails to provide adequate guidance on the key issue of consumer choice in relation to snack products specifically.

Brunstrom and colleagues (Brunstrom, Rogers, Pothos, Calitri, & Tapper, 2008; Brunstrom & Shakeshaft, 2009; Brunstrom, Shakeshaft, & Scott-Samuel, 2008) have more specifically examined consumers' lay beliefs on expected satiety. Brunstrom (2009) makes the compelling point that consumer meal-size selection is to large extent guided by perceptions of *expected satiety* even more so than product liking. Brunstrom, (2008) developed an innovative methodology to quantify these perceptions of expected satiety on the basis of perceived equi-caloric portion sizes. Brunstrom, Shakeshaft, et al.'s (2008) research shows that consumer perceptions of expected satiety value guide consumer choices, but also that this lay knowledge on expected satiety tends to deviate from the scientific nutritional knowledge of the objective satiety value based on the energy content of food products (Brunstrom, Shakeshaft, et al., 2008). Brunstrom et al.'s research is particularly relevant in the context where consumers can vary the portion size to adjust for required satiety value (i.e. enough to bridge the gap until the next meal). We build on this research by considering more than one time span (Brunstrom et al. examined a five-hour gap till the next meal) and by the usage of snack products with a fixed portion size rather than quantities that are adjustable to the ideal. After all, in most real-life situations snack products are available in fixed portion sizes, and consumers tend to eat full portions as these represent the consumption norm (Wansink, 2004).

The present research aims to bring this important line of research on consumer perceptions of satiety one step further in the context of snacking behaviour. Specifically, it has the following research aims:

1. Explore consumers' snack product choice in situations that differ in the time gap between meals and hence in satiety requirements. (This is an extension of the Brunstrom and Shakeshaft (2009) research that addresses a five-hour time span.) More specifically, we hypothesize that;

a. Items higher in carbohydrates are chosen more frequently in a one-hour time gap till the next meal than in a four-hour time gap till the next meal
b. Items higher in protein are chosen more frequently in a four-hour time gap till the next meal than in a one-hour time gap till the next meal.
c. Items higher in fat are more frequently chosen in a four-hour time gap till the next meal than in a one-hour time gap till the next meal
d. In a one-hour time gap till the next meal more products are selected that have a lower level of perceived satiety
e. In a four-hour time gap till the next meal more products are selected that have a higher level of perceived satiety

2. Explore consumer terminology and perceptions in relation to product-related satiety. (This is an extension of the Murray and Vickers (2009) research as our study focuses on product-related satiety knowledge rather than on the more abstract concepts of hunger and fullness.)
3. Understand how perceived satiety value differs between snack products as a result of nutritional composition and consumer perceptions.
4. Identify groups of individuals by similarities or dissimilarities in their satiety judgments

Methodology

Participants

One hundred forty Dutch-speaking undergraduate and graduate students of Wageningen University (98 women and 42 men) ranging in age from 17 to 29 years (M=20.57, SD= 2.18) were recruited around college campus in the spring of 2009. They received € 5,- for their participation in the experiment.

Stimuli

The products in this study were selected to systematically vary in their macronutrient content and were classified as either relatively high or low in fat

(high=>25g per 100g), carbohydrate (high=>35g per 100g), and protein (high=>10g per 100g). As there are three macronutrients in which products can be either high or low, eight groups were needed to cover all the possible macronutrient combinations. For each of the eight groups, two exemplars were selected (see Table 2.1) to ensure realism. To select the two most appropriate snack products per experimental cell, an objective measure was needed to compare the products. Since it is standard in the Western society to depict all nutritional information on products per 100 gram, this was used as the objective measure to select the sixteen snack products.
The 16 selected snack products were all available at regular *AH To Go* shops, convenience stores at Dutch railway stations offering ready-to-eat products.

Table 2.1: Snack food exemplars with their macronutrient and calorie content in grams per 100g

				Macronutrient content per 100g				Calories / 100g
FAT	CHO	PRO	Exemplar	Fat	Carbohydrate	Protein	Fibre	
Lo	Lo	Lo	Grapes	0	16.0	0.6	2.0	67
			Banana	0.2	18.8	1.2	0.4	82
Lo	Lo	Hi	Curd cheese	0	3.0	13.0	0	66
			Mini-pizza	16.0	24.0	12.0	1.7	285
Lo	Hi	Hi	Liquorices	0.3	72.0	12.0	0	340
			Savoury snacks	22.0	60.0	12.0	1.0	480
Lo	Hi	Lo	Dutch spiced cake	.9	72.6	2.8	3.7	310
			Whole meal biscuit with raisins	12.0	62.0	6.3	10.0	390
Hi	Lo	Lo	Mixed nuts	67.0	18.0	8.5	3.0	670
			Profiterole	26.4	13.5	4.4	0	309
Hi	Lo	Hi	Cheese	31.0	0.0	25.0	0	370
			French sausages	45.0	21.0	29.0	0	530
Hi	Hi	Lo	M&M's	26.8	59.0	9.8	4	516
			Puff pastry filled with apple	26.0	38.0	3.0	2.5	400
Hi	Hi	Hi	Sausage rolls	27.0	35.0	10.5	0.5	423
			Double coated peanuts	29.0	46.0	16.0	2.5	510

Procedure and measures

Product choices

Participants were randomly assigned to one of the three experimental conditions and asked to indicate their individual product choice in response to the scenario with which they were confronted. Scenarios varied as a between-subject factor in terms of whether information on the time gap till the next meal occasion (favourite main dish) was provided or not, and whether this meal would be eaten after one hour or four hours. The dependent variable is the snack product choice in different experimental conditions. Participants were presented with the following scenario: "It is now 16.00 hours and you have just arrived at the train station. You are feeling a bit hungry and decide to go to the shop at the station to buy something to eat. Which of the following snack products would you choose?" Depending on experimental condition they got: (a) no further information on the time gap until the next meal, (b) one-hour gap, and (c) four-hour gap. "Which of the following snack products would you choose?"

Participants had to make a choice based on pictures that were standardized in the sense that they were taken with the same distance and therefore show the products in a comparable size to each other. No nutrition information was shown to the participants. All products used in this study are common snack products in the Netherlands. A pre-test showed that participants are familiar with all of the snack products.

Attribute generation and rating

After completion of the choice task, each participant was confronted with 10 triads of snack products to elicit consumer attributes relating to satiety. The triads were selected in a way that all eight experimental cells balanced between the triads. Participants were shown one of the two versions of the triad questionnaire, in which the constant factor in both the questionnaires was the experimental cell. For example, in both versions of the questionnaire a picture from the experimental cell low in fat, low in protein and low in carbohydrates was depicted but instead of the banana used in version one of the questionnaire, the grapes were used in version two.

In a repertory grid task (Kelly, 1955), the participant identified one of three products in response to the question: "If you ate the indicated products, which

product would stop you from feeling hungry for the longest?" After selecting one of the three products, the participant was asked: "Why do you think that the chosen product stops you from feeling hungry for a longer period of time than the other two products?" The participant was then asked to construct a 7-point scale, anchored at one end by the selected attribute and at the other by the attribute selected in response to the question: "If your answer is the left hand label of the scale, which attribute would then best fit the products that you did not select? Please put this as the right hand label of the scale". Participants rated all 16 products on the self-constructed scale before proceeding to the next triad.

Other measures

Participants were asked to rate all 16 products for *satiety* on a 7-point Semantic Differential scale, ranging from 1 (*very fast*) to 7 (*not fast at all*), by answering the question: "How fast would you get hungry again after eating this product?" The results of this measure are further referred to as: 'overall satiety ratings'.

Data on age (in years) and gender were collected. Participants indicated when they had last eaten prior to the experiment (open question) as well as "how much do you feel like eating at this moment in time", rated on a 7-point scale, ranging from 1 (*feel not at all like*) to 7 (*very much feel like*).

Data analysis

Product choices

Product choices and how they vary across different scenarios were analysed using cross tabulation and Chi-square analysis was used on a 3 x 8 matrix to detect differences due to task instruction and particularly differences due to experimental condition (a), (b) and (c), i.e. no time indicated, time gap of one and four hours, respectively, until the next (main course) eating occasion. This same analysis was used to detect differences between the one-hour scenario (b) and four-hour scenario (c) and no time indicated (a) versus time indicated (b/c). To not violate one of the assumptions of the Chi- square analysis, experimental cells instead of the product choices were used as the variable of interest in this analysis. Logistic regression was applied to test whether product choice (dependent variable) in the different experimental conditions varied as a function of macronutrient content. Independent variables are the dummy coded (low vs. high) macronutrient (fat, carbohydrate, and protein) content of the products.

To test if the perceived satiety level of a snack product influenced the product choice, a logistic regression was applied with product choice used as a dependent variable and the dummy coded (low vs. high) perceived satiety level as independent variable.

Consumer terminology

The perceptual structure of satiety perceptions was identified from the attribute ratings of the products on the self-generated attribute scale (the ten triads), using the unrestricted attribute elicitation methodology suggested by Steenkamp, Van Trijp, and Ten Berge (1994). Non-linear multiset canonical correlation analysis with optimal scaling (OVERALS) was applied to extract common orthonogal underlying dimensions despite individualized terminology. The dimensions were interpreted on the basis of the matrix of loadings of the self-selected attributes on the dimensions. Product ratings on the dimensions were extracted as factor scores on each of the dimensions.

Importance of perceptual satiety dimensions

The contributions of the perceptual satiety dimensions on the standardized overall satiety ratings was assessed from individual-level linear regression analysis with overall satiety ratings for the sixteen products as dependent variables and the product factor scores as independent measures.

Influence of macronutrients on satiety

The influence of macronutrients and fibre on the standardized overall satiety ratings was assessed from an individual-level linear regression analysis with the overall satiety ratings as dependent variables and the macronutrient and fibre dummies (low vs. high) as independent variables.

Nutritional basis of perceptual satiety dimensions

The nutritional basis of satiety perception was assessed from a dummy regression with product factor scores as dependent variables and the macronutrient dummies (low vs. high) for carbohydrate, fat, protein and fibre as independent variables. Average consumer data were used as input for this analysis instead of individual ratings.

Differences in satiety judgments

Standardized overall satiety scores of the sixteen snack products were used in a hierarchical cluster analysis, Ward method (Hair, Black, Babin, & Anderson, 2008), to determine the appropriate number of clusters. K-means cluster analysis was applied on standardized overall satiety scores to assign each participant to a cluster.

Regression analysis with overall satiety ratings for the sixteen products as dependent variables and the product factor scores as independent measures was used to determine the differences in the importance of the perceptual satiety dimension for each of the clusters. Differences between the segments in age, gender, last eating occasion and how much they felt like eating during the experiment between the segments were assessed by analyses of variance (ANOVA).

Results

Product choices

Sausage rolls and mini-pizza were popular afternoon snack products in all three experimental conditions. Low fat, high carbohydrate, and high protein products such as liquorices and savoury snacks, and high fat, low carbohydrate, and low protein products such as profiteroles were in general less often preferred as an afternoon snack by the participants.

Table 2.2: Frequencies of product choice in different experimental conditions

Fat	CHO	Protein	Snack product	(a) No time indicated (baseline)	(b) 1-hour interval	(c) 4-hour interval
Lo	Lo	Lo	Grapes	5	6	1
			Banana	5	1	5
Lo	Lo	Hi	Curd cheese	1	0	2
			Mini pizza	8	8	11
Lo	Hi	Hi	Liquorices	0	3	0
			Savoury snacks	1	0	0
Lo	Hi	Lo	Dutch spiced cake Whole meal biscuit	4 7	4 5	6 2
Hi	Lo	Lo	Mixed nuts	1	0	3
			Profiterole	0	0	0
Hi	Lo	Hi	Cheese	2	0	0
			French sausages	2	1	0
Hi	Hi	Lo	M&M's	3	4	1
			Puff pastry filled with apple	4	5	3
Hi	Hi	Hi	Sausage roll	8	4	9
			Double coated peanuts	0	1	3
Total				49	41	48

Table 2.2 shows that overall snack choice does not differ significantly (X^2=17.33, df= 14, p=.239) between the three experimental conditions. Also the product choice in the one-hour scenario does not differ significantly from the choices made in the four-hour scenario (X^2=8.96, df= 7, p=.256) and there is no significant difference in product choice between the scenario where no time was indicated till the next meal and the scenarios that were specific on the time to bridge till the next eating occasion (X^2=6.49, df= 7, p=.484)

It was expected that items higher in carbohydrates would be more frequently chosen in the one-hour scenario and indeed logistic regression (table 2.3) indicated that in the one-hour scenario, participants were more often inclined to choose for a product higher in carbohydrates and lower in fat or protein. It

was also hypothesized that in the four-hour scenario participants would choose a product higher in protein or in fat. However this was not confirmed by the analysis as the participants in the four-hour scenario did not more often choose a high protein or high fat product over products high in carbohydrates.

Table 2.3: Summary of logistic regression analysis providing beta coefficients (B) and standard error (SE) for the influence of the dummy coded macronutrients and fibre on the products chosen in the one-hour scenario and the four- hour scenario.

	Snack product choices[1]			
	One-hour scenario		Four-hour scenario	
	B	SE	B	SE
CHO[2]	.72*	.35	.06	.33
Fat[2]	-.71*	.34	.41	.31
Protein[2]	-.83*	.40	-.53	.40
Fiber[2]	-.74*	.42	-.60	.42
Constant	-3.72		-2.35	
Chi Square	11.127*		4.087	
Nagelkerke R^2	.044		.015	

Note. [1] scored: product is selected =1, Product is not selected =0

[2] scored: product is high in CHO, Fat, Protein or Fibre = 1, product is low in CHO, Fat, Protein or Fibre = 0

**p<0.01

*p<0.05

Also participants' satiety perception of a product does not seem to influence product choice in the experimental conditions. It was expected that in the one-hour scenario more products were selected that have a lower level of perceived satiety and in the four-hour scenario products were selected that have a higher level of perceived satiety. But logistic regression analysis indicated that products perceived as providing a lower level of satiety were not more often chosen in the one-hour scenario (B= -.28, Wald= .937, p=.33) and that products seen as providing a higher level of satiety were not more often chosen in the four-hour scenario (B= -.07, Wald= .048, p=.83).

Perceptions of satiety values

When confronted with the 10 triads of the repertory grid, participants were able to generate on average 7 unique attributes to describe their underlying reasons for satiety perceptions. To formalize the consumer terminology in quantitative results, the OVERALS analysis suggests four underlying common dimensions accounting for 65.67% (2.627/4) of the variance. Table 2.4 shows the frequencies of attributes per dimension with a loading exceeding .5 for at least five participants.

On the basis of the attributes that only load frequently or highly on a particular dimension, and are therefore most important in the labelling process of that dimension (underlined in Table 2.4), the four perceptual dimensions can be interpreted as: Fat, Multi-item, Savoury, and Dairy–protein. Attributes that load highly on the Fat dimension are high in fat–low in fat, fat–lean and saturated fat–unsaturated fat. Important attributes for the Multi-item dimension are more related to consumption characteristics, with long consumption time–short consumption time and multi-item product–product in one piece as examples. Savoury-related attributes such as savoury–sweet, salty–not salty, salty–sweet and savoury–not savoury all have high loadings on the savoury dimension. Important attributes for the Dairy–protein dimension are high in protein–low in protein, dairy–non dairy and creamy–non creamy. Some attributes such as, for example, provides fullness–doesn't provide fullness, large amount of food–small amount of food, and nutritional value–low in nutritional value load highly on more than one dimension.

Table 2.4: Summary of non-linear multiset canonical analysis providing the frequency of attributes per dimension with a loading exceeding .5 for at least five subjects. Eigenvalues of perceptual dimensions are in parentheses and underlined attributes are unique for that particular dimension and do not load frequently or highly on the other three dimensions

Dimension/ attributes	Frequencies	Dimension/ attributes	Frequencies
1. Fat (.804)		*2. Multi-item (.652)*	
High fat–low fat	84	Provides fullness–doesn't provide fullness	30
Rich–light	37	High in fibres–low in fibres	25
Large amount of food–small amount of food	30	Large amount of food–small amount of food	20
Provides fullness–doesn't provide fullness	29	High in carbohydrates–low in carbohydrates	12
High caloric–low caloric	20	Long consumption time–short consumption time	10
Contains meat–doesn't contain meat	16	Satiating–non satiating	9
Fat–lean	12		
Unhealthy–healthy	11	Nutritional value–lower nutritional value	6
Proper meal–snack product	9	Multi-item product–product in one piece	5
Warm snack–cold snack	8		
Saturated fat–unsaturated fat	6		
High in energy–low in energy	6		
Low fat–high fat	5		
Makes you feel full quickly–makes you feel full slowly	5		
Nutritional value–lower nutritional value.	5		
More food–less food			
3. Savoury (.609)		*4. Dairy–protein (.563)*	
Savoury–sweet	19	High in protein–low in protein	9
Sweet–non sweet	14	High in fibre–low in fibre	8
Salty–not salty	10	Dairy–non dairy	6
High in fibre–low in fibre	10	Creamy–non creamy	5
High in sugar–low in sugar	7		
Nutritional value–low in nutritional value	6		
Salty–sweet	5		
Savoury–not savoury	5		

The snack product positions on the perceptual dimensions (Figures 2.1 and 2.2) support these interpretations. High fat products, such as sausage rolls and sausages, load highly on the fat dimension (Figure 2.1), whereas low fat products such as grapes and banana have relatively low loadings. Products that load highly on the multi-item dimension (Figure 2.1) such as liquorices and M&M's consist of multiple pieces, whereas one-piece products such as bananas have a lower loading on this dimension. The savoury dimension (Figure 2.2) goes from sweet products with a low loading on the dimension, such as M&M's and profiterole, to higher loading products with a salty taste such as nuts and savoury snacks; and dairy products such as curd cheese and cheese have a high loading on the Dairy–protein dimension (Figure 2.2), whereas non dairy products such as puff pastry filled with apple have a lower loading.

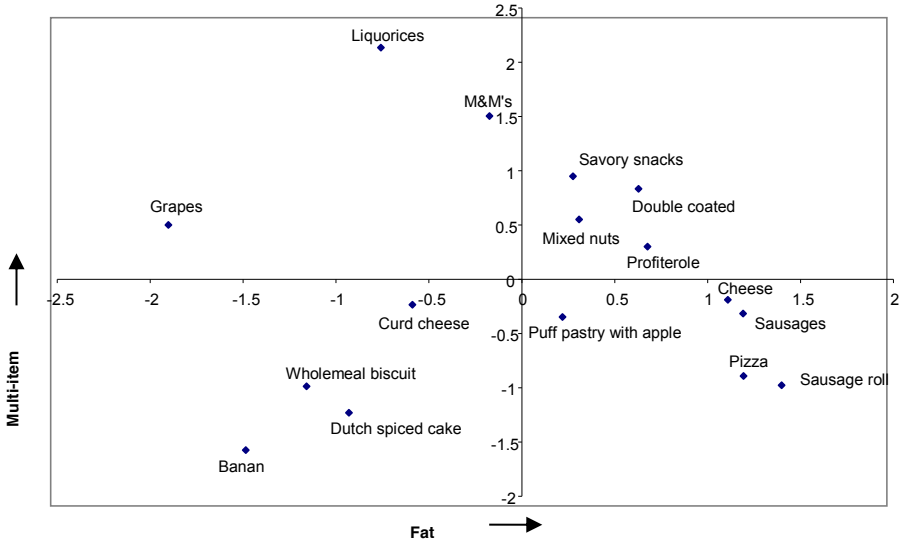

Figure 2.1: Snack product positions in the canonical space of the Fat and the Multi-item dimensions.

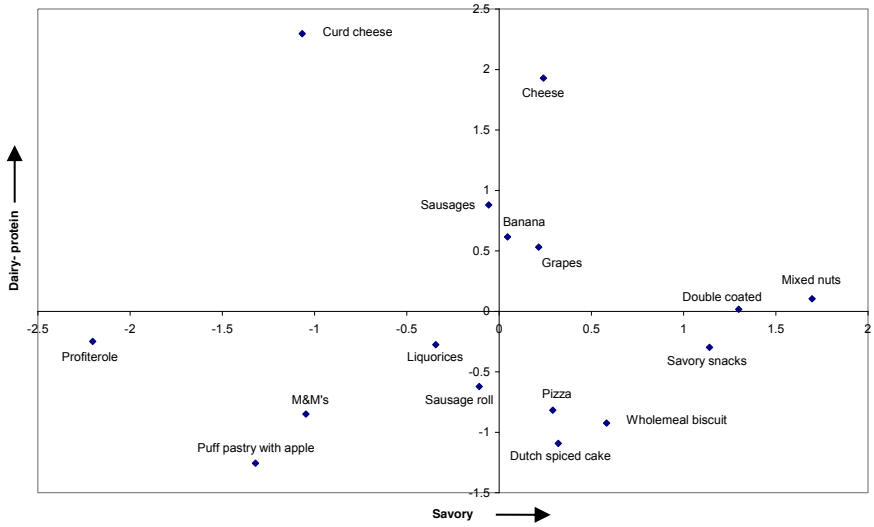

Figure 2.2: Snack product positions in the canonical space of the Savoury and the Dairy–protein dimensions.

Nutritional basis of perceptual dimensions

The perceptual dimensions seem to have a nutritional basis (Table 2.5). The explained variance in the consumer perception of fat, explained by the macronutrients and fibre is 61.6%, with the macronutrient fat as most important for this dimension *(β=0.61, P <0.01)*. The explained variances for the savoury and Diary–protein perceptual dimensions are also relatively high, 42.7% and 55.3%, respectively. The macronutrients protein and carbohydrates are most strongly related to the Dairy–protein perceptual dimension and fat, protein and fibre are all significantly related to the savoury perceptual dimension. Macronutrients are less important for the Multi-item dimension; they explain a small part in the variance, 14.7%, of this perceptual dimension.

Table 2.5: Summary of multiple regression analysis providing standardized regression coefficients for the macronutrients and fibre explaining the four perceptual dimensions

	Fat	Multi-item	Savoury	Dairy–protein
CHO	0.02	0.39**	-0.02	-0.68**
Fat	0.61**	0.03	-0.24**	-0.06**
Protein	0.48**	0.01	0.50**	0.45**
Fibre	-0.03*	-0.04	0.70**	0.19**
F	894.506**	96.189**	415.576**	691.527**
DF	(4,11)	(4,11)	(4,11)	(4,11)
R^2	.616	.147	.427	.553

**p<0.01
*p<0.05

The influence of the perceptual dimensions and macronutrients on satiety

Table 2.6 shows that both the perceptual dimensions and the macronutrients explain only a small proportion of the satiety ratings. Of all constructs, fat appears to be the most salient concept in satiety judgments. Both the Fat dimension (*β=0.36, P <0.01)* and the macronutrient fat (*β=0.21, P <0.01)* are highly predictive for the perceived satiety ratings. The macronutrient protein (*β=0.24, P <0.01)* is predictive for the perceived satiety ratings as well. Carbohydrates (*β=-.14, P <0.01)* are seen as providing the least satiety and are also frequently named as an attribute in the Multi-item dimension (*β=-.23, P <0.01)*, which is the only dimension that leads to a lower level of perceived satiety.

Table 2.6: Summary of multiple regression analysis providing standardized regression coefficients for the four perceptual dimensions and the macronutrients and fibre explaining satiety ratings.

	Satiety ratings			
	Overall (N=140)	1 (N=41)	2 (N=48)	3 (N=51)
Fat	.36**	.28**	.56**	.43**
Multi-item	-.23**	-.39**	-.14**	.09**
Savoury	.09**	.26**	.03	.07
Dairy–protein	.03**	.18	.08	.01
F	137.423**	75.738**	103.304**	48.512**
DF	(4,2235)	(4,651)	(4,763)	(4,811)
R^2	.197	.318	.348	.218

**p<0.01
*p<0.05

Differences in satiety judgments

Table 2.7 shows the results of the segmentations on the basis of differences in satiety judgments of groups of individuals. The cluster analysis identified three groups of individuals in the population that differ in their satiety expectations. The satiety expectations of the 41 participants in cluster 1 are mostly influenced by the multi- item dimension, they perceive multi-item products as proving less satiety compared to products in one piece (β*=-.39, P <0.01)*. Additionally, they focus on the perceptual dimensions of fat (β*=0.28, P <0.01)* and savoury (β*=0.26, P <0.01)*. The 48 participants in cluster 2, see the perceptual dimension of fat (β*=0.56, P <0.01)* as the most important dimension for the satiety value of a product. The remaining 51 participants of cluster 3 are mostly influenced by the perceptual dimension of fat (β*=0.43, P <0.01)* and follow the multi-item dimension (β*=0.09, P <0.01)* in lesser extent. There are no significant differences between the three clusters in experimental condition, age, and gender.

Table 2.7: Summary of multiple regression analysis providing standardized regression coefficients of the perceptual dimensions explaining satiety ratings for the three clusters
**p<0.01

Dimensions	Satiety ratings	Macronutrients	Satiety ratings
Fat	.36**	CHO	-0.14**
Multi-item	-.23**	Fat	0.21**
Savoury	.09**	Protein	0.24**
Dairy–protein	.03**	Fibre	0.13**
F	137.423**	F	58.675**
DF	(4,2235)	DF	(4,2235)
R^2	.197	R^2	.095

*p<0.05

Although the three clusters all fit the data on the expected satiety ratings better compared to the overall analysis (see table 2.7), not too many differences can be observed when ranking the mean expected satiety level of the snack products per cluster (table 2.8). All clusters have pizza, cheese and sausages in their top six of snack products with the highest expected satiety and have grapes and liquorices ranked in the bottom six.

But where clusters 1 and 2 both rank most multi-item products in the bottom six, individuals in cluster 3 expect a higher level of satiety from many of these snack products. Savoury snacks and M&M's are respectively ranked on places 6 and 7 while they are in the bottom five of the clusters 1 & 2.

Table 2.8: Mean predicted expected satiety level of snack products by cluster, ranked from the highest level of predicted expected satiety to the lowest.

	Cluster 1 (N=41)		Cluster 2 (N=48)		Cluster 3 (N=51)	
		M		M		M
1	Cheese	5.95	Pizza	6.00	Mixed nuts	5.53
2	Mixed nuts	5.59	Sausage rolls	5.58	Cheese	5.45
3	Pizza	5.34	Puff pastry filled with apple	5.25	Double coated peanuts	5.41
4	Banana	5.37	Sausages	5.08	Pizza	5.21
5	Sausages	5.05	Dutch spiced cake	5.04	Sausages	5.13
6	Sausage rolls	5.00	Cheese	5.00	Savoury snacks	5.07
7	Double coated peanuts	4.51	Profiterole	4.64	M&M's	4.72
8	Curd cheese	4.49	Banana	4.54	Sausage rolls	4.65
9	Whole meal biscuits	4.44	Whole meal biscuits	4.35	Puff pastry filled with apple	4.43
10	Dutch spiced cake	4.31	Curd cheese	4.02	Profiterole	4.41
11	Puff pastry filled with apple	4.00	Mixed nuts	3.83	Liquorices	4.14
12	Savoury snacks	3.56	Double coated peanuts	3.54	Curd cheese	3.47
13	Profiterole	3.19	Savoury snacks	3.40	Whole meal biscuits	3.37
14	M&M's	2.80	M&M's	2.91	Banana	3.33
15	Liquorices	2.80	Liquorices	2.62	Dutch spiced cake	3.23
16	Grapes	2.88	Grapes	2.10	Grapes	2.72

Discussion

In the early nineteen eighties, research was already being undertaken to assess the satiating capacities of macronutrients and food products (Bellisle, 2008). It is only recently that this stream of literature has been expanded to consumer behaviour by studying consumer perceptions of satiety in relation to food decision making (Brunstrom, Shakeshaft, et al., 2008). The present study extends this relatively new area of research by focusing on consumer perceptions of satiety in the context of snacking behaviour.

Variation in satiety requirements does not seem to significantly influence consumers' snack product choices. It can be that consumers base their choices on their present preferences (e.g. Which product do I like the most? Which product provides a sufficient amount of satiation?), rather than on their future needs. An alternative explanation for the non-significant difference in product choices may be that the perceived satiety level of snack products varies between consumers. As shown in the results section on differences in satiety judgments, some consumers base their satiety judgments more on whether the product exist of multi items or is in one piece, others on a product's perceived level of fat. So a product that is perceived as high in satiety by one consumer can have a different satiety value for other consumers.

Although consumers seem not to adapt their snack product choice to the satiety requirements of a situation, they do have specific ideas about the product features that influence the satiety level of a product. The present research shows that different product characteristics influence the level of perceived satiety. Products perceived as fat, high in protein, with a savoury taste and in one piece are expected to have a higher level of satiety compared to sweet products and products that exist of multiple small items. As such the present paper extends our knowledge on how physiological properties of food affect consumer perceptions of expected satiety

In the context of consumer terminology in relation to satiety-related product characteristics, often one of the three macronutrients comes to consumers' mind. Products high in fat or protein provide the highest level of satiety in the eyes of the consumer, and carbohydrates the lowest. These perceptions are not in accordance with scientific nutritional knowledge on the objective satiety value of macronutrients. Protein provides indeed the highest level of satiety, but the satiating capacity of fat is overestimated by consumers in the present study (Bellisle, 2008; Skidmore, 2007). Although consumers often mention macronutrients in relation to the satiety value of foods, they seem not to make satiety-related snack product choices based solely on the food's macronutrient composition.

Both macronutrients and the perceptual dimensions seem to have only a small influence on individuals' satiety perceptions. A possible explanation is that

consumers do not base their satiety judgments on separate product features but rather use their past experiences with the complete product to determine the satiety level and use this knowledge in future situations. This is known as the learned satiety value of products (Brunstrom, 2007; Higgs, 2008).

But when consumers are confronted with an unfamiliar product to which they cannot transfer these past experiences directly, then the taste, look, and structure of the product are compared with similar product features in memory to enable individuals to make inferences about the satiety level of the new product. This may have implications for the introduction of new products (van Trijp & van Kleef, 2008).

Currently, more satiety-enhancing products are entering the market and most of these products are unfamiliar to consumers (van Kleef, et al., 2010). They can only make inferences about the satiety level of the product based on what they see, and therefore may need some additional information on specific product characteristics, in the form of labels or claims on product packaging (van Kleef, et al., 2010). It is of importance that this information is in line with the mental model of the consumer, that the used terminology is familiar and that the level of knowledge on nutrition of the average consumer is taken into account.

The present study is limited to the extent that snack product choices were only hypothetical; actual choices would have provided more accurate information. Furthermore, it is probable that, because of the scenarios used, not only was the level of satiety manipulated, but the time of consumption, the afternoon, was also emphasized. The stimuli in this study were selected on the basis of their macronutrient content and not specifically on their suitability as an afternoon snack. Therefore it is possible that some of the snack products did not fit the afternoon situation entirely and were not even taken into consideration as a possible satiety choice. Additional research is needed to determine whether actual product choices are in line with these hypothetical snack product choices and whether the terminology used by consumers to describe the satiety level of snack products can be extrapolated to other food products.

In conclusion, this research showed that, when consumers are confronted with situations that vary in satiety requirements, they do not make significantly

different snack products choices. But they do have specific ideas about the product features that influence the perceived satiety level of a product. Products perceived as fat, high in protein, with a savoury taste and in one piece are expected to have a higher level of satiety compared to sweet products and products that exist of multiple small items.

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Chapter 3

Consumer understanding, interpretation and perceived levels of personal responsibility in relation to satiety-related claims

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Abstract

Following means-end chain theory, we explored for a number of satiety claims the extent of inference making to higher-level benefits than actually stated in the claim, using internet-based questions and tasks. Respondents (N=1504) in U.K., France, Italy and Germany participated in the study. The majority of these respondents correctly interpret satiety-related claims; i.e. they largely limit their interpretation to what was actually stated. They do not expect a "magic bullet" effect, but understand that personal efforts are required to translate product attributes into potential weight control benefits. Less-restrained eaters were at lower risk for over-interpreting satiety-related claims, whilst respondents with a stronger belief that their weight is something that they can control accept more personal responsibility, and better understand that personal efforts are required to be effective in weight control.

Overall, these results indicate there is likely to be a relatively low level of consumer misinterpretation of satiety-related claims on food products.

Introduction

Appetite control is a complex phenomenon under the joint control of a variety of sensory, cognitive and physiological signals in response to the consumption of food(s) (Blundell et al., 2010). At the phenomenological level it manifests itself in sensations of hunger and fullness (satiety). Whereas satiety is a subjective feeling of a reduction in the motivation to eat, hunger is an unpleasant state that can be relieved through consumption (de Graaf, 2011). Foods differ in the extent to which they induce feelings of satiety, based on their composition among other factors (Holt, Brand Miller, Petocz, & Farmakalidis, 1995). There is a large volume of experimental studies showing that acute satiating effects of foods can be influenced by their energy density and macronutrient composition (Anderson & Woodend, 2003; Camire & Blackmore, 2007; Ello-Martin, Ledikwe, & Rolls, 2005; Halton & Hu, 2004; Ledikwe et al., 2006; Van Kleef, Van Trijp, Van den Borne, & Zondervan, 2012) as well as non-nutritive components such as specific fibres (Wanders et al., 2011). Blundell et al.(2010) provides a rather complete review on how to assess the satiating effects of foods in an objective, sensitive and reliable manner.

It is arguably beneficial for consumers to be informed on the satiating effects of foods where this is been adequately substantiated and described, as such information may provide a means in managing feelings of hunger and satiety (Mela, 2011). Satiety-related claims on food products have, however, recently generated substantial debate, both in academic (Bellisle & Tremblay, 2011; Blundell, 2010; Booth & Nouwen, 2010; Booth & Nouwen, 2011; Mela, 2011; Smeets & van der Laan, 2011) and legislative circles (EFSA Panel on Dietetic Products, 2011). Recent European legislation (EFSA Panel on Dietetic Products, 2011) on health-related claims on foods has set out two important criteria that also apply for satiety-related claims: [1] any claim should not go beyond the demonstrated scientific evidence, and [2] the average consumer must be able to understand the effects expressed in the claim (Blundell, 2010). The recent academic debate seems to centre around three interrelated issues. The first is whether subjective feelings of satiety in themselves represent a relevant health-related benefit. Booth and Nouwen (2010) recently initiated a heated discussion by arguing that satiety is irrelevant, because of its lack of predictive value for subsequent consumption in the long run. Others (Blundell,

2010; De Graaf, 2011; Mela, 2011) have taken the position that the benefits inferred from (substantiated) satiety-related claims can be rightful in their own, provided that they do not overpromise in terms of consumer understanding.

With regard to consumer understanding, concerns have been expressed that satiety claims will be interpreted beyond their literal meaning to imply that products deliver (direct) weight control or even weight loss benefits. As stated by Bellisle and Tremblay (2011), "Satiety claims can be misleading and even dangerous when they are misrepresented or misinterpreted as slimming claims". However, other experts (De Graaf, 2011; Mela, 2011) have pointed to the lack of any relevant, objective data to support this position . If properly substantiated satiety-related claims would have benefit to the consumer as an aid in personal efforts to control their appetite, the issue of understanding and interpretation becomes highly relevant. More specifically, are these claims understood by the average consumer as an adjunct to other primary behavioural efforts required for effective weight control? A key concern is that consumers may interpret such benefits as "magic bullets" (Roe, Levy, & Derby, 1999) that lead to "automatic" weight loss, rather than as part of a broader behavioural repertoire necessary to achieve effective weight management. Again, expert opinions also seem to diverge on whether satiety claims on products play a role as an adjunct to weight control (De Graaf, 2011; Mela, 2011) vs. being interpreted "all the way through" as a guarantee for weight control and even weight loss success (Bellisle & Tremblay, 2011; Booth & Nouwen, 2010; Booth & Nouwen, 2011; Smeets & van der Laan, 2011) ,carrying the risk that consumers abdicate their own responsibility for a broader repertoire of voluntary behaviours.

To our knowledge, the present study is the first to directly address these issues using objective, quantitative consumer research methods in a large population. We have used means-end chain theory (Gutman, 1982) as a framework to structure the different levels of inferences that consumers may make for satiety-related claims. Essentially this model assumes that from their perception of concrete information (e.g. the stated product attributes), consumers infer functional (e.g. what the product does functionally) and psycho-social (e.g. emotional) consequences. These product related perceptions then form the basis for further cognitive elaboration processes to imply functional and psycho-social benefits (e.g. What it does *for me* functionally and emotionally?).

At a final level of cognitive elaboration these consequences are interpreted in the context of relevant goals that the consumer wants to achieve or to avoid. Using this model added with supplementary questions, this study specifically explores (a) whether and to what extent consumers over-interpret satiety claims as weight management claims, and (b) whether and to what extent consumers recognize products with satiety claims as an adjunct to other wilful behavioural efforts they need to undertake for effective weight management.

Methods

Respondents

Respondents (N=1504) of four different European countries: UK, France, Italy & Germany participated in an internet based questionnaire. Respondents in all four countries were recruited by a market research agency (GFK, The Netherlands), that used age (adults only) and gender (similar mix of male and female) as selection criteria. Respondents were approached via e-mail and compensated for their participation. Demographic characteristics of the total and each national sample are presented in table 3.1.

Procedure

The questionnaire used in this study was developed in English and translated by native speakers with relevant research expertise into German, French and Italian. These translations were then back translated to English by another native speaker. Differences between both translations were discussed and translations were adapted when appropriate. Comprehensibility of the questionnaire was tested in a small group, and results were used to further refine the questionnaire (e.g. clarity of instructions).

Table 3.1: Mean (SD) of demographic variables, weight related issues and estimated assignment of personal responsibility score per country. See methods for details of scales.

	All respondents (N=1504)	U.K. (N=375)	Germany (N=378)	France (N=376)	Italy (N=375)
Males/ Females	750/754	186/189	189/189	188/188	187/188
Educational level*	2 (0.8)	2 (0.8)[a]	2 (0.8)[a]	2 (0.7)[a]	2 (0.7)[a]
Income level*	2 (0.9)	2 (0.9)[a]	2 (0.9)[a]	2 (0.9)[a]	2 (0.8)[a]
Age, yr.	40 (14)	39 (14)[a]	40 (14)[a]	40 (15)[a]	41 (13)[a]
Body weight, kg	74.4 (17.8)	73.7 (17.0)[a]	79.4 (20.9)[b]	71.9(16.6)[a]	72.4 (16.5)[a]
BMI	25.3 (5.3)	25.1 (5.4)[a]	26.3 (5.8)[b]	24.6 (4.9)[a]	25.0 (5.0)[a]
Prevention of weight gain, difficult/ easy	2.7 (1.1)	2.8 (1.1)[a]	2.8 (1.1)[a]	2.6 (1.0)[a]	2.6 (1.1)[a]
Body weight perception (too thin / too heavy)	4.9 (1.2)	4.9(1.2)[a]	4.9 (1.1)[a]	4.9 (1.2)[a]	4.8 (1.2)[a]
Active dieting (don't / do)	4.3 (1.8)	4.5 (1.8)[a]	4.3 (1.7)[a]	3.8 (1.7)[b]	4.4 (1.9)[a]
Restraint score	27.5 (8.5)	27.4 (8.8)[a]	26.9 (8.6)[a]	27.2 (8.2)[a]	28.6 (8.2)[a]
Weight locus of control	20.4 (3.8)	20.2 (3.7)[a]	20.4 (3.9)[a]	19.6 (3.8)[a]	21.7 (3.6)[a]

*Scored as 1, 2, or 3 respectively, for educational level reported as low, middle or high, and for income level reported as less than, approximately at, or more than the national modal income.

Note: Variable means for the four countries in the same row sharing the same superscript are not significantly different from each other ($p<0.05$).

Claims

In this study, respondents were confronted with the following five test claims that may be considered satiety-related:

- Contains active fibres
- Increases fullness
- Helps to control hunger
- Helps you want to eat less
- Keeps you going between meals

Although the claim "Contains active fibres" is not a satiety claim *per se*, it was used as an example claim for an ingredient that has often been linked to satiety in the consumer and scientific literature (Carrillo, Varela, & Fiszman, 2012; Lynam, McKevitt, & Gibney, 2011; Van Trijp & Van der Lans, 2007). In addition, and to have a baseline for consumer perceptions, the claim "Contains B vitamins" was included as a clearly non-satiety related claim. Figure 3.1 shows the expected levels of interpretation of claims on possible benefits by respondents, based on the literal meaning of the claims, including the potential levels of over-interpretation. Upward deviations in consumer perception were taken as an over-interpretation of the claim, beyond what is literally stated (i.e. what should have been substantiated in a product making the claim) with maximum levels of over-interpretation ranging from 2 to 6 depending on the type of claim.

Perceived benefits

Based on the means-end chain framework, 4 different levels of inference making were defined for 7 perceived benefits that consumers might extract from the stated claims:

- Product attribute level (content):
    1. Contains specific ingredients (nutrient information)
- Product benefit level:
    2. Fills your stomach (functional product benefit)
    3. Feel full for longer (emotional product benefit)
- Behavioural consequence level:
    4. Controls appetite (functional behavioural consequence)

5. Make it through the day (emotional behavioural consequence)

- Goal/outcome related consequence level:
    6. Controls calorie intake (weight management outcome-related consequence)
    7. Lose weight (weight loss outcome-related consequence)

The relationship of the claims with these 7 benefit alternatives were assessed in ranking and rating described below.

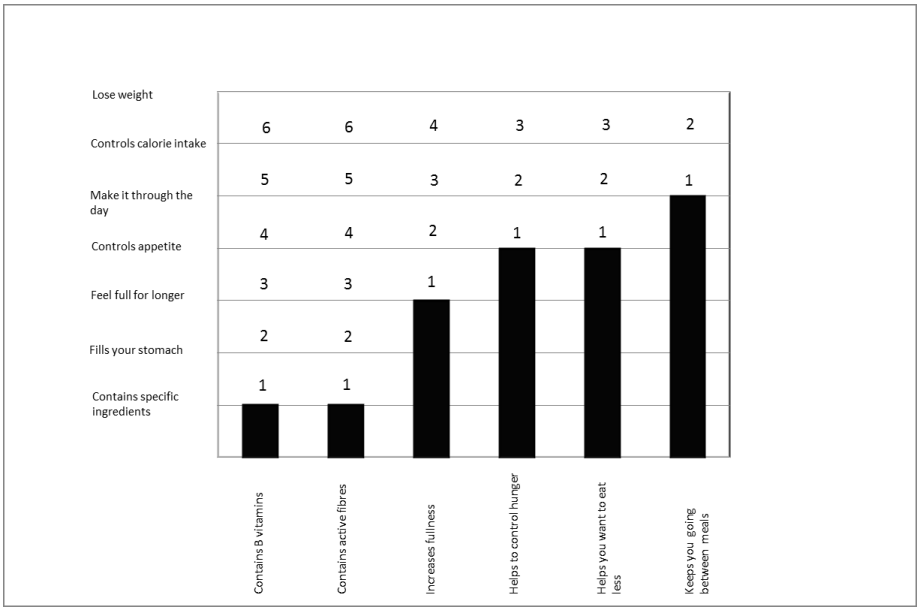

Figure 3.1: The "correct" level of interpretation based on actual scientific substantiation described by each claim. Numbers in the graph indicate the possible numbers of levels of over-interpretation of each claim

Response tasks and measures

Respondents' perceptions of the benefits inferred from all the satiety-related claims were measured in relative terms in a ranking task and also in absolute terms for one randomly selected claim per subject.

Ranking task

Respondents were consecutively presented with the five satiety claims plus the "Contains B vitamins" claim in random order, each with the question: "Imagine you encounter a product with the following claim (Claim 1-5 and B -vitamin claim), can you please assign each of the perceived benefits to the best-fitting box?" For each claim respondents were presented with the 7 possible perceived benefits and had to drag-and-drop each benefit into one of 3 boxes to indicate whether that benefit "reflects claim well", "does somewhat reflect the claim", or "does not reflect the claim". As a second step, they subsequently rank-ordered the claims further within the response boxes in which they had placed them. Ties in the ranking of the perceived benefits were not allowed.

Rating task

As a second task, respondents were presented with only one claim (randomly selected from the five satiety-related claims) and each of the 7 perceived benefits, and asked: "For the following claim (claim 1-5; e.g. "This product contains active fibres"), please indicate the extent to which you agree with the following statements", and the 7 perceived benefits were shown in random order. Responses were collected on a 7 point scale, with end poles labelled from 1 (strongly disagree) to 7 (strongly agree) for each of the benefits.

Additional measures

Respondents reported their age in years, weight in kilograms, height in centimetres, educational level (low, middle or high) and income level (less than, approximately at, or more than the national modal income).

The following questions regarding weight gain and dieting behaviour were also asked:

- Prevention of weight gain: "How difficult or easy do you think it is to prevent weight gain", rated on a 5 point scale from 1 (very difficult) to 5 (very easy).
- Body weight perception: "How would you rate your body weight", rated on a 7 point scale from 1 (far too thin) to 7 (far too heavy).
- Active dieting: "I am actively trying to keep from gaining weight, rated on a 7 point scale from 1 (I certainly don't) to 7 (I certainly do).
- The restrained eating scale, a subscale of the Dutch Eating Behaviour Questionnaire (Van Strien, Frijters, Bergers, & Defares, 1986) was used to assess dietary restraint. All ten questions were answered on a 5 point

scale: never (1), seldom (2), sometimes (3), often (4), very often (5) for a possible total restraint score of 5-50.

- The Weight Locus of Control Scale (Saltzer, 1982) to measure perceived personal responsibility for weight status as a personality characteristic. All four questions were answered on a 7 point scale from 1(strongly disagree) to 7(strongly agree), for a possible total score of 7-28.

Ascription of personal responsibility

For each of the seven benefits, respondents were also asked to indicate to what extent the benefit (e.g. "Fills your stomach"), is delivered entirely through the product, or is delivered entirely through personal efforts, or requires a certain balance between these two to be obtained. Respondents answered this question by placing a "slider" on a 100mm visual analogue scale, anchored by "entirely up to the product" to "entirely up to your personal efforts".

Data analysis

Statistical analyses were carried out with IBM SPSS Statistics 19. Significance was assessed at $\alpha = 0.05$. Repeated measures analysis of variance was used to evidence differences in importance of perceived benefits for the five satiety-related claims, with claim as a between subjects factor and the scores on the perceived benefits as a within-subject factor. Sidak was used a post-hoc test. ANOVA was used to identify which claims scored significantly higher on the perceived benefits "Controls calorie intake" and "Lose weight". To detect if respondents interpret satiety claims to higher levels and which respondents are most prone to over-interpretation we first counted per claim the frequency with which a particular respondent had placed an association in the box: "reflects claim well" for a higher level association than actually stated by the claim. We computed the over-interpretation scores of the different claims (excluding "contains B vitamins") into an overall over-interpretation score (ranging from 0 to 18). We then used this score in a Multiple Regression Analysis as the dependent variable and all additional measures as independent variables. To detect differences in perceived personal responsibility we used the mean personal responsibility score as the dependent variable and all additional measures were used as independent variables in a Multiple Regression Analysis.

Results

Differences in national samples

There were no significant differences between the different national samples in the gender distribution, reported education or income levels, age, beliefs about ease of preventing weight gain, bodyweight perception, weight locus of control, or restraint scores. However, German respondents were significantly heavier ($F(3, 1458)= 14.34$, $p<0.001$) and had a higher body mass index (BMI) ($F(3, 1433)= 7.63$, $p<0.001$) than respondents of the other three countries. And the French scored significantly lower on the "active dieting" scale ($F(3, 1500)= 10.99$, $p<0.001$) compared to respondents from the U.K., Germany and Italy. Demographic characteristics of the total and each national sample are presented in table

Consumer interpretation of satiety-related claims

Table 3.2 and figure 3.2 show how respondents in general interpret different satiety-related claims. The claim "Contains B vitamins" provides a first benchmark for the results in Figure 3.2. In principle this claim is not at all satiety-related. However, although the majority of respondents indicate that this claim only relates to the presence of specific ingredients in the food product, a substantial number of respondents indicate the claim reflects satiety and weight related benefits. Note that the number of participants that has the perceived benefit "Lose Weight" in their top 3 of best fitting benefits, is larger for the "Contains B vitamins" claim compared to any of the satiety- related claims. The claim "Contains active fibres" is clearly recognized primarily as a content claim, with limited over-interpretation in terms of satiety and weight-related benefits. The "Increases fullness" and "Helps to control hunger" claims follow similar patterns in terms of benefit perceptions on the part of the respondent, with the "Increases fullness" claim more strongly associated with the perceived benefit of "Feel full for longer", and the "Helps to control hunger" more strongly associated with the perceived benefit of "Controls appetite". The more functional claim "Helps you want to eat less" has a higher degree of primary association with the benefits of "Controls calorie intake" and "Lose weight", this was less the case for the claim "Keeps you going between meals". The interpretations identified in the (within-subjects) ranking task results are to a large degree reflected in the (between-subjects) rating task results (Table 3.2). These data indicate that respondents primarily relate claims to their intended,

actual benefit meaning (see Figure 3.1) or a level lower than that. For all 5 claims the expected perceived benefit was always rated higher compared to the benefits "Controls calorie intake" or "Lose weight" (Table 3.2). The claims that were significantly most often associated with these two perceived benefits ("Controls calorie intake": (F(4,1499)=11.01, p<0.001); "Lose weight":(F(4,1499)=10.69, p<0.001) are "Helps to control hunger" and "Helps you want to eat less".

Individual differences in over-interpretation of satiety-related claims

Table 3.3 shows that the country, average income vs. high income, gender, age, bodyweight perception, restrained score and weight locus of control all contribute significantly to the inference-making (over-interpretation) scores (F(16,1420)=11.20, p<0.01). UK respondents showed less over-interpretation of claims relative to the other nationalities. Restraint scores were very consistently related to a tendency to over-interpret all claims (including "Contains B vitamins"). Other factors (including those related to body weight and dieting) show no consistent relationship with tendency to over-interpret claims.

Ascription of personal responsibility

The perceived level personal responsibility (Figure 3.3) differs between the perceived benefits. Respondents recognize, "Contains specific ingredients" (M= 30.1, SD= 28.2) "Fills your stomach" (M= 40.2, SD= 26.2) and "Make you feel full for longer" (M= 41.5, SD= 25.6) are generally delivered by products more than personal efforts. However, for "Controls appetite" (M= 49.2, SD= 24.8), scores were balanced between product and personal efforts. For the perceived benefits "Make it through the day" (M=5.7, SD= 24.5), "Controls calorie intake" (M= 55.1, SD= 26.4) and especially "Lose weight" (M= 63.2, SD= 23.7), an increasing preponderance of personal efforts are seen as required to obtain the benefit. Respondents differ in the amount of personal responsibility they assign in regard to obtaining the perceived benefits (Table 3.4). Most noticeable is that respondents who score higher on the weight locus of control scale, scored more in line with expectations on the ascription of personal responsibility scale (F(15,1421)=4.38, p<0.01). Respondents that perceive their weight as something that they can control, think more strongly that personal efforts are less important to obtain benefits as "fills your

stomach", "feel full for longer", but they understand better that more personal efforts are required to "control calorie intake" or to "lose weight".

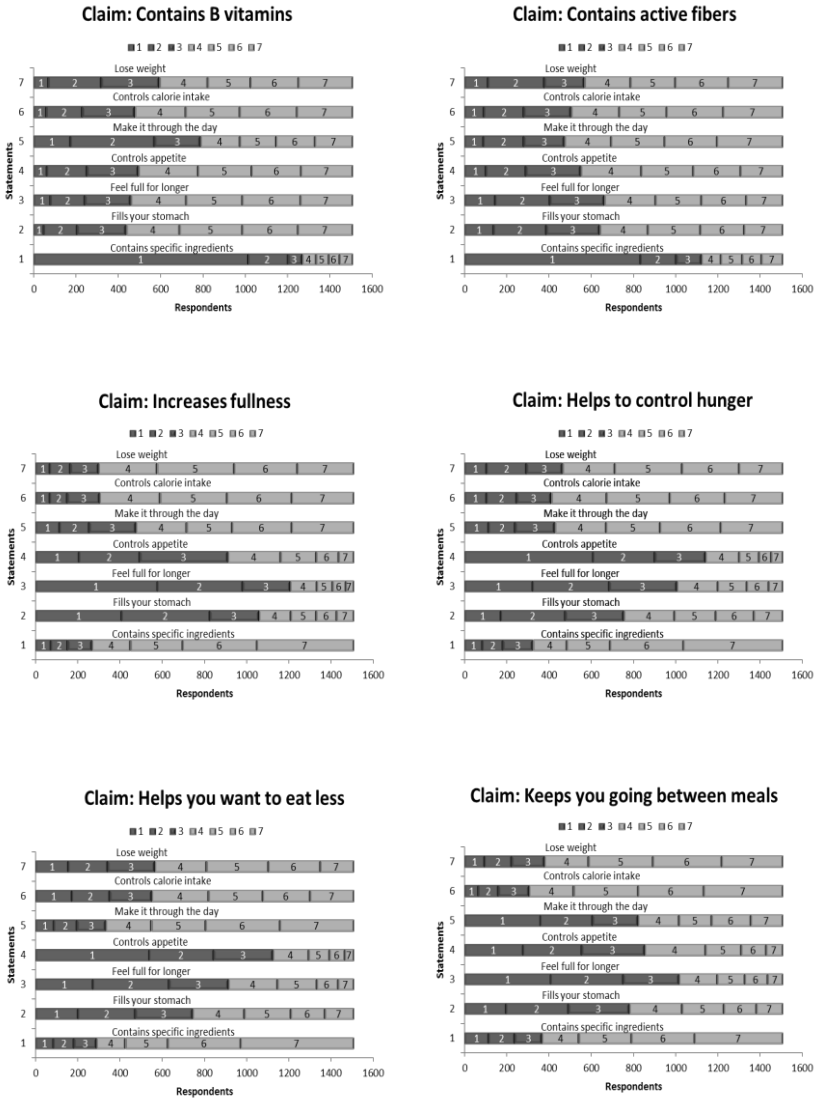

Figure 3.2: Initial consumer response (ranking task), relating perceived benefits to claims. Shows the number of respondents ranking perceived benefits from 1-7 for all six claims. The number of respondents that had a certain perceived benefit in their top 3 is depicted in dark grey to facilitate interpretation of the figure.

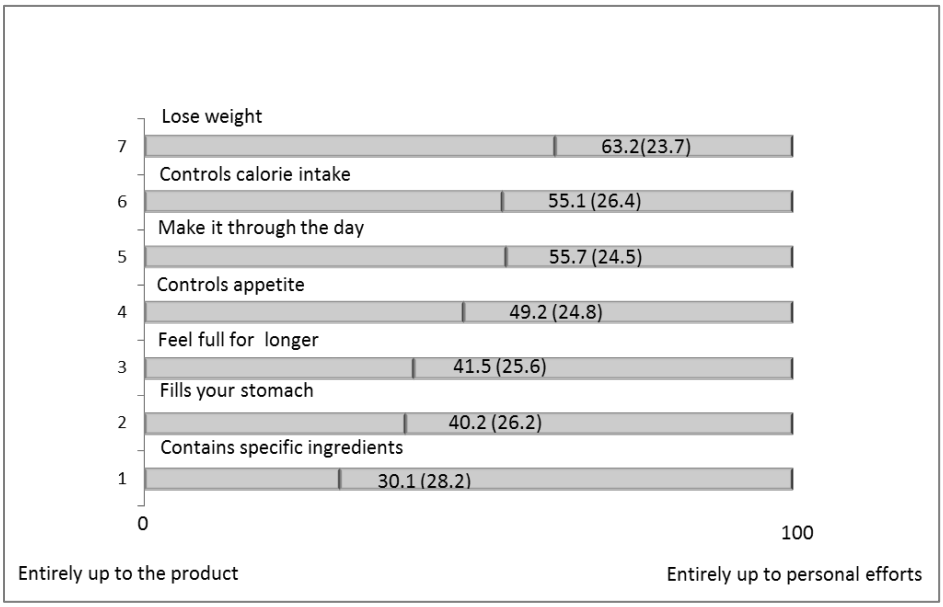

Figure 3.3: Ascription of personal responsibility, with mean (SD) personal responsibility score per perceived benefit.

Table 3.2: Mean (SD) intensity ratings for each of the perceived benefits per claim (1= strongly disagree; 7 = strongly agree)

		Perceived benefits						
		Contains specific ingredients	Fills your stomach	Feel full for longer	Controls appetite	Make it through the day	Controls calorie intake	Lose weight
Claims	Contains active fibres	5.23(1.52)[a]	3.78(1.66)[b]	3.90(1.71)[b]	3.77(1.62)[b]	3.65(1.55)[b]	3.74(1.55)[b]	3.80(1.56)[b]
	Increases fullness	3.86(1.63)[a]	5.29(5.29)[c]	5.59(1.48)[d]	5.07(1.45)[c]	4.51(1.54)[b]	4.08(1.57)[a]	4.13(1.56)[a]
	Helps to control hunger	3.98(1.68)[a]	4.90(1.47)[c]	5.21(1.45)[d]	5.42(1.33)[e]	4.38(1.55)[b]	4.20(1.64)[b]	4.39(1.64)[b]
	Helps you want to eat less	4.02(1.71)[a]	4.89(1.45)[c]	5.24(1.37)[d]	5.41(1.34)[d]	4.50(1.52)[b]	4.46(1.65)[b]	4.54(1.54)[b]
	Keeps you going between meals	3.78(1.72)[a]	4.78(1.54)[b]	5.15(1.55)[c]	4.72(1.55)[b]	4.82(1.61)[b]	3.73(1.65)[a]	3.99(1.57)[a]

Note: Means in the same row sharing the same superscript are not significantly different from each other (p<0.05)

Table 3.3: Summary of multiple regression providing standardized regression coefficients of demographic variables, weight related issues and personal responsibility score explaining over-interpretation of all claims combined and all claims separately

Main effects	Total of claims	Contains active fibres	Increases fullness	Helps to control hunger	Helps you want to eat less	Keeps you going between meals	Contains B vitamins
Restraint score	0.234**	0.183**	0.102**	0.173**	0.127**	0.178**	0.206**
Active dieting	-0.018	0.007	0.008	-0.054	0.000	-0.054	-0.015
Bodyweight perception	-0.094*	-0.069	-0.080	-0.058	-0.012	-0.005	-.130**
Prevention of weight gain,	-0.037	-0.032	-0.036*	-0.011	-0.019	-0.002	-0.037
BMI	0.047	0.061	0.031	0.008	0.044	-0.040	0.047
Weight locus of control	-0.56*	-0.042	0.021	-0.001	0.033	-0.050	-0.169**
Personal responsibility	-0.042	-0.022	-0.076**	-0.079**	-0.064*	0.013	0.045
Gender	0.052	0.062*	0.090**	0.025	0.059*	0.006	-0.041
Age	0.052	0.130**	0.018	0.014	-0.030	0.029	0.001
U.K. vs. Germany	0.247**	0.124**	0.205**	0.227**	0.125**	0.144**	0.217**
U.K. vs. France	0.180**	0.080*	0.200**	0.191**	0.161**	0.065	0.072*
U.K. vs. Italy	0.162**	0.087**	0.192**	0.171**	0.037	0.090**	0.103**
Middle vs. low educational level	0.009	-0.024	0.011	0.028	0.028	0.008	0.006
Middle vs. high educational level	-0.022	-0.009	-0.012	-0.038	0.044	-0.018	-0.056*
Average income vs. low income	-0.018	-0.001	-0.016	-0.006	0.003	-0.023	-0.035
Average income vs. high income	-0.063*	-0.057	-0.035	-0.008	-0.007	-0.039	-0.096**
F	11.198**	7.859**	7.329**	6.922**	4.889**	3.728**	11.109**
df	(16,1420)	(16,1420)	(16,1420)	(16,1420)	(16,1420)	(16,1420)	(16.1420)
R^2	0.112	0.081	0.075	0.072	0.052	0.040	0.111

*p<0.05**p<0.01

Table 3.4: Summary of multiple regression providing standardized regression coefficients of demographic variables, weight related issues and personal responsibility score explaining over-interpretation of mean personal responsibility and personal responsibility per perceived benefit

Main effects	Mean personal responsibility	Contains specific ingredients	Fills your stomach	Feel full for longer	Controls appetite	Make it through the day	Controls calorie intake	Lose weight
Restraint score	0.017	0.077*	0.014	0.030	0.029	-0.031	0.025	-0.081*
Active dieting	0.011	-0.036	0.029	0.031	-0.003	0.014	-0.005	0.028
Bodyweight perception	-0.011	-0.040	-0.042	-0.025	0.029	0.034	-0.004	0.004
Prevention of weight gain	0.101**	0.049	0.076*	0.088**	0.090	0.047	0.061*	0.051
BMI	0.064	0.050	0.047	0.043	0.034	0.027	0.047	0.041
Weight locus of control	-0.115**	-0.240**	-.147**	-0.184**	-0.081**	-.009	0.042	0.128**
Gender	-0.029	-0.044	-0.040	-0.060	-0.003	-0.010	0.008	0.020
Age	-0.030	-0.005	-0.016	-0.029	-0.064*	0.001	-0.033	0.008
U.K. vs. Germany	0.029	0.083	0.030	0.029	-0.040	0.161**	0.042	-0.191**
U.K. vs. France	-0.087 *	0.065*	-0.063	-0.017	-0.028	-0.188**	-0.062	-0.126**
U.K. vs. Italy	-0.089*	0.040	0.005	0.010	-0.039	-0.091**	-0.164**	-0.184**
Middle vs. low educational level	0.001	0.052	-0.022	-0.006	-0.001	-0.009	-0.007	-0.011
Middle vs. high educational level	-0.007	0.007	-0.011	-0.004	-0.001	-0.001	-0.012	-0.012
Average income vs. low income	0.015	-0.014	0 .033	0.024	0.008	0.025	-0.007	0.000
Average income vs. high income	0.011	0.015	0.014	0.011	0.020	0.005	0.010	-0.029
F	4.375**	7.753**	3.587**	4.710**	1.811*	10.401**	3.852**	5.089**
df	(15,1421)	(15,1421)	(15,1421)	(15,1421)	(15,1421)	(15,1421)	(15,1421)	(15,1421)
R^2	0.044	0.076	0.036	0.047	0.019	0.099	0.039	0.051

*p<0.05 **p<0.01

Discussion

The present study shows that over-interpretation of satiety-related claims is limited, and that consumers are fairly good in interpreting these claims correctly. This was apparent both in terms of the benefit inferences that they make, as well as the recognition of personal responsibility (personal effort required in addition to what the product can deliver) in order for "higher order" outcome related benefits (such as controlling caloric intake and realizing weight loss) to be realized.

The assertion that consumers interpret satiety claims "all the way through" to imply weight loss benefits was not found this objective assessment. Instead, consumers appear to be relatively accurate in interpreting these claims, to stay close to their literal meaning (i.e. what is actually claimed). However, wording of claims is crucial here, as for example the claim "Helps you want to eat less" is more strongly interpreted in terms of weight management and weight loss benefits than other claims (such as "Keeps you going between meals").

Results show that there is quite a large group of respondents that connect a non-satiety claim as "Contains B vitamins" to the apparently unrelated perceived benefit "Lose weight". Theoretically, this can be explained by the conversation maxims (Grice, 1975) and spreading activation theory (Collins & Loftus, 1975). Health claims form part of the conversational discourse between food manufacturers and consumers (Leathwood, Richardson, Sträter, Todd, & van Trijp, 2007). Because such discourses follow specific conversations maxims (Grice, 1975), there is a risk of over-interpretation of claims beyond their literal meaning (Roe, et al., 1999). For example, the consumer will assume that the sender will apply the maxims of parsimony (say no more than needed) and relevance (say what is personally relevant to the receiver), both potentially leading to over-interpretation of the claim. Especially the application of the maxim of relevance might have influenced the results in this study. When filling out the questionnaire, respondents were constantly confronted with aspects of satiety and weight loss. Although some of these questions were not satiety related, respondents will reason that since the previous questions were on satiety and weight loss, this particular question must have something to do with that as well.

In addition, spreading activation theory (Collins & Loftus, 1975) explains that when activating a certain concept in memory, automatically other concepts that are somehow related to this first concept are activated as well. The satiety/ weight loss prime in this study was the first concept activated in memory of the respondents. Spreading activation theory predicts that the human mind tries to connect the concept that is presented next, in our case the claim "Contains B vitamins", to one of the concepts activated by the satiety/ weight loss prime. Automatically leading to associations with satiety/ weight loss that might not be correct. In case we would have provided the claim "Contains B vitamins" in a different context, for example "improves brain function", inferences towards brain functioning would have been made. This makes it very difficult to prevent over-interpretation of information in general. To limit interpretation beyond the literal meaning of a claim it is important to present any claim in a neutral context, and more specifically for satiety- related claims, a weight loss context should be avoided at all times.

Some authors (Blundell, 2010; De Graaf, 2011; Mela, 2011) have argued that intermediate benefits such as "Feeling full for longer" and "Keeps you going between meals" might be relevant health-related benefits to consumers in supporting their self-control, as an adjunct to a broader repertoire of goal-oriented behaviours. This would be a topic for future research as the present study has only explored benefit inferences from different satiety-related claims, and not to what extent these benefits would be appreciated by the consumer nor their effectiveness in supporting particular health-related behaviours or outcomes.

The present study also identified specific consumer groups that might be more prone to over-interpretation of claims in general. This provides an important insight from a public health policy point of view. Specifically, the fact that restrained eaters exhibit a higher tendency to over-interpret claims including satiety-related claims may be worth further investigation. Restrained eaters are a consumer group that would be interested in and actively searching for products with a satiety-related claim, and yet more vulnerable to over-interpreting their promise. Especially in todays' obesogenic environment it is important not to discourage consumers who actively make an effort to control their eating and attain a healthy weight. If satiety claims would generate consistently unrealistic

product expectations, this might hinder the establishment of a healthy food pattern in consumers who most need to make changes.

When interpreting these results it is important to keep in mind that body weight perceptions and active dieting were not consistently related to a tendency to over-interpret claims. Furthermore, consumers in general recognized that control of calorie intake and weight loss were predominantly attributable to personal efforts rather than being delivered by products.

Interestingly, we also find cultural differences in the proneness to over-interpretation of claims. UK consumers are less likely to do so, compared to French, Italian and German consumers. This country difference can be the result of the fact that manufactured (vs. home-made) foods are more popular in the U.K. and with that U.K. inhabitants have possibly a longer or deeper history of exposure to health and nutrition-related claims (Grunert, Wills, & Fernández-Celemín, 2010). From the present study, it is not clear whether this is a response style issue and/or a substantive issue. Nevertheless, this might be an issue worth further investigation.

The present study adopted two different methodologies to explore consumer (over-) interpretation of satiety related claims. The initial expectation was that the rating tasks of the different verbalizations of a set of satiety related claims would stimulate cognitive processing, resulting in automatic links to higher order benefits, and as a consequence would hide differences between claims in terms of benefit perceptions (Van Trijp & Van der Lans, 2007). Claims were first evaluated in comparative terms in a ranking tasks of benefits extracted and in a second task each respondent rated only one claim in a monadic task. Against our expectation, the results of the within-subjects ranking task and the between-subjects rating tasks were remarkably similar. This convergence between methods, supports us in the confidence that the results are robust and not subject to strategic response styles on the part of the respondents. We suggest that methods similar to those used here could be more widely and routinely applied to provide a more objective basis for both regulatory and commercial decision-making, as a way to verify the consumer interpretation of claims, where this may be in doubt.

Present study is not without its limitations. First, the study was restricted to four European countries only. Although these represent major populations and economies within Europe, there may be further regional or cultural diversity in the interpretation of satiety claims. Future research might explore this in other countries or specific sub-groups than those in this research, to confirm if these results can be more widely generalized. Second, the study shows that wording of satiety claims can affect the benefit inferences that consumers make from them, a finding well established in the framing literature (Levin, Schneider, & Gaeth, 1998; Rothman, Bartels, Wlaschin, & Salovey, 2006; Rothman & Salovey, 1997). The present study was restricted to five satiety claims only, and future research might further elucidate the conversation logic behind these and other claims to further understand the underlying rules and regularities in the (over-) interpretation of claims. Thirdly, under- interpretation was not assessed in this study, as from a commercial perspective under-interpretation is inherently less likely. There is competitive pressure for marketers to communicate a product in ways that generate the strongest and most differentiating propositions. Regulatory guidance is also designed around minimizing risk of over-claiming and misleading in this direction (Under-interpretation is arguably poor marketing). Finally, in the present study the satiety claims were tested as such and not presented as part of a broader on-pack communication and/or different products. Claim-carrier combinations have a profound impact on consumer perception (Van Kleef, Van Trijp, & Luning, 2005) as consumers would probably take the "totality of the marketing evidence" into account when making benefit inferences. This provides a promising direction for future research, not only for academic research but also for claim regulation.

In conclusion, the results suggest that, in general, consumers interpret such claims to reflect what is actually stated, and recognize that 'higher' benefits such as reduced calorie intake or weight loss are primarily realized through personal efforts, where products may be an adjunct. We believe that the methodology applied here not only has relevance to the academic field of research on product-related claims, but also for legislation of those claims.

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Chapter 4

The influence of packaging design and claim on satiation expectations and consumption

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Abstract

Often, a food product's packaging is the only information, prior to consumption, a consumer receives about the product. Different packaging elements as weight, shape, colour, images, lettering and claims can be used to gather information and to build product expectations. In current paper, it is hypothesized that the overall appearance of a package has the ability to convey a message to the consumer and with that can influence satiation expectations and food intake. Two packages were developed for the same cookie: a package that signals a light and easy to digest cookie and a package that communicates a satiation enhancing cookie. In a pilot study (N=236), these two packages were tested for differences in satiation expectations with the presence of either a taste ("New recipe, now even tastier") or a satiation ("Added fibre, provides a feeling of fullness sooner") claim. In the main study (N=96), a 2 (light packaging vs. satiation enhancing) by 2 (taste claim vs. satiation claim) between subjects design, these packages were tested on their influence on caloric intake. Results indicate that packaging influenced satiation expectations: participants expected a lower feeling of fullness and less time till a next consumption moment when they were presented with a light package with a taste claim compared to all other packaging formats. Packaging did not only influence satiation expectations but did also affect actual consumption. A satiation-enhancing package with a taste claim influenced caloric intake in a similar way as a light package with a satiation claim. Unexpectedly, a satiation-enhancing package with a satiation claim increased caloric intake. Hence, package cues may be of substantial relevance to consumers' food consumption.

Introduction

Accurate regulation of food intake has proven to be a challenging task for many people. Often, more calories are consumed than energy is expended, which is one of the leading causes of overweight and obesity (Swinburn et al., 2011). Two important processes in the regulation of food intake are satiation and satiety. A feeling of satiation develops during the course of a food consumption event as a signal for the decision to stop eating, and as such influences the size of meals (Blundell et al., 2010). A feeling of satiety becomes relevant after food consumption as a signal to refrain from or to start eating again, and as such determines the timing and frequency of subsequent meals and snacks. Subjective feelings of satiation and satiety are both crucially important in the process of managing food intake. Satiety is mostly influenced by post-ingestive signals as gastric factors and satiety hormones. But for satiation, monitoring of what has been eaten, sensory experiences and satiation expectations are more important, since many of the post-ingestive signals only appear when consumption is already finished (Benelam, 2009; Yeomans, 2010).

An important factor in the formation of satiation and satiety expectations is the information on the satiation value of foods gathered through previous experiences. Through encounters with different food products, people learn how much to consume to be satiated at the end of a consumption episode (satiation) and for how long this amount will keep them satisfied (satiety). Previous research on sensory and flavour perception indicates that expectations can be biased as a result of external cues included in packaging design such as weight, shape, colour, images, lettering and claims (Garber, 2000; Becker, van Rompay, Schifferstein, & Galetzka, 2011; Moskowitz, Reisner, Lawlor, & Deliza, 2009; Deliza & MacFie, 1996).

Although research on this topic is limited, there is reason to believe that satiation and satiety expectations can also be influenced by different packaging cues. Fay et al. (2011) showed that a smoothie branded as "highly satiating" was expected to be more satiating, before as well as after consumption, compared to similar smoothies from a diet and a control brand. Piqueras-Fiszman & Spence (2012) showed that yoghurt served in a heavier container is expected to be more satiating and is perceived as denser compared to the same yoghurt from a visually identical but lighter container.

Building on these findings, the present study explores to what extent packaging design affects consumers' satiation expectations and food intake. Packaging design has the potential to influence satiation expectations through two belief formation processes (Steenkamp, 1989): informational belief formation (e.g. satiation claim) and inferential belief formation (e.g. packaging colour, images). In the case of informational belief formation, the consumer uses information provided by the manufacturer, as product claims, to form expectations. In inferential belief formation, consumers use learned associations with for example colours and images to form product expectations (Kauppinen-Räisänen & Luomala, 2010). These associations have a cultural basis, learning is based on the connections made between colours and meaning (Grossman & Wisenblit, 1999). By activating prior established knowledge and associations product expectations are build (Becker, et al., 2011).

Unfortunately there is little prior research to specifically link packaging colour to satiation expectations. In the present research, we therefore build on light versus dark colours in an attempt to build satiation expectations. Specifically, we developed a ("light") package for a light and easy to digest cookie and a ("satiation enhancing") package for a satiation enhancing cookie. These two packages are tested for differences in satiation expectations with the presence of either a taste ("New recipe, now even tastier") or a satiation ("Added fiber, provides a feeling of fullness sooner") claim. In the main study these packages with either a taste or a satiation claim are tested on their influence on caloric intake. We hypothesize that both the "satiation enhancing" packaging without a satiation claim and the packaging that conveys the message: "light and easy to digest" with a satiation claim reduce caloric intake. This would show that it is possible to develop a package that has the potential to influence consumption through satiation expectations without the presence of an explicit claim.

Pilot study: satiation expectations from packaging designs

The aim of this pilot study is to assess the satiation expectations generated by the developed stimulus material.

Participants and procedure

Two hundred and thirty-six Dutch participants (195 women) ranging in age from 18 to 54 years (*M*= 22.2, *SD*= 4.1) were recruited through e-mail to participate in an internet based survey. The pre-test used a 2 (product appearance: light vs. satiation enhancing) by 2 (taste claim vs. satiation claim) between subjects design. Participants were randomly assigned to one of four conditions.

Stimuli

Current study used Kellogg's special K Mini Break original cookies as stimulus material. Based on the original packaging we developed a ("light") package for a light and easy to digest cookie and a ("satiation enhancing") package for a satiation enhancing cookie. The packages were based on existing associations between colour and meaning. Prior research suggests that bright colours as white and yellow are often associated with purity and happiness (Aslam, 2006) and dark colours as black, brown and purple with heaviness (Meerum- Terwogt & Hoeksma, 2001). Therefore the colours white and yellow are mainly used in the light package for the easy to digest cookie and the colours black/brown and purple in the package of the satiation-enhancing version of the cookie (see figure 4.1).

Claims

The packaging of the Mini breaks displayed the claim "Added fibre, provides a feeling of fullness sooner" in the satiation claim condition or emphasized the tastefulness of the Mini breaks: "New recipe, now even tastier", seen by participants in the taste claim condition. Nowadays, many manufacturers use taste claims to promote their products. To ensure realism, we therefore included a taste claim in our studies.

Measures

Participants were asked to evaluate the Mini breaks based on the packaging shown to them on their computer screen (figure 4.1). In addition, participants were shown a picture with 48 grams of the mini break cookies (figure 4.2) presented in a bowl (the same picture was used in all experimental conditions) and were asked to answer the following question on a visual analogue scale to measure expected satiation: "Please indicate the expected feeling of fullness after consuming the mini breaks in the picture" (0-100 mm with end poles

labelled as not full at all- extremely full) to measure expected fullness after consumption. Expected satiety was measured by the following statement: "Imagine you eat all the mini breaks displayed in the picture, how long will it take before you feel the need to start eating again? Please indicate this in minutes" (0-300 minutes) to measure the expected time till next meal.

Data analysis

Univariate analysis of variance was used to assess main and interaction effects of packaging design and claim with expected satiety and expected satiation as dependent variables.

Results

Analysis of variance did not indicate a main effect of packaging (F (1, 232)= 2.23, p=0.14) or claim (F (1, 232)= 1.70, p=0.19) on the expected fullness after consumption or a main effect of packaging (F (1, 232)= 2.48, p=0.12) or claim (F (1, 232)= 2.36, p=0.13) on the expected amount of minutes till the next consumption moment. We observed an interaction effect of packaging and claim on the expected fullness (F (1, 232)= 3.81, p=0.05) and on the amount of minutes (F (1, 232)= 7.34, p< 0.01) till the next eating moment after consuming the Mini breaks. Both the expected fullness (M= 39.0, SD= 22.5) and the amount of minutes till next consumption (M= 67.2, SD= 35.4) were lower when Mini breaks were presented in a light packaging without a satiation claim compared to the light packaging with a satiation claim ($M_{fullness}$= 48.1, SD= 20.4; $M_{minutes}$= 90.0, SD= 41.8) and the darker packaging with ($M_{fullness}$= 48.6, SD= 22.2; $M_{minutes}$= 90.2, SD= 41.5) or without ($M_{fullness}$= 46.8, SD= 20.1; $M_{minutes}$= 83.9, SD= 46.2) a satiation claim.

Conclusion

The present results confirms the expectation that expected satiation of the Mini break cookies differs as a result of informational belief formation (claim type) and inferential belief formation (packaging design). Participants expected a lower feeling of fullness and less time till the next consumption moment when they were presented with a light package with a taste claim compared to all other packaging formats.

Figure 4.1. Stimulus material used in both pilot study and main study. Top row: packaging of light, easy to digest cookies with a satiation claim (R) or a taste claim (L). Bottom row: Packaging of satiation enhancing cookies with a satiation claim (R) or a taste claim (L).

Figure 4.2. Picture of 48 grams of Mini break cookies presented in a bowl.

Main study

In the main study the effect of claim type and packaging design on caloric intake was tested.

Methodology

Participants

Dutch speaking students (N=109) of a Dutch university were recruited on college campus. Sixteen of these participants already participated in the pre-test and were therefore, after participation, excluded from the main study. The remaining ninety-six participants (78 women) ranged in age from 17 to 49 years (*M*=21.1, *SD*=3.4). Participants received €2. - as a reward for participation in the experiment. BMI ranged from 17.2 to 29.7 (*M*=21.7, *SD*=2.5) and participants with food allergies were not allowed to participate in the study.

Design and procedure

Present study used a 2 (light packaging vs. satiation enhancing) by 2 (taste claim vs. satiation claim) between subjects design. Participants were randomly assigned to one of four conditions. The packaging of the Mini breaks displayed the claim "Added fibre, provides a feeling of fullness sooner" in the satiation claim condition or emphasized the tastefulness of the Mini breaks: "New recipe, now even tastier", seen by participants in the taste claim condition. As a cover story we told participants that we were developing a marketing strategy for Mini Break cookies. Participants were asked to evaluate the (packaging of the) Mini Break cookies and to especially pay attention to product - packaging compatibility. They were instructed to study the pictures of the Mini Break packaging in detail and to answer several questions about them. Meanwhile they were presented with 96 grams (390.7 kcal) of (identical) Mini Break cookies (Kellog's Special K Mini Breaks original) of which they could consume as much as they liked. These cookies were selected because of their grainy structure and light colour so that they can fit in all four conditions.

Measures

Main dependent variables were evaluations of Mini Breaks, feelings of hunger and satiation after consumption, caloric intake.

Evaluation of Minibreak cookies

Participants evaluated the Minibreak cookies on 100mm visual analogue scales (end poles labelled as completely disagree/ completely agree) on their fresh taste, whether they look/ taste expensive, their attractiveness, their healthfulness, tastefulness in general, their structure and whether they are suitable as a light snack.

Feelings of hunger and satiation

Feelings of hunger and satiation were measured at the start and the end of the experiment, on series of 100mm visual analogue scales by answering the questions: "How hungry are you?", "How full are you?", "How satiated are you?", all anchored by the terms "not at all" to "extremely" and the questions: "How strong is your desire to eat?" anchored by: "extremely low" to "extremely high" and "How much do you think you could eat right now?" , anchored by: "nothing at all" to "a very large amount" (Blundell et al., 2010). Reliability analysis confirmed ($\alpha > 0.91$) that the five items could be meaningfully combined into a single measure. For that purpose, scores were added up (after appropriate rescaling of items) into a single index ranging from 0-500.

Caloric intake

The Mini breaks were weighed out of sight of the participants when the experiment was finished. Information on energy content provided by the food manufacturer was used to determine calorie intake. The consumed amount was calculated by subtracting the quantity left from the initial quantity of Mini breaks. Calorie intake was estimated by multiplying the amount consumed with the energy density information of the product.

Dietary restraint & current restriction of food intake

The restrained eating scale a subscale of the Dutch Eating Behaviour Questionnaire (Van Strien, Frijters, Bergers, & Defares, 1986) was used to assess dietary restraint. Reliability analysis suggested that the items could meaningfully be combined into an overall scale (Crombach's $\alpha = 0.89$).

Background variables

Age, gender, self-reported height and weight, which were used to calculate Body Mass Index (BMI) were provided by participants at the end of the

questionnaire. In addition, current restriction of food intake was measured on a 7 point scale at the end of the questionnaire with the question: "Are you currently restricting your food intake?" anchored by: "not at all" and "very much".

Data analysis

Repeated measures analysis was used to assess main and interaction effects of packaging and claim with feelings of hunger and satiation before and after consumption as within subject factors. Univariate analysis of Variance was used to assess main and interaction effects of packaging and claim with evaluation of Mini breaks and caloric intake as dependent variables. Current restriction of food intake by participants was added as a covariate.

Results

Randomization checks

There were no significant differences in hunger feelings at the start of the experiment (p=0.85), restrained eating score (p= 0.31), BMI (p= 0.59), age (p= 0.91) and gender (p= 0.71) between the four experimental conditions.

Evaluation of Mini breaks

Univariate analysis of variance indicated a main effect of packaging on taste, expensiveness, attractiveness and suitability as a light snack. Mini breaks in a light package were perceived as having a fresher taste (F(1,92)=83.93, p<0.001), less expensive (F(1,92)=4.79, p<0.05), more attractive (F(1,92)=7.91, p<0.01), and more suitable as a lighter snack (F(1,92)=4.93, p<0.05), compared to Mini breaks from a satiation enhancing package. Analysis also showed a main effect of claim on expensiveness and tastefulness. Mini breaks were evaluated as more expensive (F(1,92)=9.78, p<0.001) and less tasty (F(1,92)=3.99, p<0.05) when a satiation claim was displayed on the package instead of the taste claim. In addition, we found an interaction effect of packaging and claim on liking of the structure of the cookies (F (1, 91)= 4.02, p< 0.05). The texture of Mini breaks from a satiation enhancing package with taste claim and a light package with a satiation claim was less liked compared to the texture of Mini breaks from a

satiation enhancing package with satiation claim and a light package with a taste claim (table 4.1).

Table 4.1. Mean (SD) freshness, taste, perceived expensiveness, attractiveness, texture, suitability as a light snack, hunger feelings before consumption, hunger feelings after consumption and caloric intake of Mini breaks from a light and satiation enhancing package with a satiation or a taste claim

	Light taste claim	Light satiation claim	Satiation enhancing taste claim	Satiation enhancing satiation claim
Freshness	73.4 (26.7)[a]	72.0 (16.7)[a]	32.6 (24.2)[b]	36.6 (19.2)[b]
Taste	80.0 (13.1)[a]	72.2 (15.8)[b]	77.9 (12.7)[ab]	74.5 (12.7)[ab]
Texture	82.3 (10.2)[a]	78.6 (13.4)[ab]	75.7 (13.9)[b]	81.6 (8.3)[a]
Expensiveness	38.6 (16.5)[a]	52.3 (21.9)[b]	48.4 (24.2)[b]	60.6 (17.8)[c]
Attractiveness	55.5 (18.1)[a]	62.4 (20.7)[a]	41.6 (28.0)[b]	51.2 (20.2)[a]
Suitable as a light snack	74.5 (16.5)[a]	72.5 (17.1)[a]	63.8 (20.4)[b]	65.7 (22.6)[b]
Hunger after consumption	277 (93)[a]	264 (112)[a]	255 (98)[a]	275 (89)[a]
Caloric intake	126 (99)[ab]	91 (90)[a]	103 (78)[ab]	139 (101)[b]

Note: Means in the same row that share the same superscript are not significantly different from each other

Feelings of hunger and satiation before and after consumption

Repeated measures analysis indicated a main effect of time of measurement on hunger feelings (F (1, 92)= 43.13, p<0.001). Participants were more satiated after consuming the Mini Break cookies ($M_{hunger\ before}$ = 268, SD=97; $M_{hunger\ after}$ = 221, SD = 93). There were no significant main effects of claim (F (1, 92)= 1.48, p=.23), packaging (F (1, 92)= .14, p=.71) or an interaction effect of packaging and claim (F (1, 92)= 2.83, p=.10) on time of measurement of hunger feelings.

Caloric intake

Univariate analysis of variance did not show a main effect of claim (F (1, 91)= .055, p=0.816) or packaging (F (1, 91)= .414, p=0.552) but indicated an

interaction effect of packaging and claim on caloric intake (F (1, 91)= 4.19, p< 0.05). Figure 4.2 shows that respondents ate more of the cookies when the packaging colour and claim were congruent (light packaging with taste claim or satiation enhancing packaging with satiation claim) compared to the packages where these cues are inconsistent (light package with satiation claim or satiation enhancing package with taste claim). A satiation-enhancing package with a taste claim (M=103.18, SD=77.72) influences caloric intake in a similar way as a light package with a satiation claim (M=91.3, SD=80.7). Caloric intake was higher when participants were confronted with a light package with a taste claim (M= 126.3, SD= 99.3) and, against our expectations, for participants who were shown a satiation-enhancing package with a satiation claim (M=139.3, SD= 101.1).

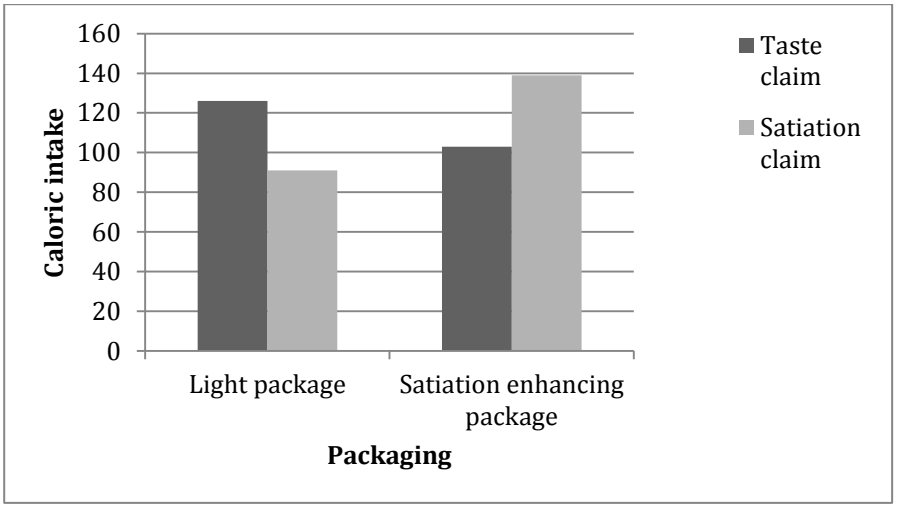

Figure 4.2: Calorie intake in kcal, for the light and dark coloured packaging either displayed with a taste or a satiety claim.

Discussion

The present study explored to what extent satiety and satiation expectations and actual caloric intake is affected by packaging design through the processes of information belief formation (presence of a satiety claim vs. a taste claim) and inferential belief formation (packaging colour). Four packages were designed, either light coloured or dark coloured and with either a taste or a satiation claim. A pilot study on these packages indicates that, in terms of

satiety expectations, a satiation claim adds little to a satiation enhancing packaging, but increases satiation expectations for the light package without a satiation claim (but with a taste claim) to the level of the satiation-enhancing package either with a taste or a satiation claim. Participants expected a lower feeling of fullness and less time till a next consumption moment when they were presented with a light package with a taste claim compared to all other packaging formats.

The main study showed that packaging colour and claim also affected caloric intake, but without affecting hunger feelings after consumption. As expected, a satiation (rather than a taste) claim on a light package reduces caloric intake, and does so to the level of a satiation enhancing packaging with a taste claim. However, contrary to expectations a satiation claim on a satiation-enhancing package increases rather than decreases caloric intake.
Our consumption study suggests a central role for packaging – claim congruency in driving caloric intake. In other words if both the claim and the packaging (light packaging with taste claim or satiation enhancing packaging with satiation claim) are congruent, caloric intake is higher than when these are incongruent (light packaging with satiation claim or satiation enhancing package with taste claim). Two explanations might account for these findings. First, as all groups consumed the same Mini Breaks it might be that from the satiation enhancing packaging with the satiation claim respondents were "over-expecting" high satiation levels which were not confirmed during consumption. As a result they might have been "waiting" for the internal satiation cues to set in and therefore were not monitoring their consumption. For a light package with a taste claim such satiation expectations were not activated and hence may not have restricted consumption, whereas in the case of a satiation claim on a light package, satiation expectations may have been triggered cognitively from the claim with lower caloric intake as a result.

Chambers et al (2013) also found unexpected expectation effects, but for low satiating foods. They used the term 'rebound appetite phenomenon' to explain their finding that consuming a low satiating food that consumers expected to be high satiating may actually stimulate appetite. As one direction of future research it might be worthwhile investigating if similar effects occur when the test product actually is a really satiation enhancing product.

However, this interpretation from satiation expectations is not fully supported from the results of the pilot study. This study showed that only for the light packaging with the taste claim satiation expectations were lower than for any of the other conditions. A more likely explanation could be found from the concept of claim-packaging congruency. It could be argued that claim-packaging congruency leads to effort-free processing of the package, activating mindless eating. When the claim and packaging are incongruent, it leads to more cognitive processing and detailed inspection, and a more focused thinking explicitly towards the concept of satiation level and hence more mindful consumption. Future research is needed to explore whether depth-of-processing might account for our findings.

An important policy implication of our study is that satiation expectations are affected by the overall (implicit) packaging design as much as specific (explicit) satiation claims, and that packaging-claim interactions determine consumer interpretation (expected satiation level) as well as caloric intake (health outcome). Within the current EU regulation on satiety and satiation claims (EFSA Panel on Dietetic Products, 2011), most hunger and satiety-related claims are rejected by the European Food Safety Organization. The results of the present study suggest that there is room in packaging design to signal satiation value, even in the absence of an explicit claim.

As a limitation, the current study only investigated the influence of packaging-induced satiation expectations on the consumption of cookies. Whether the consumption of other (snack) food products can similarly be influenced needs to be tested in future research. In terms of design, the present study instructed participants to invest at least one minute to explore the packaging before rating the packages. In real life choice and consumption contexts, consumers will likely spend less time and attention, which might affect the results.
Further, we used a snack product that most probably was unfamiliar to the majority of the participants. They could only form satiation expectations based on the visual cues and information provided. For the consumption of a more familiar product, previous experiences with the product may become more salient in the formation of satiation expectations. This "learning effect" will probably mediate the effect of packaging on consumption, suggesting future research on repeated exposure to the product.

In conclusion, the current study showed that overall package appearance matters in the formation of satiation expectations and has the potential to influence consumption. For most people, it is difficult to regulate food intake. Multiple small changes in the environment, as the communication of satiation value through packaging appearance, might be helpful tools in the management of food intake.

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Chapter 5

Strengthening satiety through the interaction of internal and external cues: influence of claim expectations on food consumption

Abstract

Both internal physiological cues as well as external cues have been shown to influence satiety and food intake. Yet, it remains unclear which combination of cues is most effective in reducing food portion sizes. In three studies it was investigated whether the interaction of an internal cue (manipulated feeling of fullness by 300 kcal breakfast vs. 600 kcal breakfast) and external cue (absence or presence of a satiety claim: "This muesli contains added fibre; therefore you will feel full for a longer period of time") can affect satiety expectations and with that can influence caloric intake during next meal. The results of studies 1 & 2 indicate that only the combination of an internal feeling of satiety and a satiety claim are effective in reducing caloric intake during next meal. A satiety claim that is not matched with an internal feeling of satiety seems to have the opposite effect in that participants increased their caloric intake during a subsequent meal. In study 3, we were not able to replicate this effect in a larger population. Further research is necessary to determine under which conditions the interaction between an internal feeling of fullness and a satiety claim is effective in decreasing food intake during next meal.

Introduction

Obesity is still a major health problem in many societies worldwide and is the consequence of repeated imbalance in energy intake versus expenditure. Changes in the food system, as the increased supply of cheap, palatable, energy-dense foods, are possible dominant drivers of the obesity epidemic of the last decades (Swinburn et al., 2011). As a result, a diet consisting of processed foods that is high in saturated fats and sugar but low in fibre has become increasingly popular since the 1980s (Cordain et al., 2005; Popkin & Gordon-Larsen, 2004). Not only a food's nutrient composition, as being high in fat or sugar, is of importance in the development of obesity also the consumption frequency and consumption amount at any particular occasion matter.

Consumers are most often not aware of how they determine consumption amount (Wansink, 2010), and do not realize that their volume decisions are under the influence of both internal and external cues. Consumption volume decisions are often made without too much thinking, so-called mindless eating (Wansink, 2010) and lack responsiveness to internal signals, as these are typically weak and can easily be overruled (Herman & Polivy, 1984).

The last decades, quite some research has been dedicated to study external and cognitive cues that influence consumption volume decisions (see Wansink, 2004 for a review). One aspect that has started to gain importance is that of the expected satiety and satiation level of a product. Several studies have shown that such expectations might play a major role in decisions regarding consumption volume (Brunstrom, Rogers, Pothos, Calitri, & Tapper, 2008; Brunstrom & Shakeshaft, 2009; Brunstrom, Shakeshaft, & Scott-Samuel, 2008; Fay et al., 2011). Food products can differ greatly in expected satiety level: 200 kcal of pasta is expected to have the same amount of satiety as 385 kcal of pizza (Brunstrom, Shakeshaft, et al., 2008). Foods that are expected to deliver less satiety correlate with higher portion size estimations (Brogden & Almiron-Roig, 2010).

External cues influencing product expectations and beliefs have been found to strongly affect satiety expectations. Already in 1972, Wooley discovered that people tend to report feelings of hunger and fullness in accordance with their beliefs on what they ate rather than the actual caloric content. Participants' food intake was reduced and feelings of fullness 20 minutes after consuming a meal

were increased when the test food was positioned as 'high calorie' (Wooley, 1972). Similarly, Crum and colleagues (2011) showed that the level of the peptide ghrelin had a steeper decline when a milkshake was labelled as "indulgent" than when the same milkshake was labelled as "sensible", indicating that participants' internal feelings of satiety were in line with what they believed they were consuming. Studies on the effects of beliefs and expectations on feelings of satiety are not always consistent. Yeomans and colleagues (2001) found that realistic food labels (low fat labels at soup) did not alter appetite ratings 30 minutes after consumption of the test meal. The authors suggest that the ability of labelling to change the subsequent appetite are short-lived. It might be that the labels did not produce the desired satiety expectancies.

In a recent study, Brunstrom et al. (2011) might have found one of the mechanisms behind these inconsistent labelling results and state that it is key for a satiety manipulation to be believed. In their study, two groups of participants were given a similar fruit smoothie and were shown the smoothies ingredients. Half of them, however, were shown a large portion of fruit and the other half a small portion. The following day, participants returned to the lab and where asked to indicate whether they believed that the amount of food shown to them was actually used in the smoothie. Interestingly, participants who were shown the large portion size of fruit reported higher levels of fullness than those who saw the smaller portion size of fruit. Only when participants believed the portion manipulation, their hunger feelings were in accordance with the amount of food shown to them. Non-believers were not influenced by the portion size shown to them (small vs. large), their hunger feelings did not differ across manipulations. Overall, this suggests that people can be 'tricked' (within boundaries) into feeling full or hungry depending on what they think they eat.

Although many cues influencing the amount of food consumed have been identified, we do not yet fully understand which combinations of cues are most successful in decreasing portion sizes. Previous research primarily focused on identical foods and showed that manipulating beliefs and expectations about a food, by the use of product claims can influence the satiety that it conveys and the amount of food consumed (Brunstrom, et al., 2011; Crum, et al., 2011; Wooley, 1972). However, it is likely that satiety claims are more persuasive and influential if they are credible, because they can be verified by people themselves and judged to be consistent with experience. This is in line with the

expectations-confirmation theory (Anderson, 1973; Oliver, 1980) which predicts that expectations, together with perceived performance determines ultimate satisfaction. If perceived performance is equal to the expected, satisfaction is the result. Performance that is slightly better or worse than expected triggers an assimilation effect, resulting in a shift from perceived performance towards expectations. But when the contrast is larger and performance is not able to live up to expectations, the consumer will be dissatisfied. This theory turned out to be also applicable in expectancy research with outcome variables other than satisfaction. For example, caffeine expectancy research (Elliman, Ash, & Green, 2010) shows that caffeine only enhanced performance when participants received accurate information regarding the caffeine content of the coffee. When they were given caffeinated coffee with inaccurate information or decaffeinated coffee irrelevant of the information provided, performance decreased.

In this paper, we build on these insights in the context of satiety. Specifically, we combine a physiological cue, a 300 kcal breakfast versus a similar breakfast but now with 300 calories covertly added to stimulate post-ingestive satiety cues, with a cognitive cue, absence or presence of a satiety claim ('This muesli contains added fibre; therefore you will feel full for a longer period of time'). In doing so, we aim at decreasing caloric intake during next meal by the manipulation of satiety feelings. The expectations-confirmation theory implies that when the satiety claim is supported by internal signals, expectations and performance match, the claim is seen as more persuasive; participants will feel less hungry and will adjust their food choices on a later occasion. Participants will either select/consume fewer calories and/or will consume different food products of which they think will better fit the situation. In addition, we hypothesize that an internal feeling of satiety that is not paired with a satiety claim is more effective than a satiety claim without the internal feeling of satiety. Because in the latter situation, the product falls short of expectations, the consumer will be dissatisfied and will probably consume more calories.

We will first test our hypotheses in a small-scale explorative study (Figure 5.1), with the caloric content of the breakfast as a between subjects factor and absence/ presence of satiety claim as a within subject factor and with hunger feelings and serving size during lunch as dependent variables. In studies 2 and 3 (Figure 5.2 & 5.3) we use a 2 (caloric content breakfast: 300kcal vs. 600kcal) by 2 (taste vs. satiety claim) between subjects design (study 2) and a 2 (caloric content breakfast: 300kcal vs. 600kcal) by 3 (no claim vs. taste claim vs. satiety

claim) between subjects design. With these studies we aim to confirm the findings of study 1 in a larger sample. Hunger feelings, feelings of hunger/ satiety mentioned by the participant in response to a general open ended question 1.5h after breakfast, caloric intake during lunch, food choices and persuasiveness of the claim are used as the dependent measures.

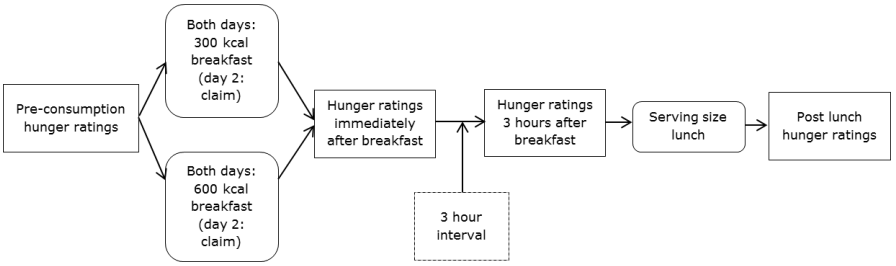


Figure 5.1: Design study 1 for both days, with claim (absent versus present) as a within subject variable and caloric content of the breakfast as a between subjects variable with feelings of hunger and serving size during lunch as dependent measures on both days.

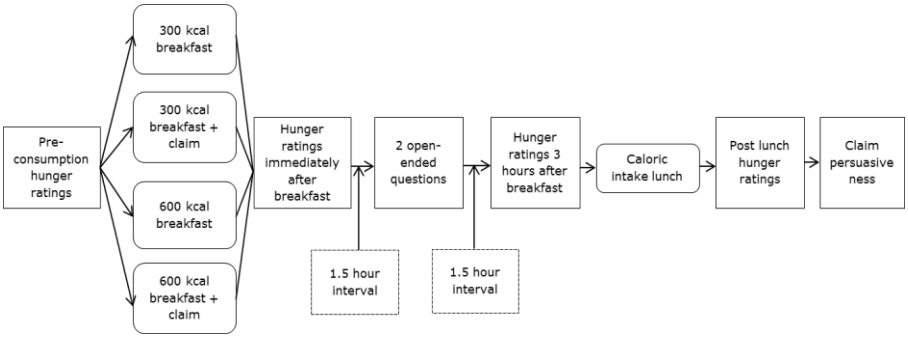


Figure 5.2: Design study 2, with claim and caloric content as between subjects variables with feelings of hunger, feelings of hunger between lunch and breakfast, caloric intake during lunch and persuasiveness of the claim as the dependent measures.

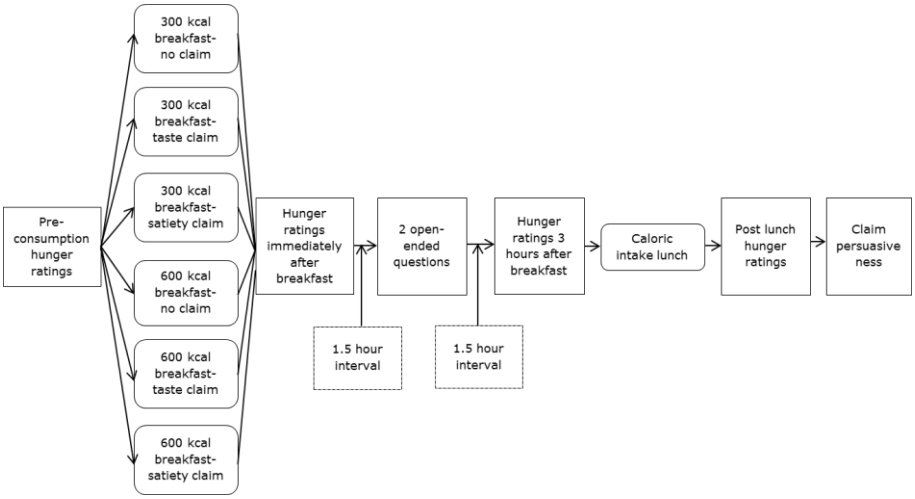


Figure 5.3: Design study 3, with claim and caloric content as between subjects variables with feelings of hunger, feelings of hunger between lunch and breakfast, caloric intake during lunch and persuasiveness of the claim as the dependent measures.

Study 1

Material and methods

Participants

Thirty-four Dutch-speaking students and staff of the university of applied sciences in Den Haag (22 women) ranging in age from 17 to 56 years (M=22.64, SD= 7.02) were recruited on college campus. Participants did not receive any fee for their participation in the experiment. BMI ranged from 16.14 to 29.98 (M=21.64, SD= 3.22) and participants with food allergies were excluded from the study.

Institutional review board and funding source

The institutional review board approved all studies in this paper. The funding source did not have any involvement in study design, data collection, analysis

and interpretation of the data, in the writing of the report and in the decision to submit the article for publication.

Design

This study used claim (present vs. absent) as a within subject factor and caloric content of breakfast (300 kcal breakfast vs. 600 kcal breakfast) as a between subjects factor. Due to the possible learning/ memory effect of the claim we were not able to use a full within subject design. Therefore we chose to use this partly within subject design to still be able to control for the large variance between participants in amount eaten, a well-known phenomenon in consumption studies (Blundell et al., 2010).

Participants were scheduled for both breakfast and lunch at two subsequent days. They were randomly assigned to either a low caloric breakfast at both days or a high caloric breakfast. At the second day, the package of the yoghurt with muesli displayed the claim: 'This muesli contains added fibre; therefore you will feel full for a longer period of time'. They were asked not to eat anything on the morning of the study. Breakfast was served at 10.15 am. Participants were instructed to consume the entire breakfast consisting of yoghurt with muesli and orange juice (200ml). In the high caloric version of the breakfast, the yoghurt was enriched with 78 gram (300 kcal) of a dextrin-maltose supplement (Fantomalt, Nutricia, Zoetermeer, The Netherlands). The 300kcal difference Fantomalt manipulation was previously successfully used in a study by De Graaf & Hulshof (1996). The supplement contained 95 g digestible carbohydrates per 100 g and a pre-test indicated no differences in taste and consistency of the yoghurt. During breakfast, participants filled out a questionnaire on the likability and taste of the products and were asked to refrain from eating in the period between breakfast and lunch but were allowed to drink water, coffee and tea in between. Participants were offered an ad libitum lunch at 12.15 pm. Each participant was asked to self-select food products from a buffet. They could choose from different kinds of bread (white, whole wheat, raisin bun, croissant), soups (vegetable, tomato), topping/filling (ham, cheese, chicken, boiled egg, jam, chocolate sprinkles, fruit sprinkles, butter, sugar), fruits (banana, apple, tangerine) and several drinks (orange juice, milk, yogurt drink, buttermilk, coffee, thee, water). Participants were encouraged to consume as much food as they liked and were allowed to

go back to the buffet for a refill. As a filler task, participants filled out some questionnaires on food preferences and eating order.

Measures

Main dependent variables were self-reported feelings of hunger and serving behaviour during lunch.

Feelings of hunger

Feelings of hunger and satiety were measured on series of 100mm visual analogue scales by answering the questions: 'How hungry are you?', 'How full are you?', 'How satiated are you?', all anchored by the terms 'not at all' to 'extremely' and the questions: 'How strong is your desire to eat?' anchored by: 'extremely low' to 'extremely high' and 'How much do you think you could eat right now?' , anchored by: 'nothing at all' to 'a very large amount' (Blundell, et al., 2010). On both days, the participants completed these questions four times: before breakfast, after breakfast, before lunch and after lunch. Reliability analysis confirmed ($\alpha > 0.72$) that the five items could be meaningfully combined into a single measure. For that purpose, scores were added up (after appropriate rescaling of items) into a single index ranging from 0-500.

Serving size

Participants were asked to select products from a buffet-style lunch, one by one. Choices made were registered. Food leftovers were not measured after consumption; therefore we are not able to say anything on the amount of calories consumed and use serving size as an dependent variable. Information on energy content provided by food manufacturers was used to determine serving size in calories (Kcal).

Background variables

Age, gender and self-reported height and weight, which were used to calculate Body Mass Index (BMI), were provided by participants at the end of the questionnaire.

Data analysis

GLM repeated measures was used to assess main and interaction effects of claim and caloric content of the breakfast with claim as a within subject factor, caloric content of the breakfast as a between subjects factor and hunger feelings and serving size during lunch as dependent variables.

Results

Randomization checks

There were no significant differences in hunger feelings before breakfast (p=0.37), liking of lunch and breakfast (p = 0.74), BMI (p = 0.99), age (p = 0.34), dietary restraint (p = 0.28) or gender (p=0.14) between the groups having a 300 or a 600 calories breakfast (table 5.1).

Table 5.1: Mean (SD) age, gender, BMI, restrained score and liking breakfast for the low caloric and high caloric breakfast groups.

	Low caloric breakfast (N=18)	High caloric breakfast (N=16)
Age	23.7 (8.9)	21.3 (3.5)
Gender	F=14 M=4	F=8 M=7
BMI	21.6 (2.9)	21.6 (3.7)
Dietary restraint score	24 (7.9)	21 (7.7)
Liking breakfast	4.6 (1.5)	4.5 (1.3)

Effects on hunger feelings and serving size lunch

It was hypothesized that a claim attached to a high-caloric breakfast food would decrease levels of hunger over time (immediately after consumption, just before lunch and directly after lunch). In addition, it was expected that only the interaction effect of claim and caloric content of the breakfast would be significant. So we hypothesized no significant main effects of claim and caloric content of the breakfast, which we assessed with a mixed model ANOVA. Indeed, we did not find any main effects of claim and caloric content of the

breakfast, for hunger feelings measured after breakfast, before and after lunch (all Ps>0.12). But we also didn't find an interaction effect of claim and caloric content of the breakfast on hunger feelings after breakfast ($F(1,32)=2.59$, *ns*), before lunch ($F(1,31)=1.51$, *ns*) and after lunch ($F(1,32)=0.55$, *ns*). See table 5.1 for mean hunger feelings.

Table 5.2: Mean (SD) hunger feelings before/ after breakfast, before/ after lunch and chosen serving size during lunch.

	Low caloric breakfast (N=18)		High caloric breakfast (N=16)	
	No claim	Claim	No claim	Claim
Hunger feelings before breakfast	308 (92)	319 (102)	306 (67)	326 (61)
Hunger feelings after breakfast	187 (53)	194 (80)	199 (46)	171 (69)
Hunger feelings before lunch	348 (50)	377 (57)	342 (63)	336 (62)
Hunger feelings after lunch	135 (48)	148 (51)	119 (43)	115 (74)
Serving size lunch in kcal	710 (64)	726 (52)	697 (68)	580 (37)

With regard to the serving size of the lunch we hypothesized that participants who had a high caloric breakfast with a satiety claim would serve themselves the lowest amount of calories during lunch and participants with a low caloric breakfast with a satiety claim the highest amount of calories, because of dissatisfaction with the claim. Therefore we expected a significant interaction effect of claim and caloric content of the breakfast but no significant main effects. GLM repeated measures did indeed not indicate a significant main effect of claim ($F(1,32)=1.92$, *ns*) nor caloric content of the breakfast ($F(1,32)=1.04$, *ns*) but did show a marginal significant interaction effect of claim and caloric content of the breakfast ($F(1,32)=3.37$, $p=0.076$) . Figure 5.4 and table 5.2 show that serving size during lunch is highest when participants had a low caloric breakfast combined with a claim and that the least amount of

calories were consumed when participants had a high caloric breakfast with a satiety claim.

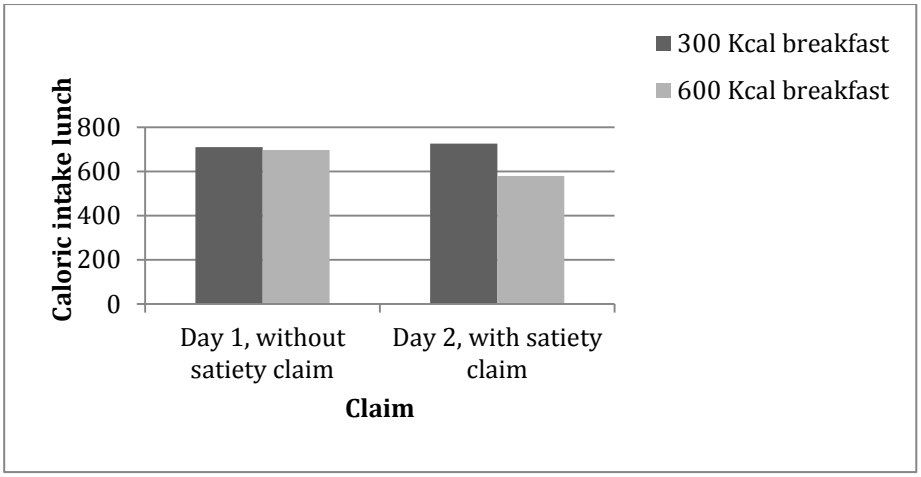


Figure 5.4: Serving size in Kcal during lunch for the low and high caloric breakfast groups, breakfast presented either with or without satiety claim.

Discussion

Study 1 showed that hunger feelings did not significantly differ between different claim-breakfast combinations, but that a satiety claim can have an effect on serving size as long as the claim is congruent with internal feelings. No placebo effect was observed: when a claim promised a prolonged feeling of fullness, but internal signals were not in line, no effect on serving size was observed. However, because the present study used a partly within subjects design, we cannot rule out the rival explanation that the effect is due to learning from the post-ingestive consequences of the lunch at day 1 rather than the claim-caloric breakfast content interaction. Therefore, study 2 will seek for replication of the effect in a between subjects study design, where the effects of time and claim-caloric content compatibility can be disentangled.

Another limitation of the present study is that it only focussed on serving size (i.e. how much respondents selected from the buffet), but not on how much participants actually ingested. Although serving size is an indication for the calories consumed during lunch (Rolls, Roe, & Meengs, 2006a, 2006b, 2007), it

would be more helpful to know the actual calorie intake. Therefore, serving size is replaced by actual caloric intake during lunch in study 2. In addition we measure hunger feelings, feelings of hunger/ satiety mentioned by the participant in response to a general open-ended question 1.5h after breakfast, food choices and persuasiveness of the claim.

Study 2

Material and methods

Participants

Dutch-speaking undergraduate and graduate students (N=103) of a Dutch University (96 women) ranging in age from 17 to 29 years (*M*=21, *SD*= 2.4) were recruited on college campus. Participants could choose from different snack- and skincare products as a reward for their participation in the experiment. BMI ranged from 15.7 to 27.5 (*M*=21.6*, SD*=2.3*)* and participants with food allergies were excluded from the study.

Design and procedure

This study used a 2 (caloric content breakfast: 300kcal vs. 600kcal) by 2 (satiety claim vs. taste claim) between subjects design. Participants were randomly assigned to one of the four conditions and were asked not to eat anything on the morning of the study. Breakfast was served between 8.00 am and 10.00 am. Participants were instructed to consume the entire breakfast consisting of yogurt with muesli and a glass of orange juice (200 ml). In the high caloric version of the breakfast, the yogurt was enriched with 78 gram (300 kcal) of a dextrin-maltose supplement (Fantomalt, Nutricia, Zoetermeer, The Netherlands). During breakfast, participants filled out a questionnaire on the likability and taste of the products and were asked to evaluate a manipulated picture of the muesli package they had for breakfast. The label of this muesli package either displayed the claim: 'Added fibre, therefore you will feel full for a longer period of time', seen by participants in the satiety claim condition or emphasized the tastefulness of the muesli: 'even tastier', seen by participants in

the taste claim condition. Participants were asked to refrain from eating in the period between breakfast and lunch but were allowed to drink water, coffee and tea in between. When leaving the lab, participants were given an envelope and asked to open it 1.5h later. Inside the envelope was a questionnaire that asked participants to answer two general open-ended questions (i.e. 'How do you feel right now' and 'What were you thinking of just before you answered these questions') to indirectly assess hunger and satiety feelings.

Next, participants were offered an ad libitum lunch three hours after breakfast. Each participant was asked to self-select food products from a buffet. They could choose from different kinds of bread (white, whole wheat, raisin bun, cream crackers, whole wheat crackers, Dutch spiced cake), topping/filling (ham, cheese, chicken, jam, chocolate sprinkles, fruit sprinkles, and butter), fruits (banana, apple, tangerine) and some drinks (orange juice, milk, yogurt drink, buttermilk, water). Participants were encouraged to consume as much food as they liked and were allowed to go back to the buffet for a refill. As a filler task, participants filled out some questionnaires on food preferences and eating order.

Measures

Main dependent variables were hunger feelings, feelings of hunger/ satiety mentioned by the participant in response to a general open ended question 1.5h after breakfast, caloric intake during lunch, food choices and persuasiveness of the claim. See study 1 for a description of the feelings of hunger measurement.

Hunger feelings between breakfast and lunch

To get an understanding of midmorning hunger and satiety feeling, participants were asked to answer the following two short questions exactly 1.5 hours after breakfast. To prevent demand effects, these questions were formulated in a very general way: 'How do you feel? - can you please describe this is a few sentences?' and 'What were you thinking of just before you answered these questions- can you please describe this in a few sentences?' In case a participant used a hunger/ fullness related word, this was scored. It was also registered if the participant used the words 'full' ore 'not yet hungry' in their answer.

Food choices/Caloric intake

Participants were asked to select products from a buffet-style lunch, one by one. Choices made were registered. After lunch all leftover lunch products were weighed out of sight of the participants. Information on energy content provided by food manufacturers was used to determine calorie intake. The consumed amount was calculated by subtracting the quantity left from the initial quantity of foods and drinks selected from the buffet. Calorie intake was estimated by multiplying the amount consumed with the energy density information of the product.

Persuasiveness of the claim

Persuasiveness of the satiety claim: 'Added fibre, therefore you will feel full for a longer period of time' was measured by eight items after lunch. For all the experimental conditions the satiety claim was stated on top of the page. Only the participants in the satiety claim present condition had seen the claim before on the muesli packaging. Participants were asked to determine if they found the claim convincing, effective, useful, interesting, informative, believable, if they would buy a product with this claim and if they would prefer a product with this claim over a product without the claim. All items were rated on a 7 point scale ranging from 1 (not at all) to 7 (very). Reliability analysis suggested that the items could meaningfully be combined into an overall persuasiveness scale (Crombach's $\alpha = 0.82$).

Dietary restraint

The restrained eating scale a subscale of the Dutch Eating Behaviour Questionnaire (Van Strien, Frijters, Bergers, & Defares, 1986)was used to assess dietary restraint. Dietary restraint was added as a covariate to the analyses because of its well-known effect on food consumption (Blundell, et al., 2010) and could therefore influence our findings.

Data analysis

Univariate analysis of variance was used to assess main and interaction effects of satiety claim and caloric content of breakfast with claim persuasiveness, feelings of hunger, caloric intake lunch and food choices as dependent variables. Dietary restraint was added as a covariate. Hunger feelings between breakfast and lunch: Chi-square analysis was used to detect differences in word choice of participants to describe their feelings 1.5h after breakfast between the

four experimental conditions. The influence of perceived persuasiveness of the satiety claim for participants who were confronted with this claim during breakfast was analysed by a regression analysis with caloric intake during lunch as a dependent variable and caloric content of the breakfast and perceived persuasiveness of the satiety claim as independent variables.

Results

Randomization checks

There were no significant differences in hunger feelings before breakfast (p=0.41), liking of breakfast and lunch (p= 0.80), restrained eating score (p=0.30), BMI (p=.34) and gender (p=0.26) between the groups.

Feelings of hunger

There were no significant main or interaction effects of the caloric content of the breakfast and presence or absence of claim for the hunger feelings after breakfast and after lunch (all Ps>0.11). For hunger feelings just before lunch we only expected an interaction effect of claim and caloric content of the breakfast. This expectation was partly confirmed as, next to a significant interaction effect between claim and caloric content (F(1,96)=4.07, p<0.05), we also found a main effect for the caloric content of the breakfast (F(1,96)=7.58, p<0.01). Participants felt hungrier after a low caloric breakfast, hunger feelings decreased with the combination of a high caloric breakfast and a satiety claim. Table 5.3 depicts the mean (SD) hunger feelings before and after breakfast and before and after lunch.

Hunger feelings between breakfast and lunch

Participants were asked to fill out the open-ended questions on current feelings and wellbeing 1.5h after breakfast. Of the 103 participants in this study, 51 referred to either hunger or fullness in their answers. There were no significant differences in the number of participants per condition that indicated hunger/fullness related thoughts (X^2(3)= 1.77, *ns*). However, the wording used in their answers differed significantly per experimental condition (Table 5.4). Participants in the low caloric breakfast group without a satiety claim used more often 'not yet hungry' to describe their feelings while participants in the

high caloric breakfast group with satiety claim more often used the word "full" ($X^2(6)= 16.72$, $p<0.01$).

Food choices lunch

Lunch items were grouped into the following four categories: breads, toppings, drinks and fruits (see design and procedure for specific items). Univariate analysis of variance only indicated a main effect of caloric content of the breakfast on bread intake ($F(1,99)= 4.60$, $p<0.05$). Participants who consumed a low caloric breakfast ate more of the bread products in calories (M=288; SD=13) compared to participants in the high caloric breakfast group (M=247; SD=13). No main effect of claim or an interaction effect of claim ($F(1,99)= .003$, *ns*) and caloric content of breakfast ($F(1,99)= .62$, *ns*) on bread intake were discovered. In addition we did not find any main effects of caloric content of the breakfast and claim or an interaction effect of caloric content and claim on caloric intake from toppings (*caloric content:* ($F(1,99)= .38$, *ns*); *claim:* ($F(1,99)= 1.28$, *ns*); *caloric content * claim:* ($F(1,99)= 3.26$, *ns*), drinks (*caloric content:* ($F(1,99)= .52$, *ns*); *claim:* ($F(1,99)= .10$, *ns*); *caloric content * claim:* ($F(1,99)= 2.65$, *ns*) and fruits (*caloric content:* ($F(1,99)= .07$, *ns*); *claim:* ($F(1,99)= .15$, *ns*); *caloric content * claim:* ($F(1,99)= .001$, *ns*).

Table 5.3: Mean (SD) age, gender, BMI, restrained score, liking breakfast, liking lunch, claim persuasiveness, hunger feelings and caloric intake lunch for the low caloric and high caloric breakfast groups with taste or satiety claim.

	Low kcal-taste claim	Low kcal-satiety claim	High kcal-taste claim	High kcal satiety claim
Age	20.8 (1.9)	21.1 (2.4)	21.1 (2.7)	20.9 (2.6)
Gender	F=23 M= 3	F= 25 M= 1	F= 23 M= 3	F= 25 M=0
BMI	22.1 (2.3)	21.4 (1.7)	21.8 (2.4)	20.9 (2.7)
Dietary restraint score	23.3 (7.2)	26.8 (7.5)	24.1 (5.8)	24.1 (7.3)
Liking breakfast	5.0 (1.1)	4.8 (1.4)	5.5 (1.1)	5.8 (9.1)
Liking lunch	5.7 (0.7)	5.6 (0.6)	5.5 (0.9)	5.5 (1.0)
Claim persuasiveness	33.7 (7.1)	35.6 (8.1)	38.6 (6.4)	38.5 (7.1)
Hunger before breakfast	346 (52)	323 (77)	350 (63)	346 (53)
Hunger after breakfast	81 (47)	105 (77)	118 (88)	96 (63)
Hunger before lunch	317 (58)	344 (65)	305 (82)	278 (85)
Hunger after lunch	107 (56)	118 (58)	110 (59)	133 (59)
Kcal intake	528 (152)	575 (131)	527 (186)	455 (148)

Table 5.4: Displays the number of participants per experimental condition that did not refer to hunger/ fullness, the number of participants that referred to hunger and the number of participants that referred to fullness.

	Low caloric breakfast taste claim (n= 26)	Low caloric breakfast with satiety claim (n=26)	High caloric breakfast taste claim (n=26)	High caloric breakfast with satiety claim (n=25)
Did not refer to hunger/ fullness	10	14	13	10
Referred to 'not yet hungry'	12	5	6	2
Referred to fullness	3	6	5	12
Missing	1	1	2	1

Caloric intake lunch

Univariate analysis of variance indicated a main effect of the calorie content of the breakfast ($F(1,96)= 4.41$, $p=0.04$) and an interaction effect of claim and caloric content of breakfast ($F(1,96)=4.34$, $p=0.04$). Figure 5.5 shows that caloric intake was 47 kcal higher when a satiety claim was attached to a low caloric breakfast ($M=575$, $SD=132$) and 73 kcal lower when a satiety claim was attached to a high caloric breakfast ($M=455$, $SD=148$) compared to the taste claim conditions (300 kcal breakfast: $M=528$, $SD=151$; 600 kcal breakfast: $M= 528$, $SD= 186$). Posthoc analysis indicated that intake only differed significantly for a low caloric breakfast and a high caloric breakfast with a satiety claim on the packaging ($F(3,99)= 2.55$, $p=0.005$)

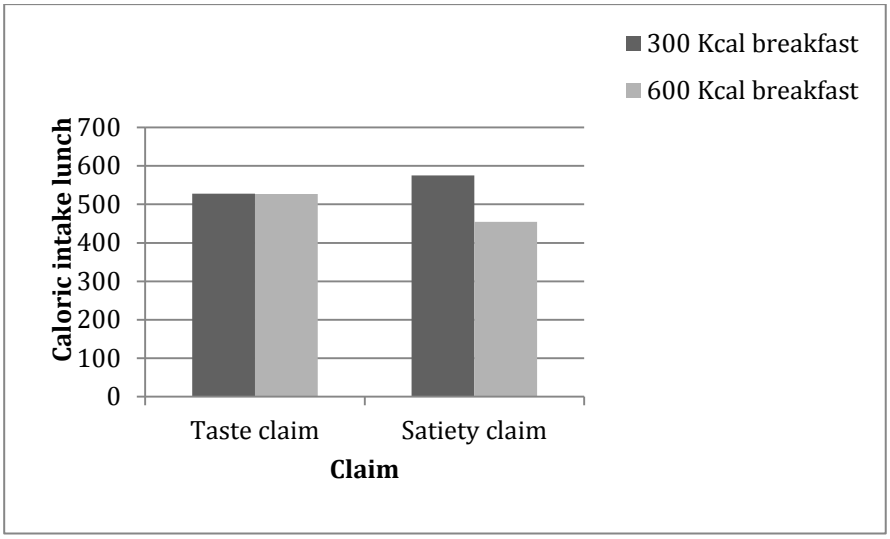


Figure 5.5: Calorie intake in Kcal during lunch for the low and high caloric breakfast groups, breakfast presented either with a taste or a satiety claim.

Persuasiveness of the satiety claim

Based on previous research (Brunstrom, et al., 2011) it was expected that the perceived persuasiveness of a satiety claim could have an effect on caloric intake during lunch. A regression analysis, only with participants who were actually confronted with a satiety claim at breakfast, with caloric intake during lunch as a dependent variable and caloric content of the breakfast, perceived persuasiveness of the satiety claim and the interaction between caloric content and persuasiveness as independent variables, did not reveal an effect of caloric content (β = -.190, *ns*), persuasiveness (β = -.038, *ns*) or of the interaction between caloric content and persuasiveness (β = -.125, *ns*) on caloric intake during lunch. In addition, regression analysis indicated that only the caloric content of the breakfast (β = -.212, p <0.05) is a significant predictor for feelings of hunger and satiety before lunch. Perceived persuasiveness (β = -.171, *ns*) and the interaction of persuasiveness and caloric content (β = -.029, *ns*) did not have an effect.

Additional analysis of participants who referred to hunger or fullness as a factor

Post hoc, we performed additional analysis on participants that referred to hunger/fullness in the open-ended questions between breakfast and lunch.

Analysis of variance revealed a significant three way interaction effect of claim, caloric content breakfast and referred to hunger or fullness ($F(1,95)= 3.95$, $p=0.05$) on caloric intake during lunch. Figure 5.6 shows that participants who referred to hunger or fullness seem to be the main drivers of the overall effect and reacted stronger to the claim manipulation compared to participants who did not refer to hunger or fullness. These two groups of participants did not differ significantly on age ($p= 0.30$), gender ($p= 0.88$), BMI ($p= 0.87$), restraint eating score ($p= 0.86$) or perceived claim persuasiveness ($p= 0.41$).

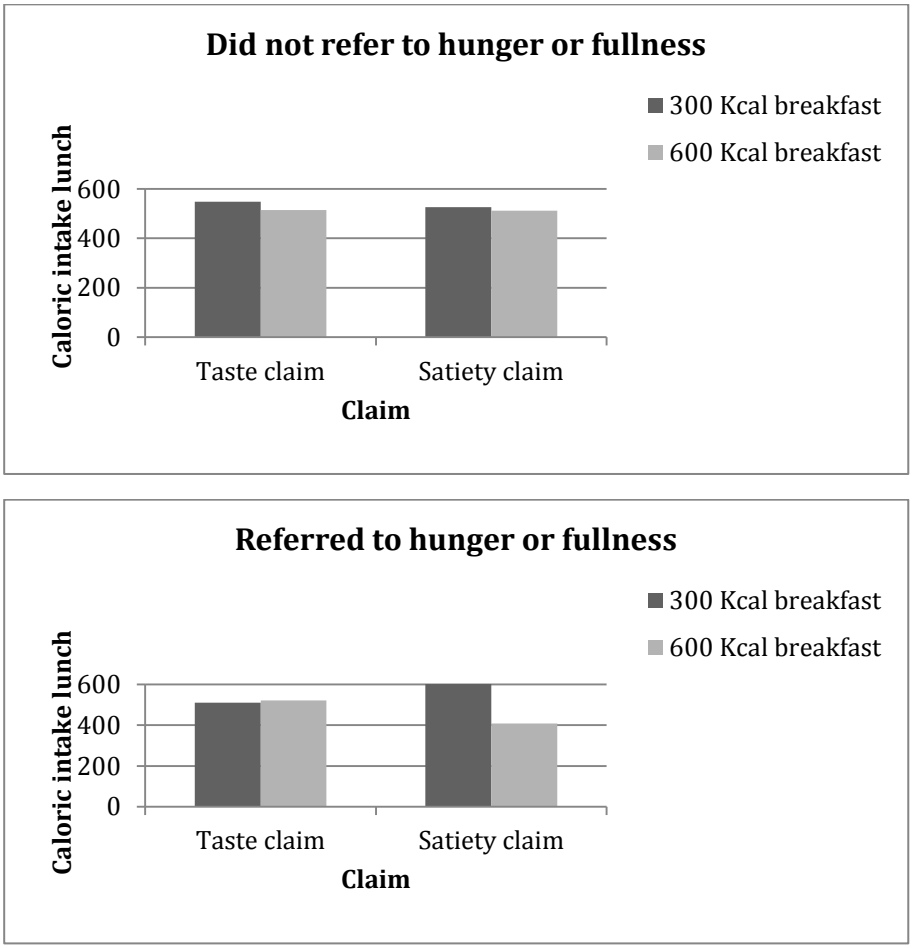


Figure 5.6: Caloric intake during lunch differently presented for participants who did not refer to hunger or fullness and participants who referred to hunger or fullness.

Discussion

Study 2, adopting a between-subjects design, confirmed the key result from study 1, namely that the compatibility between the satiety claim and the perceived effect from internal physiological cues is crucial in reducing caloric intake. Participants in the taste claim condition consumed on average 528 calories, irrespectively of breakfast type. Caloric intake was 47 kcal higher when a satiety claim was depicted on a low caloric breakfast. Caloric intake during next meal was 73 kcal lower when participants had a high caloric breakfast with a satiety claim. Additional analysis indicated that participants who referred to hunger or fullness between breakfast and lunch had a stronger reaction to the claim manipulation.

Hunger feelings just before lunch were in line with caloric intake during lunch. Participants felt hungrier after a low caloric breakfast, while hunger feelings decreased with the combination of a high caloric breakfast and a satiety claim. Food choices did not change among conditions, participants in the high caloric breakfast- satiety claim condition ate overall a bit less and did not show a diverging eating pattern from participants in other experimental conditions. One and a half hour before lunch, participants in the low caloric breakfast group with a satiety claim more often referred to being "not yet hungry" when asked for their feelings while participants in the high caloric breakfast group with satiety claim more often used the word "full". For participant who were confronted with a satiety claim at breakfast, perceived persuasiveness of the satiety claim did not have an effect on caloric intake during lunch.

A limitation of present study is that it did not have a control "no-claim" condition but only compared caloric intake after confrontation with a taste or satiety claim. Therefore, we decided to add a no claim condition to the design of study 3 and seek for replication of the combined effect of a physical feeling of fullness and a satiety claim on caloric intake during next meal in a larger population.

Study 3

Material and methods

Participants

Dutch-speaking undergraduate and graduate students (N=334) of a Dutch university were recruited on college campus. Five participants were excluded because they did not finish their breakfast. Three participants were excluded because their caloric intake exceeded 3 standard deviations from the mean in that particular experimental condition. Because of their unpredictable food intake, the participants with a restrained eating score in the top 20% were also excluded from this study. The remaining 264 participants (201women) ranged in age from 17 to 30 years (*M*=20.9, *SD*= 2.4). Participants received €10,- for participating in this study. BMI ranged from 16.4 to 31.2 (*M*=21.3*, SD*=2.3*)* and participants with food allergies were excluded from the study.

Design and procedure

This study used a 2 (caloric content breakfast: 300kcal vs. 600kcal) by 3 (no claim vs. satiety claim vs. taste claim) between subjects design. Participants were randomly assigned to one of the six conditions and were asked not to eat anything on the morning of the study. Breakfast was served between 8.00 am and 10.00 am. Participants were instructed to consume the entire breakfast consisting of yogurt with muesli and a glass of orange juice (200 ml). In the high caloric version of the breakfast, the yogurt was enriched with 78 gram (300 kcal) of a dextrin-maltose supplement (Fantomalt, Nutricia, Zoetermeer, The Netherlands). During breakfast, participants filled out a questionnaire on the likability and taste of the products and were asked to evaluate a manipulated picture of the muesli package they had for breakfast. The label of this muesli package either displayed the claim: 'Added fibre, therefore you will feel full for a longer period of time', seen by participants in the satiety claim condition or emphasized the tastefulness of the muesli: 'New recipe, now even tastier', seen by participants in the taste claim condition or did not display any information in the no claim condition. Participants were asked to refrain from eating in the period between breakfast and lunch but were allowed to drink water, coffee and

tea in between. When leaving the lab, participants were given an envelope and asked to open it 1.5h later. Inside the envelope was a questionnaire that asked participants to answer two general open-ended questions (i.e. 'How do you feel right now' and 'What were you thinking of just before you answered these questions') to indirectly assess hunger and satiety feelings.

Next, participants were offered an ad libitum lunch three hours after breakfast. Each participant was asked to self-select food products from a buffet. They could choose from different kinds of bread (white, whole wheat, raisin bun, cream crackers, whole wheat crackers, Dutch spiced cake), topping/filling (ham, cheese, chicken, jam, chocolate sprinkles, fruit sprinkles, and butter), fruits (banana and apple) and some drinks (milk, yogurt drink, buttermilk, water). Participants were encouraged to consume as much food as they liked and were allowed to go back to the buffet for a refill. As a filler task, participants filled out some questionnaires on food preferences and eating order.

Measures

The measures and data analysis of study 3 are similar to those of study 2. Please see study 2 for measures and data analysis.

Results

Manipulation checks

There were no significant differences in age (p=0.45), gender (p=0.94), BMI (p=0.30), current dieting (p=0.75), dietary restrained score (p=0.74), liking breakfast (p=0.27), liking lunch (p=0.78), claim persuasiveness (p=0.74) hunger feelings before breakfast (p=0.90), hunger feelings after breakfast (p=0.24) and hunger feelings after lunch (p=0.48) between the experimental conditions (table 5.5)

Table 5.5. Mean (SD) score for demographic variables, current dieting, dietary restrained score, liking of breakfast and lunch, hunger feelings, caloric intake and claim persuasiveness per experimental condition.

	Low kcal- no claim (N=45)	Low kcal- taste claim (N=43)	Low kcal- satiety claim (N=49)	High kcal- no claim (N=42)	High kcal- taste claim (N=43)	High kcal satiety claim (N=40)
Age	20.7 (2.9)	20.3 (2.0)	21.3 (2.6)	21.0 (2.3)	20.9 (2.2)	21.0 (2.1)
Gender	F=33 M=12	F=36 M=8	F=37 M=11	F=33 M=10	F= 33 M= 10	F= 29 M=11
BMI	21.0 (2.2)	21.0 (2.3)	21.0 (2.2)	21.2 (2.8)	22.0 (2.5)	21.5 (2.0)
Current dieting	1.7 (1.2)	2.1 (1.6)	2.0 (1.3)	2.1 (1.4)	2.1 (1.5)	2.1 (1.4)
Restrained score	20.0(6.6)	21.7(6.5)	21.1(6.4)	20.2(6.7)	20.1(1.5)	21.2(6.0)
Liking breakfast	5.0 (1.3)	5.3 (1.0)	5.4 (1.1)	5.4 (1.1)	5.6 (1.1)	5.1 (1.2)
Liking lunch	5.3 (0.9)	5.5 (0.9)	5.4 (0.9)	5.3 (0.9)	5.3 (1.0)	5.2 (1.0)
Claim persuasiveness	32.3(8.5)	33.0(6.7)	34.6(8.3)	34.8(12.9)	33.1(8.7)	33.9(5.7)
Hunger before breakfast	332 (69)	346 (67)	344 (72)	333 (67)	339 (76)	341 (57)
Hunger after breakfast	128 (72)	94 (56)	124 (85)	107 (72)	121 (84)	109 (66)
Hunger before lunch	355 (73)	344 (74)	332 (90)	310 (81	283 (83)	295 (81)
Hunger after lunch	116 (55)	113 (68)	130 (63)	108 (54)	117 (66)	129 (73)
Kcal intake	502 (25)	540 (25)	538 (24)	523 (25)	516 (25)	505 (86)

Feelings of hunger

We did not find any significant main or interaction effects of the caloric content of the breakfast and presence or absence of claim for participant's hunger feelings after breakfast and after lunch (all Ps>0.24). For hunger feelings just before lunch we expected an interaction effect of claim and caloric content of the breakfast. This was not confirmed by the data. We only observed a main effect for the caloric content of the breakfast ($F(1,96)=7.585$, $p<0.01$). Participants felt hungrier after a low caloric breakfast, independent of which claim was shown to them. Table 5 depicts the mean (SD) hunger feelings before and after breakfast and before and after lunch.

Hunger feelings between breakfast and lunch

Participants were asked to fill out the open-ended questions on their current feelings and wellbeing 1.5h after breakfast. Of the 264 participants in this study, 133 referred to either hunger or fullness in their answers. There were no significant differences in the number of participants per condition that indicated hunger/fullness related thoughts ($X^2(10)= 10.72$, *ns*). However, the wording used in their answers differed significantly per experimental condition (Table 5.6). The participants in the high caloric breakfast group with a satiety claim referred more often to feeling "full" compared to participants in all other experimental conditions who more often used the word "hungry" in their answers ($X^2(10)= 21.11$, $p<0.05$).

Table 5.6: Displays the number of participants per experimental condition that did not refer to hunger/ fullness, the number of participants that referred to hunger and the number of participants that referred to fullness.

	Referred to hunger/ fullness		If yes, referred to...	
	Yes	No	Hunger	fullness
Low kcal- no claim (N=45)	19	26	14	5
Low kcal- taste claim (N=44)	19	25	15	4
Low kcal- satiety claim (N=49)	26	23	16	10
High kcal- no claim (N=43)	27	16	20	7
High kcal- taste claim (N=43)	21	22	13	8
High kcal- satiety claim (N=40)	21	19	6	15

Food choices during lunch

Lunch items were grouped into the following four categories: breads, toppings, drinks and fruits (see design and procedure for specific items). Univariate analysis of variance did not indicate any main effects of caloric content of the breakfast and claim or an interaction effect of caloric content and claim on caloric intake from breads (*caloric content:* (F(1,258)= .003, *ns*); *claim:* (F(2,258)= .09, *ns*); *caloric content * claim:* (F(2,258)= .34, *ns*), toppings (*caloric content:* (F(1,258)= .01, *ns*); *claim:* (F(2,258)= .15, *ns*); *caloric content * claim:* (F(2,258)= .44, *ns*), drinks (*caloric content:* (F(1,258)= .50 *ns*); *claim:* (F(2,258)= .61, *ns*); *caloric content * claim:* (F(2,258)= 1.16, *ns*) and fruits (*caloric content:* (F(1,258)= 1.06, *ns*); *claim:* (F(2,258)= 1.28, *ns*); *caloric content * claim:* (F(2,258)= .27, *ns*).

Caloric intake lunch

Univariate analysis of variance did not indicate a main effect of claim (F(2,258)=.20, *ns*) and the caloric content of the breakfast(F(1,258)=.35, *ns*). In addition we did not find the expected interaction effect of claim and caloric content of the breakfast (F(2,258)=.67, *ns*). Mean caloric intake (SD) per experimental condition is provided in table 5.5.

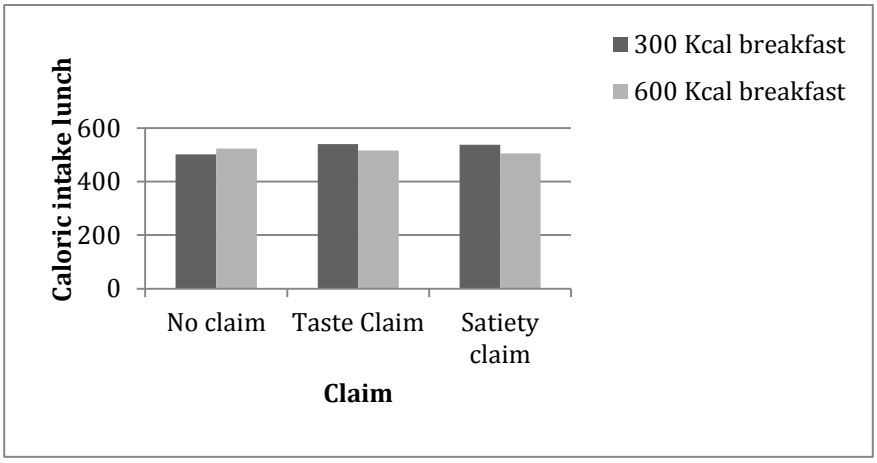


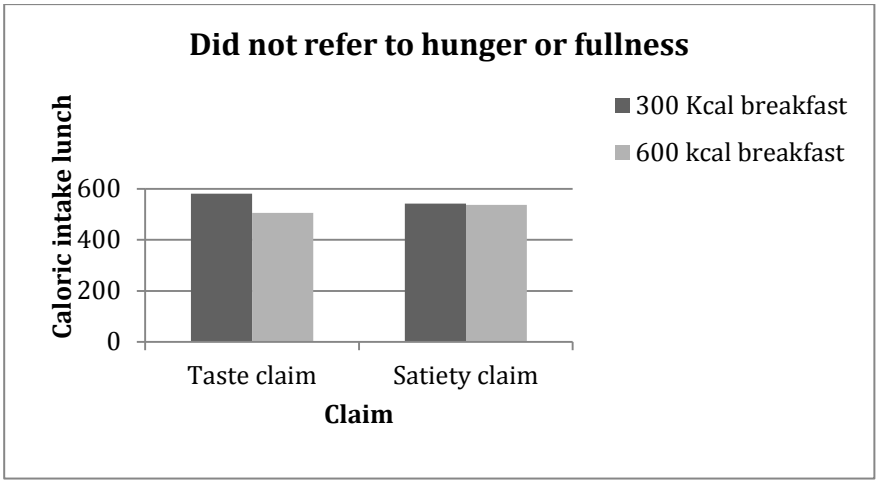
Figure 5.7: Calorie intake in Kcal during lunch for the low and high caloric breakfast groups, breakfast presented without a claim, with a taste or a satiety claim.

Persuasiveness of the satiety claim

A regression analysis, only with participants who were actually confronted with a satiety claim at breakfast, with caloric intake during lunch as a dependent variable and caloric content of the breakfast, perceived persuasiveness of the satiety claim and the interaction between caloric content and persuasiveness as independent variables, did not reveal an effect of caloric content (β = -.033, *ns*), persuasiveness (β = -.113, *ns*) or of the interaction between caloric content and persuasiveness (β = -.077, *ns*) on caloric intake during lunch. In addition, regression analysis indicated that both the caloric content of the breakfast (β= -.247, p <0.01) and perceived persuasiveness (β = -.147, p <0.05) are significant predictors for feelings of hunger and satiety before lunch. The interaction of persuasiveness and caloric content (β= .080, *ns*) did not have an effect.

Additional analysis of participants who referred to hunger or fullness as a factor

In contrast to study 2, analysis of variance did not reveal a significant three way interaction effect of claim, caloric content breakfast and referred to hunger or fullness (F(2,250)= .84, *ns*) on caloric intake during lunch. Also a similar analysis without the no-claim condition (as in study 2) did not indicate a significant result (F(1,167)= .56, *ns*).



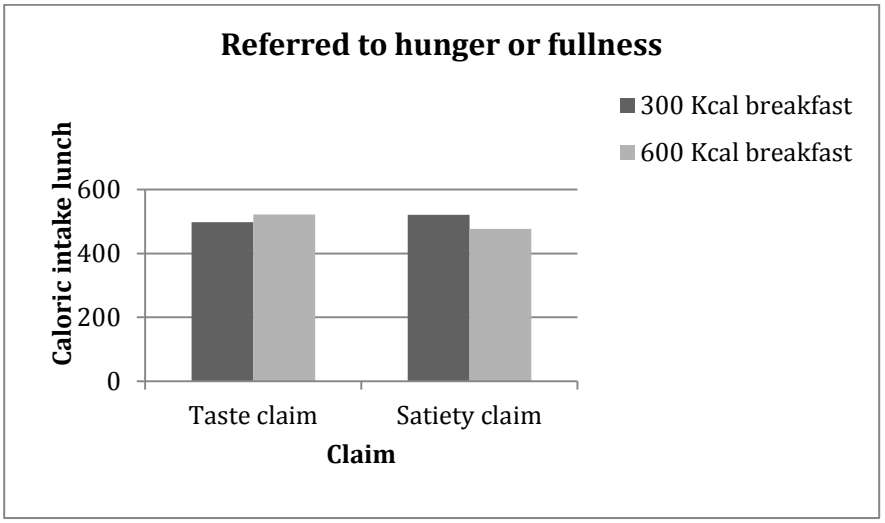


Figure 5.8: Caloric intake during lunch differently presented for participants who did not refer to hunger or fullness and participants who referred to hunger or fullness.

Additional analyses caloric intake lunch

In study 3, we were not able to replicate the significant effect of claim and caloric content of the breakfast on caloric intake during lunch as discovered in study 2. A possible explanation is that differences in participant populations influenced the results. Studies 2 and 3 differed in the sense that study 3 had a higher number of male participants and that the top 20% of restrained eaters was excluded. To rule out this rival explanation, two univariate analysis of

variance were conducted excluding all male participants (1) excluding all male participants and including the top 20% of restrained eaters (2) with caloric intake during lunch as a dependent variable and claim and caloric content of the breakfast as independent variables. Excluding all male participants did not show a difference in results. There were no main effect of claim ($F(2,194)= .66$, *ns*) and caloric content of the breakfast ($F(1,194)= 1.06$, *ns*) or an interaction effect of claim and caloric content ($F(2,19)= 1.265$, *ns*). In addition, the exclusion of males and inclusion of the top 20% restrained eaters did not influence the results. Univariate analysis of variance did not indicate a main effect of claim ($F(2,247)= 1.67$, *ns*) or caloric content of the breakfast ($F(1,247)= .46$, *ns*) and did also not indicate an interaction effect ($F(2,247)= .88$, *ns*) of claim and caloric content on caloric intake during lunch.

Discussion

Hunger feelings just before lunch depended on the caloric content of the breakfast and not on type of claim. Participants felt hungrier after a low caloric breakfast compared to participants who consumed a high caloric breakfast. Participants in the high caloric breakfast- satiety claim condition seemed to label their internal feelings differently than participants in other conditions. If they referred to being hungry or full in between breakfast and lunch they more often stated to be "full" than participants in other conditions would. The main and interaction effects of satiety claim and caloric content of the breakfast, the key results of studies 1 and 2, were not confirmed by study 3. Caloric intake during lunch was not affected by either the caloric content of the breakfast or by the type of claim. Irrespectively of experimental condition, participants consumed on average approximately 520 calories during lunch. Also food choices during lunch did not differ significantly per experimental condition.

General discussion

Present research showed inconclusive results with regard to the effect of the interaction of internal signals and a satiety related claim. Studies 1 and 2 indicated that only the combination of a physiological cue, the internal feeling of satiety, and a cognitive cue, the satiety claim, was effective in reducing caloric intake during next meal. When standing alone, neither the internal feeling of

satiety nor the satiety claim was able to affect hunger feelings or portion size. In contrast to studies 1 and 2, study 3 did not show any significant differences in caloric intake during lunch between the experimental conditions. Studies 2 and 3 differed in the sense that study 3 had a higher number of male participants and that the top 20% of restrained eaters was excluded, which might explain the different results. Additional analysis showed that excluding male participants and including the top 20% restrained eaters did generate similar results as reported in study 3 and can't therefore be an explanation for the inconclusive results. Chambers et al. (2013) conducted a similar study and were also not able to find an effect of a satiety claim on caloric intake during next meal. In this study, a satiety label and a creamy texture in combination with a high-energy version of a fruit yoghurt beverage were used to generate the strongest satiety expectations. Their results show that a creamy texture indeed influences hunger feelings and intake during next meal but that the satiety label did not have an effect.

In study 2, it mattered whether participants referred to hunger or fullness in between breakfast and lunch or not. Participants who did not refer to hunger or fullness seemed not to be affected by the type of claim during breakfast. But participants who did refer to hunger or fullness reacted more strongly to the type of claim depicted on the breakfast product. Intake was up to 140 kcal higher when a satiety claim was not supported by internal signals. It might be that those participants, following the logic of the expectations-confirmation theory, were 'disappointed' by the breakfast, expecting a more satiety enhancing meal because of the satiety claim, and compensated for this 'disappointment' by consuming more calories during lunch. Chambers et al (2013) used the term 'rebound appetite phenomenon' to explain similar findings. Their results suggest that consuming a low satiating food that appears to be high satiating actually stimulates appetite. This shows that a product presented with a satiety claim that does not actually provide an substantial feeling of fullness might have the unwanted effect of increasing caloric intake and should therefore be avoided at all times.

When a satiety claim was depicted on a high caloric breakfast, caloric intake during lunch was up to 125 kcal lower. That an increase of 300 calories in the caloric content of the breakfast in the 'best case' scenario leads to a reduction of 120 calories illustrates the struggle for caloric compensation across the day.

It clearly shows the need for the development of food products that can influence satiety feelings without adding additional calories to a consumers' diet. This has major implications for the introduction of these new satiety-enhancing products in the market place. Introducing a satiety-enhancing product, without communicating the effects such a product may have, is likely to not be beneficial for a substantial part of the consumer population. For both new and adapted products a satiety claim can help certain consumers to determine suitable portion sizes based on the expected satiety of a product.

Based on the collected data, it is difficult to explain why these two groups react differently to the used manipulations. The most logical conclusion would be that people who react more strongly to satiety claims, are the people who use external cues to guide their intake and control their appetite. A trait often associated with restrained eaters (Herman & Mack, 1975; Johnson, Pratt, & Wardle, 2012; Ogden & Wardle, 1990). But neither in study 2 nor study 3 the participants that referred to hunger or fullness and the participants that did not refer to hunger or fullness differed significantly on dietary restraint. It might be that participants that referred to hunger or fullness did not classify as restrained eaters but are in general more conscious to how they feel internally and react more strongly to external cues in the environment.

Based on previous research (Brunstrom, et al., 2011) we expected an effect of perceived persuasiveness of the satiety claim on hunger feelings just before lunch and caloric intake during lunch, which was not confirmed by the analyses. Brunstrom et al. (2011) measured believability of their manipulation with three very straight forward questions (1. Whether participants based hunger and fullness ratings on their genuine experience or on how the researcher expected them to respond 2. They had to guess the purpose of the experiment 3. Whether participants believed that the smoothie contained the amount of food that was shown to them at the beginning of the experiment), while we used a less specific scale of 8 items on persuasiveness. It might be that our 7-point scale stimulated participants to provide more nuanced answers compared to the straight forward yes/no options of Brunstrom et al. (2011) and therefore did not have an significant impact on caloric intake.

Present research is limited in the sense that it used a student sample in all studies and therefore the results cannot be generalized to the general

population. Second, all studies were conducted in a controlled environment, filtering out all other cues that have shown to influence eating behaviour and portion size determination. Most probably, effects will even by less straightforward in regular daily life, where consumers will be under the influence of many cues simultaneously. We highly recommend testing in a less controlled environment to give a better indication of the magnitude of the found effects in daily life. Finally, previous research has shown the importance of wording and framing of the claim (Levin, Schneider, & Gaeth, 1998; Rothman, Bartels, Wlaschin, & Salovey, 2006; Rothman & Salovey, 1997) and the fact that claim-carrier combinations can have an impact on consumer perceptions (Van Kleef, Van Trijp, & Luning, 2005). Present research was restricted to one carrier (yogurt with muesli) and one satiety claim. Future research might study the effects of different claim-carrier combinations and systematically vary wording of the claims. It might also be of importance to direct future research at the effect of individual differences in satiety claim manipulations, since there seems to be a group of people that reacts more strongly to those claims.

In conclusion, the results suggest that for a to-be-specified part of the consumer population, only the combination of an internal feeling of satiety and a satiety claim are effective in reducing caloric intake during next meal. Therefore we would like to argue that introducing a satiety enhancing product without communicating its benefits, or the other way around, combining a satiety claim to a product that does not generate an internal feeling of fullness is not beneficial for some of the consumers and might even increase caloric intake.

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Chapter 6

General discussion

Introduction

Accurate management of quantity of food intake is a challenging process to many consumers as evidenced by the high prevalence of overweight and obesity (Swinburn et al., 2011; Wang, McPherson, Marsh, Gortmaker, & Brown, 2011). The human body is equipped with a sophisticated appetite control system, reflecting itself in the subjective experiences of satiation (i.e. an increasing feeling of fullness accompanying food intake that leads to meal termination) and satiety (i.e. feeling of fullness after a meal that serves as a signal for the timing and size of the next consumption moment). However, there is ample evidence that actual food intake is often not guided by these internal signals (Wansink, 2004), but is rather influenced by cues in the environment that trigger consumption beyond the needs that the physiology of the body indicates. Nevertheless, the subjective experiences of hunger and fullness provide an informative guidance to adequate food intake control and provide a potential leverage for adequate management.

The present thesis focuses on satiation- and satiety-related expectations and inferences as a guide for food intake, both within and across consumption episodes. Figure 6.1 shows how the four empirical studies of this thesis are interrelated. They focus on three types of factors: physiological cues, claims on food packages and packaging design, and their role in satiation/ satiety expectations and food intake. In that sense, this thesis recognizes that satiation and satiety experiences are largely based on relevant feedback from previous consumption moments. However, next to learning from personal experiences, satiation and satiety expectations may also be inferred 'on the spot', either explicitly (as from satiety claims), but potentially also implicitly and more intuitively (as from packaging design and other factors in the eating context). In the past, external cues in food intake decisions have received considerable attention. This thesis extends that research by explicitly taking satiety and satiation expectations as central concepts. This fits current time frame, where the body of research on consumers' satiety expectations from cues such as volume (Brunstrom, Collingwood, & Rogers, 2010), unit size (Van Kleef, Kavvouris, & Van Trijp, submitted) and product inferences (Piqueras-Fiszman & Spence, 2012) is quickly growing.

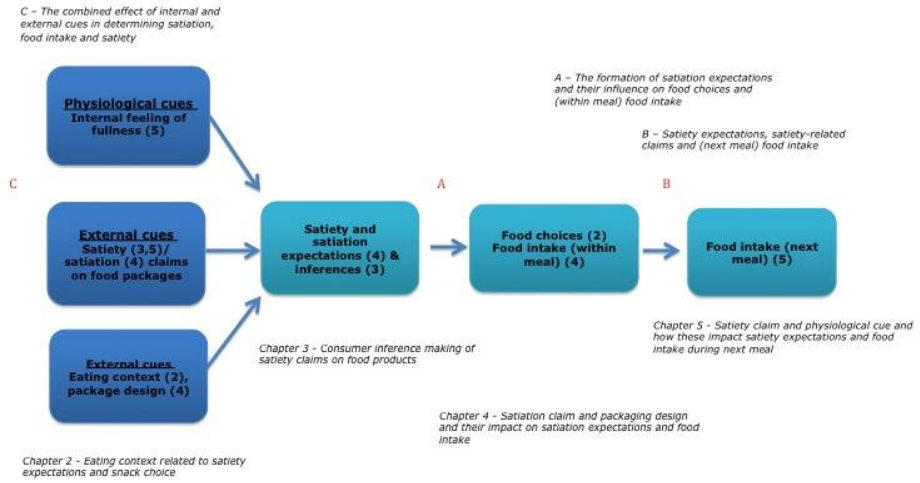

Figure 6.1 Overview of studies included in this thesis with chapter numbers in parentheses.

Overview of main findings

The specific results of the four empirical studies are summarized in Table 6.1. The study described in *chapter 2* can be regarded as the baseline chapter of this thesis. It focuses on product related satiation and satiety beliefs regarding different snacks and the extent to which consumers include these satiation and satiety beliefs in the management of their food choices. In this study, consumers are confronted with an assortment of snack options, which systematically vary in terms of satiety related factors, such as macronutrient composition and unit size. These snack products are rated on their perceived satiety value and product liking, and consumers are asked to express their choice under different eating scenarios (time till next meal). This research shows that snack products perceived as high in fat, high in protein, with a savoury taste and presented in one piece generate the highest satiety expectations compared to sweet tasting products and products that consist of multiple items. Unexpectedly, while consumers have satiety expectations when

it comes to snack products, their hypothetical snack product choices do not differ across scenarios that vary in satiety requirements. This suggests that snack product choices are not driven by satiety requirements, and possibly that satiety value perceptions are not an important distinguishing factor between alternative snack options, nor a dominant driver of snack choice.

Chapter 3 builds on these results by exploring the potential of satiety-related health claims to increase product differentiation. It specifically explores how different claim formulations may lead to different levels of satiety and satiation inferences, ranging from what the product is believed to contain (content-related inferences), to deliver (satiety related benefits), and leads to (satiety related consequences). Recently, satiety-related health claims have been under pressure, as they are believed to be mis-interpreted by consumers. A key concern is that products with satiety claims are seen as magic bullets that "automatically" lead to adequate weight management and even weight loss, while this can not be substantiated on the basis of scientific evidence (Roe, Levy, & Derby, 1999). In a large-scale multi-country survey study, consumers evaluated five different satiety-related claim formulations on the perceived effects that can be inferred from them. As both the claim formulations and the benefit inference scales differed in effect scope, the study design allows us to explore in greater detail, whether and to what extent alternative claim formulations are over-interpreted in terms of satiety-related benefit inferences. In addition, this study develops a new methodology to explore the magic bullet effect in more detail, that is the extent to which consumers believe that different levels of satiety-related benefits would result from the product use and/or require substantial effort on the part of the consumer him/herself.

The results of this study show that the level of over-interpretation of satiety-related health claims is limited. In other words, consumers are accurate in the satiety-related inferences they make from satiety-related health claims in that they stay close to the literal meaning of the claim. In terms of individual differences, the study shows that restrained eaters are slightly more prone to over-interpretation of claims. Nevertheless, their extrapolation to non-relevant benefits is limited in that they also acknowledge that personal efforts are needed to obtain specific weight management benefits. In general, consumers do not expect a magic bullet effect, but rather understand that personal efforts are required to translate claimed product attributes and benefits into potential

weight control benefits. Overall satiety-related health claims seem a powerful instrument to induce satiety and satiation-related expectations and inferences.

Chapter 4 extends these findings in two directions. First, it explores how sheer packaging design may serve as a cue for satiation and satiety related expectations and inferences, next to, and potentially in interaction with the presence of satiation-related health claims. Additionally this study extends the previous studies in moving beyond expectations and hypothetical choices, with a focus on how expectations impact on actual food intake. In this study, consumers are confronted with a package of cookies, either a light coloured packaging to trigger low satiety expectations or a dark coloured packaging to signal high satiation value of the product. These packages are presented either with a satiation-related claim ("Added fibre, provides a feeling of fullness sooner") or a taste-related claim ("New recipe, now even tastier") as a control condition. Among a number of other measures, respondents provide satiation expectation ratings and are allowed to eat as many cookies as they like in a taste test. The results confirm that packaging design and satiation-related claims are important cues for satiation expectations and inferences. A product with a satiation claim or in a satiation-enhancing package is perceived as more satiating compared to a product with a taste claim or in a light coloured package. But interestingly, these satiation expectations do not translate linearly into amount consumed. Rather, within a meal, food intake seems to be driven by packaging-claim congruency. In both situations where the satiety-related claim and the packaging colour are congruent (light packaging with taste claim or satiation enhancing packaging with satiation claim), caloric intake was higher compared to when the packaging and claim are incongruent (light packaging with satiation claim and satiation enhancing packaging with taste claim). This finding was unexpected and seems to suggest that package design coherence in communicating satiation-related signals is a potential area for future research.

Chapter 5 builds further on this coherence in satiety-related signals and also uses an actual food intake paradigm. In the studies presented in *chapter 5*, presence or absence of a satiety-related claim ("This muesli contains added fibre, therefore you will feel full for longer period of time") was combined with a disguised caloric content (300 vs. 600 kcal) of a breakfast, resulting in either match or mismatch of the satiety claim information with the physiological cues for satiety and satiation. These studies extend previous studies in the domain of satiety as

the effect of claim – physiological cue congruency is assessed on caloric intake during lunch consumed three hours later. A priori it is expected that the combination of a high caloric breakfast and a satiety claim reduces participants' caloric intake during lunch. This effect is explored in three studies.

The first two studies reported in *chapter 5* support our expectation in that they show that only the specific combination of a physiological cue, the internal feeling of satiety, and a cognitive cue, the satiety claim, is effective in reducing caloric intake during next meal. When standing alone, neither the internal feeling of fullness nor the satiety claim is able to affect subsequent food intake. In addition, these first two studies show that when a satiety claim is not supported by internal signals, caloric intake increases. However, in the third study where we attempted to replicate these findings in a larger sample we are unable to illustrate the interaction effect of satiety claim and caloric content of breakfast on food intake during next consumption episode.

Table 6.1 Overview of the empirical studies of the thesis

Chapter	Objectives	Method	Outcome measures	Major findings
2	To investigate the effect of time gap till next meal on snack choices varying in satiating properties To understand product attributes responsible for satiety expectation of snacks	Between subjects experiment (N=140) in which participants had to make a hypothetical snack choice in response to scenario that varied in time gap till next meal (one versus four hours) and a control scenario Repertory Grid task with 16 selected snacks	Hypothetical snack choices Elicited product attributes responsible for expected satiety	Consumer choices from assortment of snacks varying in satiating characteristics do not depend on expected time till next meal Snacks differ in expected satiety value. Products perceived as high in fat or protein, with a savoury taste and in one single unit have a high expected satiety value compared to sweet products and smaller unit sizes.
3	To examine which benefit inferences consumers have regarding different levels of satiety claims To examine whether and to what extent consumers view products with satiety claims as an addition to other personal efforts to manage body weight	Survey among respondents of internet panel in four countries (N=1504). They were asked to assign five satiety related claims (i.e. 'contains fibre', 'increases fullness', 'helps to control hunger', 'helps you want to eat less' and 'keep you going between meals') to their perceived benefits. These perceived benefits were presented at four increasing levels: product attribute (e.g. contains specific ingredients), product benefit (e.g. fills your stomach), behavioural consequences (e.g. controls appetite) and goal/outcome related consequences (e.g. lose weight)	Importance of perceived benefits for the five satiety related claims Perceived level of personal responsibility for each of the given benefits.	Consumers primarily relate satiety claims to their intended, actual benefit meaning or lower levels (i.e. product attributes). Country differences exist in over-interpretation of satiety claims; UK consumers over interpret to a lesser extent. Particularly restrained eaters exhibit a higher tendency to over-interpret satiety-related claims Consumers recognize that higher order outcomes (such as losing weight) need additional personal efforts to obtain.
4	To examine the effects of food package and satiation claim on expected satiation and actual food intake of a snack	In two (satiation claim: absent versus present) by two (package design: satiation enhancing versus light) between subjects experiments, participants tasted and rated savoury snacks (N= 236 for pilot study on expectations and N=96 for main study involving actual food intake)	Satiation expectations Actual food intake of snack	A satiation claim that is congruent with the food package at which it is displayed (i.e. designed to emphasize satiation through colours and pictures) leads to higher satiation expectations and higher food intake than no satiation claim or a satiation claim displayed at a food package suggesting lightness.
5	To examine whether and how a (miss) match between calorie content of breakfast (a physiological cue) and satiety information provided (a claim at food package) influence subsequent food intake during lunch	Three experiments with a physiological cue (manipulated feeling of fullness by 300 kcal breakfast vs. 600 kcal breakfast) and an external cue (absence or presence of a satiety claim: "This muesli contains added fibre, therefore you will feel full for a longer period of time") Study 1 (N=34) used satiety claim (absent versus present) as a within subject factor and caloric content of breakfast as a between subjects factor. Study 2 (N=103) used claim (taste vs. satiety) and caloric content breakfast as between subjects factor. Study 3 (N=334) used claim (no claim vs. taste vs. satiety) and caloric content breakfast as between subjects factors.	Food served during lunch (study1) Food intake during lunch (studies 2 and 3)	It is not clear whether the combination of an internal feeling of satiety and a satiety claim are effective in reducing caloric intake during next meal. Studies 1 & 2 indicate that only the combination of an internal feeling of satiety and a satiety claim are effective in reducing caloric intake during next meal. A satiety claim that is not matched with an internal feeling of satiety seems to have the opposite effect in that participants increased their caloric intake during a subsequent meal. In study 3, we were not able to replicate this effect in a larger population.

Reflection, interpretation and recommendations for future research

The studies reported in this thesis are designed according to the model represented in Figure 6.1, which provides a useful framework for reflection on the findings. Specifically, we will focus on 3 key elements:

a. The formation of satiation expectations and their influence on food choices and (within meal) food intake
b. Satiety expectations, satiety-related claims and (next meal) food intake
c. The combined effect of internal and external cues in determining satiation, food intake and satiety

The formation of satiation expectations and their influence on food choices and (within meal) food intake

One key assumption of the model used in this thesis, is that consumer food choices and food intake are (partly) driven by satiation considerations and expectations. Expectations about the satiating properties of foods concern the extent to which people expect a food to be filling within an eating episode.

Chapter 4 of this thesis shows that satiation claims and packaging cues have the potential to influence satiation expectations. This is in accordance with prior research. Fay et al. (2011) shows that a smoothie branded as 'highly satiating' is expected to be more satiating, before as well as after consumption, compared to similar smoothies from a diet and a control brand. Piqueras-Fiszman & Spence (2012) show that yoghurt served in a heavier container is expected to be more satiating and is perceived as denser compared to the same yoghurt from a visually identical but lighter container. Next to claims and packaging cues there are other cues that have the potential to influence satiation expectations. Volume seems to influence satiation expectations (Brunstrom, et al., 2010) and also texture has an effect on expected satiation. Hogenkamp et al.(2011) shows that a relatively thicker dairy product is expected to be more filling.

When people expect a food to be more filling, this may also influence the pre meal planning process and possibly causes a reduction in the amount of food consumed within an eating occasion. Recent research shows that satiation

expectations play an important role in portion size determination (Brunstrom, 2011; Brunstrom, Brown, Hinton, Rogers, & Fay, 2011; Brunstrom, et al., 2010; Brunstrom, Rogers, Pothos, Calitri, & Tapper, 2008; Brunstrom & Shakeshaft, 2009; Brunstrom, Shakeshaft, & Alexander, 2010; Brunstrom, Shakeshaft, & Scott-Samuel, 2008). Expected satiation seems to be even more influential than palatability when it comes to portion size selection (Brunstrom & Shakeshaft, 2009). In addition, our research (*chapter 4*) shows that cues not only have the potential to generate expectations but also affect the (within meal) amount consumed.

Expectations, generated by external cues, are formed by inferential belief formation processes (Olson, 1978). Given a set of cues available in the environment, people develop beliefs about other aspects of the food that they cannot judge directly. For example, 'this package looks bright' may result in the inferential belief that 'the cookies inside the package will not be filling'. People learn over time on which cues they can best rely. This requires reflection of previously learned information from which one can derive inferences. Learning from prior experiences seems to be crucial in the formation of satiation expectations (Benoit, Davis, & Davidson, 2010). Throughout the years, people learn to relate particular food attributes to their physiological effect. As a result, people become more or less skilled in assessing how satiating a food will be (Booth, 1972).

Research shows that it is very difficult to change prior formed satiation expectations, but the translation from a change in expectations to a change in intake amount is even more challenging (Brunstrom, et al., 2011; Hogenkamp, et al., 2011; Hogenkamp, Brunstrom, Stafleu, Mars, & De Graaf, 2012). In their study, Hogenkamp et al. (2012) served, over five days, a soup manipulated in energy density. After this repeated exposure, expected satiation did not change. Their follow-up study shows that participants are reasonably good in ordering the different types of soup on their satiating capacity, but that intake is not adapted accordingly. It can be that in such a situation, where a difference in satiation level is experienced but behaviour is not adapted, an external cue as a satiation claim or a satiation-enhancing package might help.

Our research shows that satiation expectations have the potential to influence the amount consumed within a meal. Whether these generated satiation expectations also influence food product choice, at the start of a consumption episode, is still unknown. Research indicated that for consumers, sensory appeal (taste, smell or appearance of food) is the most important factor in food

product choice (Steptoe, Pollard, & Wardle, 1995). Also price, convenience and health are considered when choosing a food product. In most cases, the number one goal of starting an eating episode is to satisfy hunger or a desire to eat. In such a situation, most food products will satisfy sufficiently. It can therefore be imagined that satiation expectations only play a small role (if any) in selecting which food to consume. More research is needed to confirm this assumption.

Satiety expectations, satiety-related claims and (next meal) food intake

In addition to satiation expectations, we assume in our model that consumers also have expectations about the satiety level of a food product. Where satiation expectations are important for within meal food intake, satiety expectations influence the timing and size of the next meal. Therefore it is interesting to know if perceived satiety levels differ between food properties/ products and whether these perceptions are taken into account when selecting food products in situations with specific satiety requirements.

Chapter 2 of this thesis shows that particular food properties, such as perceived fat, protein-content, savoury taste and unit size matter in he formation of satiety expectations. This is in accordance with research conducted by Brunstrom and colleagues (Brunstrom, 2011; Brunstrom, et al., 2011; Brunstrom & Shakeshaft, 2009; Brunstrom, Shakeshaft, et al., 2008), who show that consumers are very specific in their product related satiety expectations. When comparing the satiety evaluations of the products in their study (Brunstrom, Shakeshaft, et al., 2008), to our list of food properties associated with the satiety level of a product, it stands out that in both studies sweet and multi item products are expected to have a low satiety level while savory products are expected to be more satiating. Although consumers have specific satiety expectations when it comes to snack products, their hypothetical snack product choices do not differ across scenarios that vary in satiety requirements (*Chapter 2*). A question that can be raised given our results is whether satiety is indeed not considered relevant in snack choices or whether the methodology applied in our study was not realistic enough. Participants had to make a hypothetical choice and may have realized that they would never actually eat the

food selected in the questionnaire. So, instead of considering a future state, they may have followed their current preferences and appetitive state.

Nevertheless, a considerable number of studies have shown that people find it very hard to imagine what it is to be in a different state than the current state (de Ridder, Ouwehand, Stok, & Aarts, 2011; Evers et al., 2011; Nordgren, van der Pligt, & van Harreveld, 2008). Similar to the phenomenon that people have a hard time to understand the feelings and choices that are made by others, they find it equally difficult to know how they feel themselves when they are in a different state of mind. These are called 'hot-cold' empathy gaps (Loewenstein, 2005). When people are in 'hot' states, they are for example hungry, and do not recognize the extent to which their preferences are influenced by this (hunger) state. When people are in 'cold' states they find it difficult to image how they would feel or behave in 'hot' states. So when not hungry it is difficult to predict the choices made in a hungry state and the other way around. Read and van Leeuwen (1998) illustrate these difficulties by asking participants to make an advance choice between healthy and unhealthy snacks. They find that advance choices are influenced by both current and future hunger. Hungry participants more often chose unhealthy snacks compared to satisfied participants. For their immediate choice a week later, many participants changed their choice from the week before and rather had an unhealthy snack than a healthy one. Moreover, in *chapter 2*, snack products were used to elicit satiety considerations while it might be that consumer concerns about satiety center around meals. Snack products are often not consumed in response to hunger feelings but are used to satisfy cravings for something salty or sweet (De Graaf, 2006).

For consumers who want to adapt their product choice to the satiety requirements of a situation, satiety-related claims on packaging might be interesting. At this point in time, EU-legislation only allows satiety-related claims on packaging of products that show an effect on long-term weight management (EFSA Panel on Dietetic Products, 2011) while satiety in itself already can be beneficial for the consumer. In addition, the average consumer must be able to understand the effects expressed in the claim. This means, that satiety-related claims should not raise expectations to a level that cannot be fulfilled by the product. One important difference between satiety-related claims and many other health claims (on vitamins, antioxidants, etc.) is that satiety is a health benefit that can be experienced and judged by the consumer

(Hetherington et al., 2013). After consumption, consumers can almost immediately determine whether the product is indeed satiety enhancing and whether they would like to purchase it again. Nevertheless, it is still of importance that consumers understand the effects expressed in the claim. *Chapter 3* of this thesis shows that the average consumer correctly interprets satiety-related claims and does not expect a magic bullet effect, but understands that personal efforts are required to achieve potential weight control benefits.

The combined effect of internal and external cues in determining satiation, food intake and satiety

The final assumption in this model is that satiety-related internal and external cues can enhance each other and together determine expected and experienced satiation, food intake and satiety. We expect that internal and external cues interact in the sense that they reinforce each other, with consumers perceiving the strongest satiety feelings when both cues are present. Earlier studies conducted on this topic have generated mixed results.

Crum et al. (2011) for example found an effect of both indulgent and sensible labels on ghrelin secretion. Ghrelin is an essential indicator of energy insufficiency a physiological marker of satiety and major driver of hunger. In their study, they labelled identical 380-calorie milkshakes as either 'an indulgent 620-calorie milkshake' or 'a sensible 140-calorie milkshake'. They showed that the level of satiety after drinking a milkshake was consistent with what the participant believed he/she was consuming rather than the actual nutritional value of the milkshake. More importantly, increased levels of satiety were reflected at a physiological level in that the supposed 'indulgent' milkshake led to lower levels of ghrelin. Hogenkamp et al. (2013) did only find an effect of manipulated information after consuming a low caloric breakfast. They manipulated the information given to participants about the nature of their breakfast yogurt (low caloric or high caloric). Unbeknownst to participants, the preload either was consistent with this information or not. Their results show that when actual caloric intake was high this resulted in higher physiological satiety in which expectations generated by the information played no role. However, after consuming a low caloric breakfast, incorrectly assuming that you consumed a high caloric breakfast resulted in induced satiety.

In our first two studies of *chapter 5* only the combination of an internal feeling of satiety and a satiety claim are effective in reducing caloric intake during next meal. A satiety claim that is not matched with an internal feeling of satiety seems to have the opposite effect in that caloric intake was increased during a subsequent meal. In the larger study 3 of this *chapter* we were not able to replicate these effects. This is in accordance with the study of Chambers et al. (2013). They served a fruit yogurt beverage for lunch that one day was a high-energy version and the next day a low energy version. These beverages were either thickened with added creamy flavours or thinner less creamy versions, and either with or without labelled information about the satiating power of the beverage. Appetite ratings and energy consumed at the test lunch were used to assess satiety responses. Results indicate that sensory cues and not labelled information influence the satiating power of a beverage. The authors argue that possibly the labelled messages were overshadowed by stronger satiety cues.

These inconsistent results raise the question whether the human body (by itself or with the help of external cues) is equipped to detect relatively small differences in energy needs and whether people are able to respond by consuming more or less food. Various studies show that the appetite control system is relatively vulnerable to overconsumption in response to energy excess (Caputo & Mattes, 1992; Bellisle, Drewnowski, Anderson, Westerterp-Plantenga, & Martin, 2012). This might be a remnant of ancient times. In order to survive periods of scarcity, it was of eminent importance for our ancestors to be able to over eat large quantities of food when it was in abundance (Popkin & Gordon-Larsen, 2004). In a situation where the next meal is unpredictable in both timing and content, it is imaginable that the foods with the highest energy content are automatically selected when available. This suggests that biologically, an appetite control system that regulates satiety more strongly and with that limits food intake, would be a disadvantage for survival.

How it is physically possible to unknowingly consume more food than necessary is explained by the boundary model for the regulation of eating, developed by Herman and Polivy (1984). Following this boundary model, humans have two end states, hunger on the one end and satiety on the other end, where internal satiety signals are most influential. When in the end state of hunger, extreme hunger is experienced that urges to eat and when in the end state of satiety, unpleasant satiety feelings urge to stop eating. In between these two end states there is a zone of biological indifference. When in this zone of

biological indifference, there are no internal signals that urge to start or stop eating. Instead, food consumption is guided by external cues. This also implies that you can feel equally satisfied with a smaller quantity to eat as long as you stay in this zone of biological indifference. Van Kleef et al. (2013) for example showed that consumers felt just as satisfied after eating a smaller portion compared to a larger portion while consuming less calories. The zone of biological indifference illustrates why it is so difficult to compensate for differences in energy intake. Between certain limits, the body will not signal when to start or stop eating but relies on other cues. Literature shows that next to post-ingestive consequences, subsequent feelings of hunger and satiety, the amount of food consumed is mainly determined by sensory cues as visual and olifactory and cognitive factors as learning, social norms and memory for the quantity of food perceived to have passed through the mouth along with expectations about how full the consumer will feel (Kral, 2006; Yeomans, 2010). Most probably, all these factors are interrelated and together form the puzzle of consumption amount regulation. More research is needed to precisely understand the role of internal and external cues of satiation and satiety in the appetite control system.

Methodological considerations and limitations

Specific limitations of the employed methods have already been discussed in each of the chapters. Therefore, the discussion of methodological limitations will be focused on a more general discussion of the research paradigms used in our food related studies and surveys. In this paragraph we will discuss:

a. Subjective satiety/satiation measurement in experimental contexts
b. Experimental context vs. real life situations.

Subjective satiety/satiation measurements in experimental contexts

Many studies with regard to the influence of external cues on food intake do not measure (subjective) feelings of satiation and satiety. This might be the case because of the downsides attached to measuring satiation and satiety in an experimental context. Following Allirot et al. (2011) and Blundell et al. (2010) there are two commonly used methods in measuring satiation and satiety:

measurement of the subjective disposition to eat and measurement of biomarkers of satiety. The subjective disposition to eat is often measured by answering questions as "How hungry are you?", How full are you?" and "How strong is your desire to eat?" on visual analogue scales where participants place a vertical cursor on a line anchored at each point with opposing statements (Blundell, et al., 2010). Measurement of biomarkers of satiety is done by collecting blood samples at various times and the measurement of concentrations of different hormones that are supposed to be biomarkers of satiety (de Graaf, Blom, Smeets, Stafleu, & Hendriks, 2004). Both methods can have disadvantages when used in an experimental context. Subjective feelings of satiation and satiety are most often an intermediary endpoint in an experiment and measuring them potentially interferes with other important outcome measures as food intake. When testing the effects of external cues on food intake in an experimental setting, researchers often do not want participants to know that their food intake is the variable of interest. They for example develop cover stories to hide their manipulations and with that try to explain the presence of the food. In these kinds of experimental settings, asking the participant to fill out a questionnaire on subjective feelings of satiation and satiety or even worse to measure biomarkers of satiety can influence the participant in such a way that results become unreliable. It might be that it helps participants to understand the actual purpose of the study or that a questionnaire unintentionally activates satiety related constructs in the brain that influence the results. Nevertheless, not measuring feelings of satiation and satiety hampers the understanding of the relation between external cues, satiation and food intake. In this thesis, we deliberately choose to include subjective measurements of satiation and satiety as they are seen as the standard in food intake research (Blundell, et al., 2010). None of our studies indicated that because of measurement of satiation and satiety, participants understood the purpose of the studies and therefore behaved differently. Whether these measurements unintentionally activated satiety related constructs in the brain and with that influenced behaviour is not known, and can be an interesting subject for further research.

Experimental context vs. real life situations

All experiments described in this thesis were conducted in a laboratory environment. Some made use of scenarios with a hypothetical choice (*chapter 2*)

as an outcome measure; others followed a taste test paradigm with food consumption (during next meal) as key dependent variable (*chapters 4 and 5*). These experiments have in common that it is difficult to translate their results to real life situations. As Hetherington et al. (2013) states it: "a significant conceptual gap remains between evidence gathered in highly controlled contexts such as the experimental laboratory and claims made about satiety enhancement in the context of the day-to-day lives of the consumer". The hypothetical product choice asks a lot of the imagination of participants. In *chapter 2* participants were asked to imagine that they were hungry and want to select a product at a train station. Their favourite main meal was either one hour or three hours away. This situation might be difficult to imagine for some participants. They never take the train, bring their own food instead of buying products at the train station or normally do not choose one of the displayed products. In real life they might have made completely different decisions. A solution to create more external validity might have been to observe the purchasing behaviour of people at a train station and ask them when and what will be their next meal.

Similarly, food intake during the consumption studies in this thesis is difficult to translate to real life situations. In the laboratory, participants were only exposed to a controlled level of (external) cues. We made sure that they would only be confronted with our packaging designs and asked them to observe these packages carefully. Chances are that in a real world situation, satiety claims on packaging are completely overlooked or if detected not processed properly by the consumer. In addition, in real life situations, consumers are exposed to numerous cues at the same time. It is very possible that this overload of cues, takes away the effects of for example a satiety-related claim observed in a laboratory environment. A solution to this laboratory- real life translation is not easy to find. A highly controlled laboratory environment is necessary to get a better grasp of mechanisms and the reasoning behind discovered effects. This is essential to get science forward. But when this experiment has robust results it should be tested in a less controlled, more hybrid experimental context to ensure external validity. But it seems that many researchers are not particularly interested in testing their effects in a different setting and rather study a related or new effect in a highly controlled environment.

In conclusion, this thesis shows that although satiety does not seem to be a leading factor in food choice and food consumption, consumers are fairly good in predicting the satiety level of food products. In addition, our studies and those of others show that biases are at work with regard to how much someone eats, which powerfully change the way in which people experience satiety, both physiological and psychological. These biases can be used to the advantage of the consumer and might help to eat less while experiencing a similar level of satiety. Therefore it can be of interest to the consumer to use satiety-related external cues as claims and carefully designed packaging. Although under the condition that claims are based on substantiated effects and are well understood by the consumer.

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Summary

In 2008, worldwide an estimated 1.46 billion adults were overweight and an additional 502 million adults were obese. Being overweight or obese comes with severe health concequenses, as a high BMI is associated with type 2 diabetes, cardiovascular diseases and different types of cancers. In most instances, overweight is the result of an imbalance in energy intake and energy expediture. Adequate food intake is a crucial factor in the reduction and prevention of overweight. For many people, food intake management is a challenging process, as food is always in abundance and the appetite control system is challenged and potentially overpowered by habits, routines and cues in the external environment.

Most research on the influence of environmental cues on food intake shows how external cues often hamper internal signals and increase food consumption. However, external cues can also be used to influence people in consuming less food or delaying meal inititiation by shifting the focus on internal feelings of satiation and satiety.

The concepts of 'satiation' and 'satiety' take centre stage in this thesis. Satiation is the feeling of fullness that develops within a meal. Satiety refers to the process between two meals in which the feeling of fullness after meal one influences the timing and size of meal two. The present thesis focuses on satiation and satiety expectations and inferences as a guide for food intake, both within and across consumption episodes. More specifically, the role of physiological cues, claims on food packages and packaging design in the development of satiation/ satiety expectations and their effect on food intake is studied. This thesis takes as a starting point that feedback from previous consumption experiences is important for the development of satiety and satiation expectations. In addition, it is expected that satiation and satiety expectations also can be inferred 'on the spot', either explicitly (as from satiety claims), but potential also implicitly and more intuitively (as from packaging design and other factors in the eating context).

This thesis consists of 6 chapters. *Chapter 1*, the general introduction of this thesis, reviews the scientific evidence on how external cues can support or undermine an individuals' responsiveness to internal signals. The influence of external cues on internal signals is discussed for five different phases: meal

initiation, meal planning, consumption phase, end of eating episode and time till next meal.

In *chapter 2* it is aimed to gain more insight into how consumers' perceptions of the satiety value of snack products influence their choice of such products and to get a better understanding of consumer terminology and perceptions about product-related satiety. Snacking behaviour is initiated by feelings of hunger, or at least a desire to eat. Adequate snacking behaviour thus requires a delicate balance between the direct reward of reducing feelings of hunger versus the more temporal goal of bridging the time span until the next meal. In this chapter, participants were asked to indicate their individual product choice in response to a scenario. Scenarios varied between participants in terms of whether information on the time gap till the next meal occasion (favourite main dish) was provided or not, and whether this meal would be eaten after one hour or four hours. This study shows that, when consumers are confronted with situations that vary in satiety requirements, they do not make significantly different snack products choices. But they do have specific ideas about the features that influence the perceived satiety level of a product. Products perceived as fat, high in protein, with a savoury taste and in one piece are expected to have a higher level of satiety compared to sweet products and products that exist of multiple small items.

Chapter 3 explores whether and how consumers may (over-) interpret satiety claims, and whether and to what extent consumers recognize that personal efforts are required to realize possible satiety-related or weight loss benefits. Some argue that consumers might misunderstand satiety-related health claims. They are concerned that products with satiety claims are seen as magic bullets that "automatically" lead to adequate weight management and even weight loss, while this can not be substantiated on the basis of scientific evidence. We explored for a number of satiety claims the extent of inference making to higher-level benefits than actually stated in the claim, using internet-based questions and tasks. Respondents in U.K., France, Italy and Germany participated in the study. As both the claim formulations and the benefit inference scales differed in effect scope, the study design allows us to explore in greater detail, whether and to what extent alternative claim formulations are over-interpreted in terms of satiety-related benefit inferences. In addition, this study develops a new methodology to explore the magic bullet effect in more

detail, that is the extent to which consumers believe that different levels of satiety-related benefits would result from the product use and/or require substantial effort on the part of the consumer him/herself. The results of this study show that the level of over-interpretation of satiety-related health claims is limited. In general, consumers understand the benefit communicated through the claim and are accurate in satiety-related inferences. A group of consumers that is more prone to over-interpretation of satiety claims are restrained eaters. Although they expect more from products that carry satiety claims, they acknowledge that personal efforts are required to obtain specific weight management benefits. Similarly, all other consumer groups in our sample do not expect a magic bullet effect, but rather understand that personal efforts are required to translate claimed product attributes and benefits into potential weight control benefits.

In *Chapter 4,* the influence of satiation claims and satiation enhancing packaging on satiation expectations and food intake is tested. Often, a food product's packaging is the only information, prior to consumption, a consumer receives about the product. Different packaging elements as weight, shape, colour, images, lettering and claims can be used to gather information and to build product expectations. In *chapter 4*, we hypothesize that the overall appearance of a package has the ability to convey a message to the consumer and with that can influence satiation expectations and food intake. Two packages were developed for the same cookie: a package that signals a light and easy to digest cookie and a package that communicates a satiation enhancing cookie. In a pilot study, these two packages are tested for differences in satiation expectations with the presence of either a taste ("New recipe, now even tastier") or a satiation ("Added fibre, provides a feeling of fullness sooner") claim. In the main study, the packages in combination with the claims are tested on their influence on caloric intake. Results indicate that packaging influenced satiation expectations: participants expect a lower feeling of fullness and less time till a next consumption moment when they are presented with a light package with a taste claim compared to all other packaging formats. Packaging did not only influence satiation expectations but did also affect actual consumption. A satiation-enhancing package with a taste claim influenced caloric intake in a similar way as a light package with a satiation claim. Unexpectedly, a satiation-enhancing package with a satiation claim increased

caloric intake. Hence, package cues may be of substantial relevance to consumers' food consumption.

In *chapter 5* we study satiety instead of satiation and focus on the combination of internal and external satiety cues in reducing caloric intake during next meal. Both internal physiological cues as well as external cues have been shown to influence satiety and food intake. Although many cues that may affect the amount of food consumed have been identified, we do not yet fully understand which combinations of cues are most successful in decreasing portion sizes. In three studies it was investigated whether the interaction of an internal cue (manipulated feeling of fullness by 300 kcal breakfast vs. 600 kcal breakfast) and external cue (absence or presence of a satiety claim: "This muesli contains added fibre; therefore you will feel full for a longer period of time") can affect satiety expectations and with that can influence caloric intake during next meal. The results of studies 1 & 2 indicate that only the combination of an internal feeling of satiety and a satiety claim are effective in reducing caloric intake during next meal. A satiety claim that is not matched with an internal feeling of satiety seems to have the opposite effect in that participants increased their caloric intake during a subsequent meal. In study 3, we were not able to replicate this effect in a larger population.

Chapter 6, the general discussion of this thesis, provides an overview of and a reflection on the main findings. In addition, recommendations for future research, methodological considerations and limitations are discussed.

In sum, this thesis provides insight in consumer perceptions in relation to satiation and satiety and identifies product features that influence the perceived satiety value of food products. It proposes two different methodologies for measuring claim interpretation and shows that satiety related claims, in general, are well understood by the consumer. In addition, this thesis adds to the existing body of knowledge that both satiety related claims and packaging have the potential to influence food intake. Still, the conditions under which these kinds of external cues are most effective in reducing food intake need to be studied in more detail.

Samenvatting

Een peiling van de Wereld Gezondheid Organisatie geeft aan dat er in 2008 over de hele wereld 1.46 miljard mensen zijn met overgewicht (Body Mass Index 25-30 kg/m^2) en 502 miljoen mensen met obesitas (BMI > 30 kg/m^2). Overgewicht kan zorgen voor ernstige gezondheidsproblemen, zo wordt een hoog BMI geassocieerd met diabetes type 2, hart- en vaat ziekten en verschillende types kanker.
Een belangrijke oorzaak in het ontstaan van overgewicht is een energie inname en energie verbruik die niet met elkaar in balans zijn. In het voorkomen en terugdringen van overgewicht speelt een adequate voedsel inname dus een belangrijke rol. Voor veel mensen is het echter een grote uitdaging om hun inname te reguleren. Eten is altijd in overvloed aanwezig waardoor het interne honger en verzadigingssysteem mogelijk overstemd wordt door gewoontes, routines en signalen uit de externe omgeving zoals de grootte van het bord en verpakkingen. Onderzoek op dit gebied laat veelvuldig zien dat externe signalen vaak interne signalen van honger en verzadiging overstemmen, waardoor voedselinname toeneemt. Echter kunnen externe signalen ook gebruikt worden om mensen minder te laten eten of om een consumptiemoment uit te stellen, door juist de nadruk te leggen op deze interne honger en verzadigingsgevoelens.

In dit proefschrift staan de volgende twee begrippen centraal: (1) 'satiation', het proces tijdens een maaltijd dat er voor zorgt dat je stopt met eten, en (2) 'satiety', het proces tussen twee maaltijden in, waarbij het volle gevoel na een maaltijd invloed heeft op het tijdstip en de grootte van de volgende maaltijd. We kijken in dit proefschrift naar de invloed van satiation en satiety verwachtingen op voedselinname, zowel tijdens als tussen consumptie momenten. Daarbij onderzoeken we de invloed van interne signalen van honger en verzadiging, claims op verpakkingen en het ontwerp van verpakkingen op satiation en satiety verwachtingen en hun effect op voedselinname. In dit proefschrift gaan we er van uit dat een terugkoppeling van eerdere consumptie ervaringen zeer belangrijk is in de ontwikkeling van satiation en satiety verwachtingen. Maar denken we ook dat het goed mogelijk is dat satiation en satiety verwachtingen op het moment zelf kunnen ontstaan dan wel door expliciete signalen (bijvoorbeeld verzadigingsclaims) of door impliciete signalen (zoals verpakkingen en andere factoren in de eetomgeving).

Dit proefschrift bestaat uit 6 hoofdstukken. *Hoofdstuk 1*, de algemene introductie, bespreekt het wetenschappelijke bewijs op het gebied van externe signalen die interne honger en verzadigingssignalen kunnen versterken of doen verbleken. De invloed van externe signalen op interne signalen wordt besproken voor vijf verschillende fases: start van een consumptie moment, maaltijd planning, tijdens het consumptie moment, einde van het consumptie moment en de tijd tot de volgende maaltijd.

In *Hoofdstuk 2* staat de verzadigingswaarde van snackproducten zoals beleefd door de consument centraal. Daarbij is gekeken naar de gebruikte terminologie en de invloed van de beleefde verzadigingswaarde op de keuze van snackproducten.
Wanneer je tussen de maaltijden in honger krijgt of trek in iets lekkers kan er gekozen worden voor een snackproduct. Bij de keuze van de snack is het van belang dat hongergevoelens afnemen maar ook dat de tijd tot de volgende maaltijd probleemloos kan worden overbrugt.
In dit hoofdstuk is aan deelnemers gevraagd om een product te kiezen aan de hand van een scenario. Scenario's varieerden tussen deelnemers in de zin dat de tijd tot de volgende maaltijd (favoriete diner) niet aan iedereen was verteld en dat bij deelnemers aan wie de tijd wel verteld was, dit kon verschillen tussen 1 uur en 4 uur na de gekozen snack. Deze studie laat zien dat consumenten geen significant verschillende snack product keuzes maken wanneer ze geconfronteerd worden met situaties die verschillen in satiety behoeften. Wel hebben consumenten specifieke ideeën over product onderdelen die de verzadigingswaarde van het gehele product kunnen beïnvloeden. Producten die gezien worden als vet, eiwitrijk, met een zoute smaak en in één stuk hebben volgens de consument een grotere verzadigingswaarde dan zoete producten of producten die uit meerdere delen bestaan.

Hoofdstuk 3 onderzoekt in hoeverre verzadigingsclaims door consumenten over-geïnterpreteerd worden en of consumenten erkennen dat persoonlijke inspanning nodig is om bepaalde verzadigings- en gewichtsverliesvoordelen te kunnen bereiken, die beloofd worden door een claim. De angst bestaat dat verzadigingsclaims niet goed begrepen worden door de consument. Het kan bijvoorbeeld zo zijn dat producten met verzadigingsclaims gezien worden als producten die automatisch leiden tot gewichtsafname, terwijl dit niet wetenschappelijk bewezen is (magic bullet effect). In dit hoofdstuk hebben we

door middel van een internetvragenlijst voor een aantal verzadigingsclaims bekeken of consumenten uit Groot Brittannië, Frankrijk, Duitsland en Italië op basis van de claim voordelen verwachten die door het product niet waargemaakt kunnen worden. Daarnaast hebben we binnen deze studie een nieuwe methode ontwikkeld om het "magic bullet effect" -in hoeverre consumenten verwachten dat verzadigings-gerelateerde voordelen automatisch te verkrijgen zijn bij product gebruik of dat ze daar zelf nog inspanningen voor moeten leveren- te bestuderen. Resultaten laten zien dat over-interpretatie van verzadigingsclaims bijna niet aan de orde is. Over het algemeen begrijpen consumenten wat er in een claim gezegd wordt en zijn ze realistisch in hun gevolgtrekkingen. Consumenten die aan de lijn doen zijn vatbaarder voor over-interpretatie in verhouding tot consumenten die niet lijnen. Alhoewel deze consumenten hogere verwachtingen hebben van verzadigingsclaims begrijpen ze goed dat persoonlijke inspanningen nodig zijn om de effecten te verkrijgen. Dit geldt ook voor de andere consumenten in de steekproef.

Vaak is voorafgaande aan consumptie de verpakking van een voedingsproduct de enige informatie die een consument krijgt. Verschillende onderdelen van de verpakking zoals gewicht, vorm, kleur, afbeeldingen en claims kunnen gebruikt worden om informatie te vergaren en product gerelateerde verwachtingen op te bouwen. In *hoofdstuk 4*, wordt het vermoeden onderzocht dat een verpakking een boodschap kan over brengen aan de consument en daarmee satiation verwachtingen en voedselinname kan beïnvloeden. Twee verpakkingen zijn ontwikkeld voor hetzelfde koekje: een verpakking die het idee moet geven dat het om een licht en makkelijk verteerbaar koekje gaat en een verpakking die het idee moet geven dat het om een zwaarder, satiation versterkend koekje gaat. In een pilot studie zijn deze twee verpakkingen getest op de mate waarin zij satiation verwachtingen genereren in combinatie met een smaak claim ("Nieuw recept, nu nog smakelijker") of een satiation claim ("Extra vezels toegevoegd, daardoor heb je sneller een vol gevoel"). In de hoofdstudie zijn de verpakkingen in combinatie met de claims getest op hun invloed op voedselinname. Resultaten laten zien dat verpakkingen de potentie hebben om satiation verwachtingen te genereren: deelnemers verwachtten minder vol te zitten en schatten een kortere tijd tot het volgende consumptiemoment wanneer ze een lichte verpakking met een smaak claim hebben gezien ten opzichte van alle andere verpakkingsformats. Niet alleen beïnvloedde de verpakking satiation verwachtingen, ook heeft het een effect op voedselinname.

Een satiation versterkende verpakking met een smaak claim beïnvloed voedselinname op dezelfde manier als een lichte verpakking met een satiation claim. Echter tegen onze verwachtingen in, zorgt een satiation versterkende verpakking in combinatie met een satiation claim voor een hogere voedselinname.

In *hoofdstuk 5* wordt satiety in plaats van satiation bestudeerd en ligt de focus op de combinatie van interne en externe satiety signalen en hun invloed op voedselinname tijdens de volgende maaltijd. Zowel interne fysieke signalen als externe signalen hebben invloed op satiety en voedselinname. Al zijn er inmiddels vele signalen geïdentificeerd die effect hebben op voedselinname, het is nog niet helemaal duidelijk in welke combinatie deze signalen de meeste invloed hebben op het verkleinen van porties. In drie studies is onderzocht of de interactie tussen een intern signaal (gemanipuleerde gevoelens van volheid door een 300kcal ontbijt vs. een 600 kcal ontbijt) en een extern signaal (aanwezigheid of afwezigheid van een satiety claim: "Deze muesli bevat extra vezels, daardoor heeft u langer een vol gevoel") een effect heeft op satiety verwachtingen en vervolgens ook calorie inname tijdens de volgende maaltijd kan beïnvloeden. De resultaten van studies 1 & 2 geven aan dat alleen de combinatie van een intern verzadigingsgevoel en een satiety claim, calorie inname tijdens de volgende maaltijd vermindert. Een satiety claim die niet gepaard gaat met een intern verzadigingsgevoel heeft het tegenovergestelde effect in de zin dat deelnemers juist meer calorieën gingen eten tijdens de volgende maaltijd. In studie 3 is het niet gelukt deze resultaten te repliceren in een grotere steekproef.

Hoofdstuk 6, de algemene discussie van dit proefschrift, geeft een overzicht van en reflecteert op de belangrijkste bevindingen uit de verschillende hoofdstukken. Daarnaast worden aanbevelingen voor toekomstig onderzoek, methodologische overdenkingen en limitaties van dit proefschrift bediscussieerd.

Samenvattend verschaft dit proefschrift inzicht in consumenten percepties in relatie tot satiation en satiety en identificeert productonderdelen die invloed hebben op de geschatte verzadigingswaarde van voedingsproducten. Het stelt twee verschillende methodologieën voor om claim (over) interpretatie te meten en laat zien dat verzadigingsclaims, in het algemeen, goed worden begrepen

door de consument. Daarnaast voegt dit proefschrift aan de wetenschappelijke literatuur toe dat verzadigings-versterkende verpakkingen en claims de potentie hebben om voedselinname te beïnvloeden. Het is echter nog altijd onduidelijk onder welke omstandigheden deze externe signalen het meest effectief zijn in het verminderen van voedselinname.

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Els

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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	2010	1.2
Writing Grant Proposals	WGS	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
'Influence of claim verifiability on claim effectiveness: the effect of a satiety claim on consumption'	Conference European Health Psychology Society, Hersonissos, Greece	2011	1
'The influence of claim verifiability on claim effectiveness: the effect of a satiety claim on actual consumption'	Etmaal van de communicatie, Enschede	2011	1
'Consumer understanding, interpretation and perceived personal responsibility in relation to satiety-related claims'	British feeding and drinking group meeting, Brighton	2012	1
Bi-annual presentations IPOP meetings: Satiety & Satisfaction		2008-2012	2

III. Discipline-specific part			
Sensory perception & food preference	VLAG	2011	1
Theories and tools of narrative inquiry	MG3S	2008	1.4
Doctoral seminar on research methods in marketing	EDEN	2009	4
Doctoral seminar on consumer behaviour	EDEN	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 (optional)			
Social psychology	MCB	2009-2010	2
Sensory perception & consumer preference	MCB	2010-2011	2
Total			**32.6**

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