Mind over Stomach: A Review of the Cognitive Drivers of Food Satiation

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ABSTRACT Satiation is the main process that determines when we stop eating; it includes the decrease in sensory enjoyment and the increase in feelings of fullness over the course of eating. The cognitive processes involved in food satiation result from complex interactions between the environment and the body. This review describes how cognition shapes consumers' experience of satiation by following the externality-internality distinction. First, satiation is shaped by external cues related to the perception of food's composition, variety, and quantity. The influence of these external cues suggests that satiation is mentally constructed based on expectancies and beliefs. Second, satiation depends on consumers' awareness of, attention to, and perception of internal (or bodily) signals—whether these internal signals are experienced during a meal, remembered from a past meal, or anticipated for a future meal. This has implications for understanding the role of food marketing in hedonics and overeating.

Satiation is the main process that determines when we stop eating; it includes the decline in eating enjoyment and the increase in feelings of fullness over the course of a meal. Nutrition research has mostly focused on the bodily (gastric and intestinal), hormonal, and neural drivers of satiation, and how they promote energy balance. However, as increased food intake has been one of the main drivers of the obesity crisis (Swinburn, Sacks, and Ravussin 2009), it is important to understand why satiation does not always fulfill its physiological role of regulating the intake of energy. In other words, it is important to understand the cognitive—perceptual, attentional, reflective and memorial—factors that shape food satiation.

In recent years, food satiation—and its cognitive drivers—has seen a surge of interest in consumer psychology research. In fact, some aspects of food satiation can be generalized to most domains of consumption, insofar as consumers' enjoyment of products declines with repeated exposure or usage. This phenomenon is called "diminishing marginal utility" in economics, "adaptation" or "habituation" in psychology, "wearout" in advertising research, or "hedonic treadmill" in well-being research (Redden 2015). Food satiation deserves, however, specific attention because unlike most other products, food is ingested, such that the cognitive processes involved in food satiation result from complex interactions between the environment and the body.

This article specifically focuses on these cognitive processes. Because satiation is more an umbrella term that describes related, but not completely overlapping phenomena, the first part of this article introduces the different concepts and measurement methods of satiation. Then, this article follows the externality-internality distinction which has been at the center of most academic debates on food consumption and overeating (Schachter and Rodin 1974; Rodin 1981; Herman and Polivy 2008). According to this distinction, food consumption can be influenced by external (or environmental) cues related to food, to portion sizes, and to food marketing (Chandon and Wansink 2012), but it can also be influenced by consumers' ability or motivation to attend to internal (or bodily) cues, and in particular hunger. Accordingly, the second part of this article focuses on how satiation is influenced by external cues—related to the perception of food's composition, variety, and quantity. The third part focuses on the factors that influence consumers' awareness of, attention to, and perception of internal signals of satiation—whether these internal signals are experienced during a meal, remembered from a

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JACR, volume 2, number 4. Published online September 21, 2017. http://dx.doi.org/10.1086/693111
 2378-1815/2017/0204-0051$10.00

past meal, or anticipated for a future meal. The conclusion proposes directions for future research.

CONCEPTS AND MEASUREMENT OF SATIATION

Concepts

The term "satiation" is often used as an umbrella to designate different related concepts (see table 1).

Satiation versus Satiety. Satiation is the process that leads to the termination of eating, and satiety is the feeling of fullness or contentment that persists after eating and that suppresses further eating until hunger or appetite returns. Put otherwise, satiation is the dynamic aspect of satiety (Bellisle 2005). Satiation is more relevant when studying the factors that influence meal size and duration, whereas satiety focuses on the factors that influence the duration of the interval between eating episodes, that is, the time needed to "recover from satiety" (Bellisle and Blundell 2013). The distinction between these two concepts is subtle, however, and they have often been used interchangeably, probably because the decrease in food liking and the increase in feelings of fullness influence both the duration of a meal and the duration of the intermeal period (Garbinsky, Morewedge, and Shiv 2014a)

Pleasure versus Fullness: Sensory-Specific Satiety and Alimentary Alliesthesia. Nutrition research has extensively studied the physiological signals that promote physical (or somatosensory) fullness: the increase in gastric volume when food reaches the stomach, the intestinal signals when nutrients are digested and absorbed, and the fluctuations in hormones (ghrelin and leptin) which communicate to the brain the level of fat storage in the body (for a review, see Benelam 2009).

It is crucial to emphasize, however, that from either a physiological or a psychological standpoint, satiation does not only refer to an increase in fullness, but also a decline in enjoyment. At least two distinct forms of hedonic phenomena are associated with satiation: sensory-specific satiety (SSS; Rolls et al. 1981) and alimentary alliesthesia (AA; Cabanac 1971).[1] While both describe a decline in enjoyment, their occurrence is driven by different mechanisms and temporalities, and their relation to "fullness" is different as well.

In AA, the decrease in pleasantness comes from gastrointestinal receptors, it occurs after a certain quantity of food has been eaten, and the organism's energy needs have been satisfied (i.e., when the organism returns to "homeostasis"). In simple terms, eating is more pleasant when one feels hungry rather than full. SSS is much faster than AA; the decrease in pleasantness comes from orosensory receptors, and it occurs as soon as the subject starts eating (i.e., the first bite is the most pleasurable, then each subsequent bite is less pleasurable). In contrast with AA, SSS does not rely on food entering the stomach or the intestine, is unrelated to energy needs, and is not accompanied by feelings of fullness. For instance, SSS can occur at least in part when the food is not swallowed but only chewed or smelled (Rolls and Rolls 1997).

Another important difference between SSS and AA is that SSS is "specific" to a certain flavor, whereas AA is general. Imagine eating a chocolate cake: after a few bites, the taste, smell, and texture of chocolate start being less and less pleasant up to a point where you stop eating the cake. Still, you would enjoy the (different) flavor of an apple pie—this is sensory-specific satiety. Now imagine that you've eaten a chocolate cake and an apple pie, and you feel full to the point that even the (different) flavor of a cheesecake is unpleasant—this is alimentary alliesthesia. Hence, SSS may contribute to meal interruption if the available food is monotonic in flavor, but it can also promote meal continuation when various flavors are available.

Table 1. Satiation and Related Concepts

Satiation. Process that leads to the termination of eating, including decrease in enjoyment and increase in feelings of fullness.
Satiety. Feeling of fullness or contentment that persists after eating and that suppresses further eating.
Recovery from satiety. Return of hunger or appetite after eating.
Sensory-specific satiety. Declining enjoyment when repeatedly exposed to a certain flavor, and renewal in enjoyment when exposed to a new flavor.
Alimentary alliesthesia. Declining enjoyment of any flavor when energy needs have been satisfied and/or when physically full.
Sensory habituation. Declining appetitive responses when repeatedly exposed to a certain flavor, and renewal in appetitive responses when exposed to a new flavor.

1. Less focal to this article, a third type called "conditioned satiety" occurs when a flavor, ingested on a full stomach, is followed by an aversive digestive event ("bloat"), leading to the avoidance of that flavor for a period of time. Although this phenomenon has mostly been demonstrated in animals, there is a debate whether it can influence humans' meal size decisions (Booth 2009b).

Satiation versus Habituation. The concept of habituation has been studied in a large variety of consumption domains, including food. Whereas food satiation describes the decrease in food liking with repeated intake, food habituation describes the decrease in food wanting. Wanting here refers to appetitive responses to foods, measured by people's motivation to acquire food, by attentional biases, or by salivation. Although wanting and liking are correlated, and so are habituation and satiation (Booth 1991), they are distinct phenomena. For instance, it is the decline in liking (but not wanting) for a food at the end of a consumption episode that predicts how many days will pass until consumers want to eat the food again (Garbinsky et al. 2014a).

Further, research in neuroscience suggests that liking and wanting rely on different neural circuitries and may be dissociated. For instance overeating and obesity may be caused by greater wanting dissociated from liking (Berridge 2009). Likewise, compared with lean subjects, obese subjects exhibit slower rates of habituation but do not necessarily differ in satiation (Pepino and Mennella 2012).

Measurements

Different methods have been used in nutrition and consumer behavior research to measure satiation. They focus on different aspects, such as meal termination, fullness or enjoyment dynamics.

Ad Libitum Food Intake. One of the most common methods is ad libitum food intake. It consists of allowing moderately hungry subjects to eat a food available in unlimited quantity and measuring how much is eaten.

The main drawback of this method is that even in a laboratory environment, the effect of a manipulated factor (e.g., food type, cognitive intervention) on ad libitum intake can be explained by other factors than decreased enjoyment or increased fullness, such as dietary restraint or social norms (Mattes et al. 2005). It is therefore important to collect self-reported responses (e.g., enjoyment, fullness) at the beginning and the end of the meal. These responses are typically measured with Likert scales or Visual Analogue Scales. More sophisticated scales, such as the Hedonic General Labeled Magnitude Scale (Bartoshuk, Snyder, and Duffy 2006) or the Satiety-Labeled Intensity Magnitude (Cardello et al. 2005), offer better control for individual variations, but these scales have not yet been used in consumer behavior research (for more details on scales, see Flint et al. 2000; Booth 2009a).

The Preload Method. In a preload design (Livingstone et al. 2000), subjects sample a "preload" food where the variable of interest is manipulated. Then, after a predetermined period of time, ad libitum food intake is measured along with self-reported responses. This period of time is generally shorter than 30 minutes if sensory, cognitive, or gastrointestinal factors are of interest, and longer for postabsorptive factors (Benelam 2009).

Notice that this method focuses more on satiety (i.e., the feeling of fullness or contentment after one eating episode and its impact on a subsequent eating episode) than on satiation. Although this design avoids many of the confounding effects of the ad libitum food intake method, it has seldom been used in consumer behavior research.

"Constrained" Food Intake and Eating Enjoyment. When studying sensory-specific satiety, a common method, extensively used in consumer research, is to "constrain" moderately hungry subjects to eat a fixed quantity of food and to measure the self-reported enjoyment of the first bite, the last bite, and sometimes intermediary bites. The effect of the manipulated variable is assessed by comparing the magnitude of the drop in enjoyment from the first to the last bite across experimental conditions.

Even when the quantity is fixed, potential confounds can arise from differences in bite sizes and eating pace across participants and across conditions (Galak, Kruger, and Loewenstein 2013; Ferriday et al. 2016). To avoid these confounds, researchers often use bite-size foods (e.g., M&M's) and more or less overtly impose an eating time interval (e.g., finishing the portion while watching a 10-minute video clip).

The residual desire to eat can also be assessed as a second measure of satiation, for instance by letting participants take away as much food as they want (e.g. Galak, Redden, and Kruger 2009) or by letting them eat ad libitum after the first constrained consumption episode (e.g. Galak et al. 2013).

MINDLESS SATIATION: THE ROLE OF EXTERNAL CUES ON SATIATION

Satiation is naturally influenced by the composition, the variety, and the quantity of food consumers eat. However, this influence largely depends on the presence of cues that make composition, variety, or quantity perceptually more salient, suggesting that satiation is mentally constructed based on expectancies.

Food Composition

Research in nutrition has extensively studied the impact of food composition on satiety (for a review, see Benelam 2009). Overall, proteins seem to be more satiating than other macronutrients; high-protein (vs. low-protein) preloads reliably lead to lower food intake and greater feelings of fullness (Halton and Hu 2004). On the other hand, consumers tend to satiate less on foods high in fat and sugar, probably because these foods are more "palatable," and palatability acts on hedonic pathways in the brain that increase the drive to consume more (Drewnowski 1995; Rolls and Hammer 1995; Berthoud 2007). Holding macronutrient composition constant, the actual amount of calorie in a meal seems to have a very marginal impact on satiety. Indeed, incorporating water or air to food in order to increase its volume without affecting its calorie content or macronutrient composition will generally lead to decreased intake and increased self-reported fullness (Rolls et al. 1998; Rolls, Bell, and Waugh 2000).

In the studies mentioned above, the participants are "blind," meaning that they are not informed of food's composition. In contrast, consumer research has investigated how labels that impact perceived (but not actual) food composition influence satiation. While the overconsumption of foods labeled as "low fat" or "low calorie" is often explained by licensing effects (e.g., Wansink and Chandon 2006), perceived satiety may also play a role. Several studies show that consumers report feeling hungrier (less sated) and consume more food after sampling a preload labelled as "low fat," "low sugar," "low calorie," or simply "healthy," versus the same preload without the label (Caputo and Mattes 1993; Shide and Rolls 1995; Finkelstein and Fishbach 2010; Vadiveloo, Morwitz, and Chandon 2013). These effects are likely driven by implicit beliefs and expectancies that "healthy" foods are less filling than "unhealthy" foods (Suher, Raghunathan, and Hoyer 2016). Further, these expectancies may play a causal role in the satiety experienced after a food has been consumed, even in the absence of a physiological effect (Brunstrom et al. 2011; Plassmann and Wagner 2014).

Interestingly, foods high in fat and sugar seem less satiating based on physiological effects (Rolls and Hammer 1995) but more satiating based on expectancy effects (Suher et al. 2016). This discrepancy and the origin of expectancies are addressed in the "future directions" section.

Variety

Numerous studies show that restricting the variety of foods in a meal reduces consumption, while increasing variety stimulates energy intake. For instance, people eat 40% more calories when a four-course meal has different foods rather than the same food for each course (Rolls, Van Duijvenvoorde, and Rolls 1984). This is because the decline in sensory enjoyment over the course of a meal is much slower when the meal has varied flavors, compared to when it has monotonic flavors (i.e., variety slows down sensory-specific satiety; Rolls et al. 1981). For instance, the decline in enjoyment of popcorns eaten ad libitum is delayed when briefly interrupting popcorn consumption with a chocolate (Hetherington et al. 2006). Also, any new flavor within a meal "resets" appetitive responses (i.e., it avoids habituation; Epstein et al. 2009). For instance, repeated olfactory presentation of a cheeseburger leads to a decline in salivary response, but this response recovers when a new scent (that of an apple pie) is presented (Epstein et al. 2003). Overall, sensory-specific satiety and sensory habituation have a large influence on variety seeking behaviors; for instance, consumers are more likely to switch between sensory attributes (e.g., flavor) than nonsensory attributes (e.g., brand) when shopping for foods (Inman 2001).

Perceived (rather than actual) variety also plays a role, further suggesting that satiation is mentally constructed based on expectancies. For instance, the decline in taste pleasantness of M&M's is delayed when eating M&M's of different (vs. similar) colors, and the decline in taste pleasantness of pastas is delayed when eating pastas of different (versus similar) shapes, even though color and shape have no impact on food taste (Rolls, Rowe, and Rolls 1982). Similarly, consumers satiate more slowly (as measured by drop in liking) on jellybeans when merely their labels emphasize their different flavors (Redden 2008). Encouraging consumers to pay attention sequentially to each different flavor of a complex food can slow down, and even reverse, the drop in enjoyment (Crolic and Janiszewski 2016). The effect of satiation on variety-seeking also depends on habits: consumers selectively seek foods that are perceived as complementary to the food they've already eaten, such as seeking peanut butter after jelly (Huh, Vosgerau, and Morewedge 2016).

Portion Sizes

When offered actual larger amounts of food, people almost systematically eat more without feeling more sated and without compensating for it during the next eating episode (for a review, see Zlatevska, Dubelaar, and Holden 2014). In a famous study, participants ate 73% more soup when eating from "self-refilling" bowls that imperceptibly refilled as their contents were consumed, and these participants did not perceive themselves as more sated than those eating from normal bowls (Wansink, Painter, and North 2005). A larger portion increases satiety only if information or visual cues emphasize the increase in food quantity (Brunstrom et al. 2012). In fact, size labels may affect satiety even when actual quantity is held constant. For instance, calling the same portion "small" (rather than "medium" or "large") will result in a perception of smaller size, greater consumption but less perceived consumption (Aydinoglu and Krishna 2011).

This "portion size effect" is generally explained by the fact that portion sizes act as external social norms about what is considered typical or acceptable (Herman and Polivy 2008), and these external cues directly impact consumers' perceived satiety (Wansink, Payne, and Chandon 2007). Importantly, the portion size effect does not replicate among children below 3 years, who eat a consistent amount regardless of portion sizes (Birch, Engell, and Rolls 2000). Parental behavior, such as pressuring children to "clean their plate," may be in part responsible for consumers' inability to internally control their energy consumption in the long run (Savage, Fisher, and Birch 2007).

MINDFUL SATIATION: THE FACTORS THAT AFFECT ATTENTION TO AND PERCEPTION OF INTERNAL CUES OF SATIATION

As detailed in the previous part, satiation is largely influenced by external cues. This means that consumers may fail to rely on internal signals of satiety. A large body of research suggests that the "bodily" experience of satiation may also depend on consumers' attention to or perception of internal signals, whether these signals are experienced during a meal, remembered from a past meal, or anticipated for a future meal.

Mindful Eating and Satiation during a Meal

Consumers generally eat more when watching television, listening to music, or in the presence of others, because distraction decreases reliance on internal satiety signals (for a review, see Robinson et al. 2013). Conversely, attending to and reflecting on internal signals—and in particular signals that indicate a decrease in sensory enjoyment—can help consumers reduce their food intake (Tapper 2017). For instance, participants instructed to eat a food "until the pleasantness of the flavor subsided" ate less than participants instructed to eat "until the stomach felt full" or than participants watching television while eating (Poothullil 2002, 2005).

Relatedly, "mindfulness-based interventions" are increasingly used for weight management and refer to practices aiming to increase awareness of the thoughts, feelings, and sensations experienced while eating. In a systematic review of 19 mindfulness-based workshops and training sessions for weight loss, 13 of these showed significant weight reductions (Olson and Emery 2015). However, because of the wide range of practices that are referred to as mindfulness, it is difficult to identify a unique mechanism of action (Tapper 2017). The effect of mindfulness training on weight loss may be explained by a better reliance on internal signals of satiation (sensory enjoyment and fullness) but also by a better ability to control appetitive impulses (Papies et al. 2015). Also, mindfulness may change consumers' "eating topography," which refers to eating speed, bite size, interbite interval, and number of chews. Several experimental studies have shown that eating at a slower rate promotes self-reported fullness and reduces energy intake without compensation effect (Ferriday et al. 2013, 2016). In fact, consumers seem to spontaneously eat mindfully (more slowly and more attentively) when given a smaller portion than expected, in order to "adjust" their level of satiation to the portion size (Areni and Black 2015). However, because recovery from sensory-specific satiety can be fairly rapid, slow eating (i.e., longer breaks between each bite) may also reduce sensory-specific satiety (Galak et al. 2013).

"Memory" of a Past Meal and Its Impact on Satiety

A large body of research has shown that internal feelings of satiation are at least partially constructed in the moment, depending on how well consumers remember their most recent eating episode. Anything that disrupts or weakens the formation (i.e., the encoding) of a meal memory will impact postmeal satiety, recovery from satiety, and thus subsequent energy intake. For instance, amnesiacs may eat multiple meals because they simply don't remember their previous eating episode (Rozin et al. 1998; Higgs et al. 2008). Further, being distracted while eating (e.g., eating in front of the television) not only increases energy intake during the eating episode but also reduces the memory of the meal and increases energy intake during a subsequent eating episode (for a review, see Robinson et al. 2013). Conversely, eating while focusing on the sensory qualities of the food not only promotes satiation during the eating episode but also improves the formation of eating memories, leading to reduced food intake later on (Higgs and Donohoe 2011).

Not only the formation but also the retrieval of memories about a past eating episode plays a role. For instance, asking consumers to write about the meal they had earlier leads them to eat fewer snacks subsequently (Higgs 2002). Memory retrieval can also be "nudged." Asking consumers to indicate when they last ate on a scale ranging from "one month ago" (vs. "one day ago") to "right now" makes them perceive the temporal distance between meals as shorter and leads to a decrease in subsequent consumption (Galak et al. 2014). Also, contracting eyebrows while recalling eating a food (making the recall task "seem" more difficult) increases the desire to consume this food again (Redden and Galak 2013). Recalling the variety (vs. the monotony) of a past eating consumption makes participants enjoy subsequent eating more (Galak et al. 2009).

Memory also influences the decision to wait before eating. Garbinsky, Morewedge, and Shiv (2014b) suggest that the decision to repeat the consumption of a food is influenced by the memory of the last bite of that food, which is the least pleasant of all bites according to satiation effects. Hence, inviting consumers to recall the enjoyment of the first bite (i.e., the most enjoyable one) can make them recover more quickly from satiety and wait a shorter time before eating the food again.

Mental Simulation of Satiation: A Role for Meal Planning

Before eating or choosing what to eat, consumers often imagine (or mentally simulate) eating that food. Mental simulation is defined by Barsalou (2008) as the mental "reenactment of perceptual, motor, and introspective states acquired during experience with the world, body, and mind" (for a review, see Krishna and Schwarz 2014). Research has shown that some form of directed mental simulation could reproduce the effects of sensory-specific satiety. For instance, imagining eating one M&M 30 times in a row decreases the desire to eat M&M's, but it does not affect the desire to eat other types of foods (Morewedge, Huh, and Vosgerau 2010). Likewise, repeatedly rating or choosing among 60 foods shown in pictures decreases the actual enjoyment of foods that share a similar taste, but not the enjoyment of foods with different tastes (Larson, Redden, and Elder 2014).

Also, consumers generally plan—and try to anticipate satiation from—the quantity of food that they intend to eat (Brunstrom and Rogers 2009). However, these anticipations are generally poor: when choosing among different portion sizes of food, consumers fail to anticipate that small portions can actually be more pleasurable than larger ones—because it is the last bite of food (which is all the less enjoyable as the portion is larger) that determines overall evaluation (Rode, Rozin, and Durlach 2007; Garbinsky et al. 2014b). Cornil and Chandon (2016a) show that a specific form of mental simulation, which they call "multisensory imagery," can improve satiation anticipations. Vividly imagining the multisensory enjoyment of foods (taste, smell, texture) before choosing a portion size of a similar food can lead consumers to better anticipate that smaller portions deliver higher sensory enjoyment than larger portions and therefore to choose smaller portions while anticipating greater pleasure from it.

CONCLUSION: FUTURE DIRECTIONS

This article has described how cognition shapes consumers' experience of satiation and the consequences on food enjoyment and intake. The perceived (rather than actual) characteristics of foods strongly influence satiation, suggesting that satiation is shaped by expectancies and beliefs. Also, satiation depends on consumers' attention to or perception of internal signals—during a meal, from a past meal, or in anticipation for a future meal. The final section points out areas where little research has been done and further research is needed.

The Role of Marketing Actions

As mentioned in this article, health labels and portion size cues can influence satiation. Future research should investigate the impact of other marketing variables, and in particular calorie labeling (indicating the calories that food contains), advertising, and pricing.

The impact of calorie labeling on food intake has been largely debated in food research. In a recent meta-analysis (Long et al. 2015), calorie labeling was found to lead to a small but statistically significant reduction in the calories ordered or purchased per meal. However, no study has examined whether this decrease in food intake could be at least partly mediated by satiation. For instance, it is possible that calorie labeling draws attention to the food, rather than to the environment, reduces distraction and thus increases awareness of satiation signals.

Likewise, research has extensively studied the impact of food advertising. In particular, food advertising increases the drive to eat by activating hedonic pathways in the brain

(Kavanagh, Andrade, and May 2005) and may also increase expected and experienced eating enjoyment (Elder and Krishna 2010; Krishna, Morrin, and Sayin 2014). The impact of advertising on satiation deserves however more attention—it is possible that it also decreases awareness of satiation signals.

Finally, research has investigated the impact of pricing on food enjoyment, but its impact on satiation is less known and difficult to predict. On the one hand, high price tags (just like advertising) increase expected and experienced enjoyment (Plassmann et al. 2008), which may consequently slow down satiation. In this vein, Sevilla and Redden (2014) show that portraying a food as "rare" decreases consumers' attention to satiation signals; thus, one could expect the same consequences when presenting a food as "expensive." On the other hand, it is also possible that consumers become more mindful when eating expensive foods—such as when savoring foods at high-end restaurants—which should consequently increase reliance on satiation signals.

The Origin of Expectancies about Satiation

As mentioned in this article, consumers have specific expectancies about the satiating properties of foods (Brunstrom 2011), and these expectancies do not necessarily tally with physiological findings (e.g., foods high in fat and sugar are expected to be more filling that they actually are). Still, expectancies about the perceptual and behavioral effects of foods and drinks have a "real" impact on consumption experiences (Plassmann and Wagner 2014), even when these expectancies are inconsistent with physiological effects (Cornil, Chandon, and Krishna 2017).

However, it is unclear how beliefs and expectancies about satiation effects are shaped. Redden and Haws (2013) point at the role of motivation. They show that consumers higher in trait self-control satiate faster (measured by drop in desire) on foods portrayed as unhealthy versus foods portrayed as healthy, perhaps because high self-control consumers train themselves to enjoy healthy foods more and unhealthy foods less. On the other hand, Suher et al. (2016) point at the role of differentiated consumption experiences: it is likely that people more frequently consume unhealthy (vs. healthy) food to the point where they feel full, and therefore develop implicit associations between "unhealthy" and "more filling." This idea is consistent with findings that eating a food to satiation increases its perceived fillingness (Irvine et al. 2013). More research should investigate this question.

The Evolutionary Function of Satiation in an Evolving World

It is interesting to question the function of satiation in today's food environment. Early nutrition research has extensively studied satiation in relation to the process of energy homeostasis. Through this process, food intake is adjusted over time in a way to promote stability in the amount of fat in the body, and satiation signals ensure that the body reaches a desired homeostatic state of balance (Cabanac 1971). Likewise, sensory-specific satiety (and its impact on variety seeking) may also fulfill an evolutionary function: ensuring the consumption of various nutrients, present in foods with different flavors (Rolls 1981). In fact, all animals exhibit sensory-specific satiety, and in particular omnivores (Rolls 1986)

Over the past 40 years, the food environment has changed drastically, at least in the developed countries. With the technological advances in agriculture and industry, extremely varied and highly palatable foods are widely available and affordable. The homeostatic processes seem less and less relevant to understand food consumption, which is increasingly driven by desire rather than need for calories and nutrients (Stroebe, Papies, and Aarts 2008).

A particularly important research question is how consumers can adapt to this "obesogenic" environment. While cognitive restraint is particularly difficult when surrounded by palatable food cues (Stroebe et al. 2013), behavioral research has focused on the role of "nudges" and small changes in the eating environment such as package downsizing, smaller dinnerware, reduced visibility and convenience (Wansink and Chandon 2014), as well as size labels and container shapes (Raghubir and Krishna 1999; Aydinoglu and Krishna 2011). It would be interesting to study the impact of redesigned food environments on food satiation.

Behavioral Interventions and Consumer Welfare

Consumer research has mostly focused on interventions designed to avoid satiation because it is associated with an ongoing decrease in enjoyment, for example, by managing interruptions or by increasing the perception of variety (e.g., Redden 2008; Galak et al. 2009, 2013; Quoidbach and Dunn 2013; Crolic and Janiszewski 2016). However, satiation does not necessarily decrease the overall enjoyment of a meal, as long as consumers stop eating when it is not pleasurable anymore. In fact, satiation may be perceived as a process that allows both limiting food intake and preserving overall enjoyment (Cornil and Chandon

2016a). Future research should therefore focus on behavioral interventions that increase, rather than avoid, the awareness of satiation. This can be done by focusing on three principles (Robinson et al. 2013): avoiding distracting stimuli while eating, enhancing memory and prompting memory recall of food previously eaten, and increasing awareness of food being consumed or about to be consumed. The same principles can actually be applied in other consumption domains (e.g., information, social media, TV series), where consuming with more parsimony (or avoiding "bingeing") may improve consumer welfare.

Pleasure as an Ally for Portion Control?

Related to the previous point, pleasure might not be the enemy of healthy eating. A higher cognitive focus on sensory enjoyment can reduce ad libitum food intake (Poothullil 2005), improve the formation of eating memories (Higgs and Donohoe 2011), and lead to the choice of smaller portion sizes (Cornil and Chandon 2016a). This is partly because of an increased awareness of satiation, which makes smaller meals (as long as variety is somewhat limited) more pleasurable.

In line with these findings, several cross-cultural studies found that portion sizes and obesity rates are both lower in cultures that strongly value eating pleasures, like France and Japan (for a review, see Rozin 2005). Wansink et al. (2007) observe that, in these pleasure-oriented cultures, people pay less attention to external signals of satiation (such as stopping to eat when the plate is empty or when the television program is over) and more on internal signals (fullness, decreased enjoyment). Likewise, "Epicurean eating pleasure tendencies," a personality trait that characterizes consumers who value the sensory and aesthetic dimensions of foods, correlate with preferences for smaller portion sizes and higher well-being (Cornil and Chandon 2016b)

A better understanding of satiation also means a better understanding of food enjoyment, suggesting that we need to continue to shift the paradigm of behavioral food research from "food as health" to "food as well-being" (Block et al. 2011; Askegaard et al. 2014).

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