PLEASURE AS A SUBSTITUTE FOR SIZE: HOW MULTISENSORY IMAGERY CAN MAKE PEOPLE HAPPIER WITH SMALLER FOOD PORTIONS

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Research on overeating assumes that pleasure must be sacrificed for the sake of good health. Contrary to this view, the authors show that focusing on sensory pleasure can make people happier and willing to spend more for less food, a triple win for public health, consumers and businesses alike. In five experiments, American and French adults and children were asked to imagine vividly the taste, smell and oro-haptic sensations of three hedonic foods prior to choosing a portion size of another hedonic food. Compared to a control condition, this “multisensory imagery” intervention led hungry and non-dieting people to choose smaller food portions, yet they anticipated greater eating enjoyment and were willing to pay more for them. This occurred because it prompted participants to evaluate portions based on expected sensory pleasure, which peaks with smaller portions, rather than on hunger. In contrast, health-based interventions led people to choose a smaller portion than the one they expected to enjoy most—a hedonic cost for them and an economic cost for food marketers.

Key words: food consumption, health, portion size, nutrition, mental imagery, hedonic consumption, hedonic forecasting.
“A wise person does not simply choose the largest amount of food but the most pleasing food.”

Epicurus (341-270 BC), Letter to Menoeceus

In most fast-food restaurants and on an increasing number of other eating occasions customers ordering a beverage or dessert have to choose between different portion sizes. Most portions are much larger than the USDA recommended serving size, contributing to overeating, obesity and food waste (Hall et al. 2009; Ledikwe et al. 2005; Nestle 2003; Rolls et al. 2007; Zlatevska et al. 2014). So the question is, how can we encourage people to choose—and actually prefer—smaller food portions, and can we do it without hurting either eating enjoyment or food sales?

To curb supersizing, governments and public health institutions have advocated portion size limits and health appeals (warnings, food labelling) designed to encourage people to trade off the expected enjoyment of hedonic foods against the health benefits (Belei et al. 2012; Raghunathan et al. 2006; Shiv and Fedorikhin 1999). Such efforts have had limited success because they come at a hedonic cost for consumers who like to eat larger portions of pleasurable foods (Patterson et al. 2001), and imply an economic cost for food marketers who typically extract higher profits from larger portions (Dobson and Gerstner 2010).

This research explores ways to make people who have already decided to eat a hedonic food, actually prefer (not just choose) smaller food portions, at no hedonic cost to themselves and no economic cost to producers. Challenging the assumption that sensory pleasure is the enemy of healthy eating, we design and test a new intervention, multisensory mental imagery, as an alternative to health warnings. Our intervention asks people to vividly imagine the multisensory pleasure (taste, smell, texture) of three hedonic foods prior to choosing the size of another
hedonic food, and can be implemented with simple instructions or with more vivid menu
descriptions. A series of experiments show that multisensory imagery leads people (as long as
they are not sated or dieting) to choose smaller portions of chocolate cake or soft drinks
compared with a control condition. This effect was replicated among children and adults, and
among French and American consumers. We also show that, unlike health warnings,
multisensory imagery makes consumers expect at least as much enjoyment from (and willing to
pay at least the same price for) the smaller portions chosen compared with the larger portions
chosen in a control condition. As smaller portions are actually more enjoyable, multisensory
imagery improves the calibration between expected and actual enjoyment.

Our proposed mechanism is that multisensory imagery helps people realize that sensory
pleasure peaks with smaller portions and declines with larger portions, a phenomenon called
sensory-specific satiation. Further, multisensory imagery increases the relative importance of
sensory pleasure when choosing portion sizes and reduces the relative importance of otherwise
more salient criteria of choice like hunger or dieting constraints for dieters. By default (i.e. in a
control condition), people naturally choose large food portions when they are hungry and not on a
diet, and smaller food portions when they are sated or on a diet. Hence, because focusing on
sensory pleasure enhances the appeal of smaller portions, sensory imagery leads hungry and non-
dieting people (i.e., most restaurant patrons) to choose smaller portions than in the control
condition when they would normally focus on satisfying their hunger. However, sensory imagery
does not have this effect when people are sated or dieting and therefore already choose small
portions in the control condition.

In sum, compared with health warnings, focusing on sensory pleasure can achieve a better
balance between consumer enjoyment, business goals, and public health. Our research offers
suggestive support for an intervention that may achieve a “greater good” in the real world, although future research is needed to test the size and reliability of the effect in more realistic settings. Our findings contribute to the debate on the sustainability of the food industry—particularly fast-food restaurants—notably its ability to grow without exacerbating the obesity epidemic (Chandon and Wansink 2012; Ludwig and Nestle 2008). They extend research on ‘mindful eating’ (Kidwell et al. 2008; Papies et al. 2012), which focuses on impulsive eating but has neglected portion size choice. They also advance our understanding of the behavioral consequences of simulated eating, showing that some kinds (multisensory imagery) can increase the anticipated pleasure of eating whereas others (repeated simulated eating) reduce it (Larson et al. 2014; Morewedge et al. 2010). Overall, our results are in line with the movement advocating a paradigm shift from “food as health” to “food as well-being” and with the call for pleasure to be given a more holistic and positive role in food consumption (Block et al. 2011).

**CONCEPTUAL BACKGROUND: MULTISENSORY PLEASURE AND PORTION SIZE**

While the current obesity epidemic is largely driven by ever-increasing food portion sizes, public policy and related research efforts tend to focus on what people choose to eat instead of how much they choose to eat (Chandon and Wansink 2012). In particular, the role of sensory pleasure on portion size choice (once people know what they want to eat) is not well understood.

*Portion Size Preferences: The Role of Hunger, Health, and Sensory Pleasure*

When choosing between a small or large food portion, leaving aside price considerations, consumers are influenced by at least three expectations: (1) “Will it satiate my hunger?” (2) “How will it impact my health and weight?” and (3) “How pleasurable will it be?”
Hunger obviously leads people choose larger portion sizes (Herman and Polivy 1983). Indeed, portion size choice is governed primarily by expectations of the food’s capacity to satiate one’s hunger (Brunstrom 2014; Brunstrom and Rogers 2009; Brunstrom and Shakeshaft 2009). However, hunger is not the only factor influencing portion choice (Herman and Polivy 2014); concerns about health also influence food choices and portion size choices, particularly for chronic dieters (Glanz et al. 1998; van Strien et al. 1986), or when prompting people to think about their health and weight (Giuliani et al. 2013). For example, providing calorie and nutrition information can reduce the calorie count of food ordered in fast-food restaurants – although it is unclear whether this reduction comes from choosing smaller portions as opposed to choosing different types of food (Bollinger et al. 2011; Harnack and French 2008).

The expectation of sensory pleasure has been found to influence what food people choose to eat (e.g. Raghunathan et al. 2006) but its effect on portion size choice (when different sizes of the same food are available) is less well understood. While most food ads, especially those for fast-food restaurants, suggest that consuming more food will bring more pleasure (Harris et al. 2010), research on the physiology of eating suggests the exact opposite: Sensory pleasure peaks at the first few mouthfuls and declines with each additional mouthful. This phenomenon, called sensory-specific satiation, is clearly distinct from hunger satiation and is experienced by adults and infants alike (Mennella and Beauchamp 1999; Rolls et al. 1981), particularly for hedonic foods (Redden and Haws 2013; Sorensen et al. 2003).

Sensory-specific satiation does not simply mean that later bites are enjoyed less than the first one (i.e., marginally diminishing pleasure); it also means that smaller portions can actually be more enjoyable than larger ones. This is because the overall retrospective enjoyment of a food is not an accumulation of pleasure from each bite but actually the average pleasure over all bites
(Rode et al. 2007; Tully and Meyvis 2014; van Kleef et al. 2013), or even perhaps only the pleasure experienced in the last bite (Garbinsky et al. 2014). But regardless of whether it is influenced by the last or the average bite, the retrospective overall eating enjoyment is lower after large food portions than smaller ones.

There is a lot of research on how to prevent pleasure satiation, for example by managing interruptions (Galak et al. 2013; Galak et al. 2009; Quoidbach and Dunn 2013; Redden 2008), but somewhat less on how sensory-specific satiation can help maximize enjoyment by consuming less. While studies on mindful eating have shown that training people to pay more attention to their emotions and sensations while eating can reduce impulsive eating (Kristeller and Wolever 2010; Poothullil 2002), they have overlooked the effect of mindfulness on expected eating enjoyment and pre-intake portion size preferences. Yet studying portion size choices is important because once chosen, people tend to eat the whole portion even when they are no longer hungry (for a review, see Zlatevska et al. 2014). Moreover, mindful eating training can take up to 45 minutes and may require too much concentration to be applied to the 200 food decisions that consumers typically make each day (Wansink and Chandon 2014).

To summarize, existing research suggests that hunger leads people to prefer larger portions, whereas a health focus or dieting tendencies prompt them to choose smaller portions but expect less eating enjoyment. Focusing on sensory pleasure should, we predict, lead people to prefer smaller portions (because they provide the most pleasurable sensory experience), but the association between sensory pleasure expectations and choice of portion size is not well understood. In the following section we describe a short intervention that applies mindful eating techniques to simulated (vs. actual) consumption and explain how it increases the preference for smaller portions.
**Hypotheses: Portion Size Choice**

We design a new intervention, “multisensory mental imagery”, which consists in encouraging consumers to vividly imagine the multisensory pleasures (aroma, taste and texture) that they would experience from eating familiar hedonic foods. This deliberate form of imagery (Krishna and Schwarz 2014) is designed to mentally simulate the multisensory hedonic experience of eating indulgent food, be it in a restaurant or school setting (e.g., through imagery-rich descriptions on the menu).

Our intervention is based on mental imagery because imagined attributes are more immediately used as the criteria of choice and evaluation (Holbrook and Hirschman 1982; McGill and Anand 1989). By focusing on sensory pleasure, multisensory imagery should therefore increase the relative importance of sensory pleasure over other criteria such as hunger or dieting in driving portion choice. Furthermore, there is much evidence that simulating eating through mental imagery emulates the mental processes (emotions, cognition, sensations) engaged in actual eating (Barsalou 2008; Elder and Krishna 2012; Krishna and Schwarz 2014; Morewedge et al. 2010). By emulating these mental processes, mental imagery helps people reconstruct past experiences as well as more vividly and accurately anticipate future experiences (Hoeffler 2003; Moulton and Kosslyn 2009). Multisensory imagery should therefore help them anticipate greater sensory pleasure from smaller portions.

Our suggested mechanism is therefore that multisensory imagery will increase the relative importance of sensory pleasure when choosing portion sizes and reduce the relative importance of otherwise more salient criteria like hunger or dieting constraints for dieters. By default (i.e. in the control condition), people choose large food portions when they are hungry and not on a diet, and smaller portions when they are sated or on a diet. Hence, because focusing on sensory
pleasure enhances the appeal of smaller portions, sensory imagery should lead hungry and non-dieting people to choose smaller portions than in the control condition when they normally focus on satiating their hunger. However, sensory imagery should not lead consumers to reduce portion size when they are sated or dieting and therefore already choose small portions in the control condition. Formally:

H1a. Compared to a control condition, multisensory imagery leads hungry people (but not sated people) to choose smaller food portions.

H1b. Compared to a control condition, multisensory imagery leads normal eaters (but not dieters) to choose smaller food portions.

Hypotheses: Expected Enjoyment of Eating Small vs. Large Portions

Another important aspect of our proposed mechanism is that multisensory imagery modifies the expected enjoyment of eating different portion sizes. In general, expectations of hunger relief lead hungry people to expect greater eating enjoyment from larger portions (Cabanac 1971; Cabanac 1985). However, sensory pleasure, which actually peaks with smaller portions, can also influence the expected eating enjoyment. Hence, focusing on sensory pleasure (through multisensory imagery), should make people evaluate the enjoyment anticipated from eating different portions from a sensory pleasure standpoint rather than from a hunger relief standpoint, and therefore anticipate greater enjoyment from smaller portions. This implies that multisensory imagery should make hungry people expect at least as much enjoyment (and be willing to pay at least the same price) for a smaller portion they choose, compared to the larger portion chosen in the control condition.

These are important predictions, because they rule out the alternative explanation that multisensory imagery mentally satiates people by simulating consumption (Larson et al. 2014;
Morewedge et al. 2010). Research on simulated satiation showed that asking people to imagine eating one M&M 30 times in a row, or to evaluate the expected taste of 60 snacks in a row, makes them eat less in a subsequent taste test. Whereas both interventions rely on some kind of simulated eating, our intervention consists of imagining the multisensory pleasure of only three hedonic foods, something that people typically do in 2 to 5 minutes. Second, although we posit that both multisensory imagery and simulated satiation will make hungry people choose smaller portions, simulated satiation should also reduce the expected eating enjoyment for any food portion. In contrast, we expect that sensory imagery will actually increase the expected enjoyment of eating small food portions. Formally:

**H2a.** Multisensory imagery increases the expected enjoyment of small portions, compared with a control condition and compared with a simulated satiation condition.

**H2b.** Multisensory imagery makes hungry non-dieters expect at least as much enjoyment and be willing to pay at least the same price for their smaller chosen portions, compared with the larger portions chosen in a control condition.

*Hypotheses: Calibration of Expected and Actual Enjoyment*

Finally, although both sensory pleasure expectations and hunger can influence expected enjoyment, the satisfaction of hunger has a very limited impact on actual enjoyment (van Kleef et al. 2013), which is mostly driven by the sensory qualities of food and by sensory-specific satiation. This explains why actual enjoyment decreases with food quantity. Therefore, since multisensory imagery increases reliance on sensory pleasure (rather than hunger), multisensory imagery should also improve the calibration between the expected and actual enjoyment of food.
portions. As a consequence, multisensory imagery should also increase the likelihood that people choose a portion that they will actually enjoy more, i.e. a smaller portion.

H3. Multisensory imagery improves the calibration of expected and actual enjoyment of food portion sizes.

Study Overview

We tested these predictions in five experimental studies involving diverse populations: French and American, adults, young adults, and children. In all studies the main task was to choose among different portion sizes of a chocolate cake (and an indulgent drink in Study 1). All portions were presented simultaneously and were visibly cut from the same cake, ruling out any inferences that smaller portions might be of higher quality. The first experiment, run in a school, demonstrated the basic effect on portion size choice among hungry French children. The second experiment replicated the effect with US adult consumers, and compared the effect of multisensory imagery and simulated satiation. The third experiment tested the underlying mechanism that multisensory imagery modifies the relative influence of sensory pleasure and hunger satiation expectations on portion choice. In the fourth study we compared the effects of sensory imagery and health imagery (vs. a control condition) on portion choice, expected (pre-consumption) eating enjoyment, and actual (post consumption) enjoyment among dieting and non-dieting French women. In a final study we manipulated sensory and health imagery with simple menu descriptions and examined their effects on the portion size preferences of US adults.

STUDY 1: EFFECTS OF SENSORY IMAGERY ON THE PORTION SIZE CHOICES OF HUNGRY 5-YEAR OLDS
Study 1 tested whether multisensory imagery would make hungry children choose smaller portions of brownie and smaller glasses of a soft drink, using both hypothetical and actual choices. We conducted this study among young children from a middle-class French public school to rule out two alternative explanations: 1) that small portions are associated with higher sensory quality because they are often served in high-end restaurants; 2) that sensory imagery primes dieting goals (Trope and Fishbach 2000). Children of this age and background are unlikely to have experienced high-end restaurants or to have dieting goals. In contrast, even infants experience sensory-specific satiation (Mennella and Beauchamp 1999). This age group also allowed us to test our intervention at a time when children start to form their own perceptions of food (Rozin 1990).

Method

Forty-two children (52% female) aged 4 or 5 from two pre-school classes in France participated in the study (with the authorization of their parents and the school board). None of the children suffered from an eating disorder or obesity. The study took place between 10AM and 11:15 AM over two days, in order to ensure that none of the children were sated during the study and to ensure minimal variance in hunger. Children were randomly assigned to a food or non-food (control) sensory imagery condition and participated in the experiment in groups of four.

In the food sensory imagery condition, children saw photos of three hedonic foods (chocolate cereal, chocolate waffle, chocolate candies). The children were reminded about the five senses (covered in class during the school year) and, upon seeing each picture, were asked to cover their eyes with their hands and to imagine the multisensory consequences of eating each food (e.g., the sound made by the cereals when eaten, the sensation when chocolate melts in the mouth, the smell of the waffle, etc.). The children in the control condition went through a non-food imagery
procedure and saw three photos of children at the beach, playing with dead leaves, and making a snowman. They too were reminded about the five senses and, after covering their eyes, were asked to imagine the multisensory consequences of the non-food experiences (e.g., the sound of walking on dead leaves, the taste of a snowflake on the tongue, the warmth of the sun on their skin, etc.). In both conditions, the intervention lasted approximately 5 minutes.

We first measured hypothetical portion size choices for a projected self (Gripshover and Markman 2013). The children were given drawings of a little girl or a little boy, were told that the drawing represented them, and were asked to write their name on the poster. They were then asked to choose one of five stickers representing portions of cake of different sizes and one of five stickers representing glasses of soft drink and to place them in each hand of their self-character (see Figure 1 for examples of the drawings with stickers).

We then measured actual portion size choices. The children were taken one by one into a separate room with a table displaying six portions of chocolate brownie and five glasses of soft drink, in increasing order of size as shown in Figure 1. Following discussions with parents, we had selected the Brossard® brand of packaged brownie cake and the Oasis® brand of soft drink because they were both familiar and appealing to children. Portions of brownie ranged from 0.5 oz. (60 calories, as much as in one Oreo cookie) to 3.2 oz. (410 calories, as much as a Starbucks’ regular brownie). Glasses of soft drink ranged from 10 cl (40 calories) to 80 cl (350 calories). The children were told that they could choose one portion of cake and one glass for their afternoon snack and were asked to point at their preferred portions. The children were then asked whether they thought that the chocolate cake and the juice were “not good”, “pretty good”, or “very good”. In the afternoon (after the experiment), the children were explained the purpose of the
experiment by the school teachers and, for ethical reasons, received the same age-appropriate portions instead of their chosen portions.

Results and Discussion

We analyzed children’s choices with four ordered logit regressions, with portion size as the dependent variable and imagery condition and gender as independent variables. No participant was excluded from analysis. The results were identical when using a linear regression (which assumes equal spacing between the portion sizes) and when pooling the four estimates into a single random-effect hierarchical regression accounting for the panel structure of the data.

—Insert Figure 1 about here—

The results revealed that children chose smaller portions in the food sensory imagery condition than in the control condition across all four replications: cake stickers (resp. M=3.21, SD=1.45 vs. M=4.09, SD=1.31; β=-1.50, z=-2.34, p=.02), drink stickers (resp. M=3.58, SD=1.42 vs. M=4.35, SD=1.15; β=-2.10, z=-2.10, p=.04), real cake (resp. M=3.16, SD=1.77 vs. M=5.23, SD=1.26; β=-2.48, z=-3.56, p<.001), and real drink (resp. M=3.16, SD=1.50 vs. M=4.36, SD=1.00; β=-1.80, z=-2.81, p=.005). The random-effect regression further found that sensory imagery was equally effective for the hypothetical and real choices (p=.24) and for the foods and beverage (p>.50). Finally, almost all the children expected the chocolate cake and the drink to taste “very good” whether in the food or the non-food sensory imagery condition (respectively 95% vs. 81% for the cake, χ²(1)=.70, p=.40 and 100% vs. 90% for the drink, χ²(1)=.42, p=.50).

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1 We controlled for gender (and body mass index when available) in all the studies because they typically influence food decisions. In order to facilitate reading comprehension, we only report their effects in the very few cases when they moderated the effect of sensory imagery. All the test statistics were computed after accounting for the covariates.
Overall, study 1 found that a brief intervention by school teachers had sizeable effects on children’s choice of food portions, without requiring adults to restrict children’s options. Food sensory imagery led hungry children to choose smaller portions of hedonic foods and drinks (Hypothesis 1a). The effect held whether the target food shared common sensory characteristics with the imagined foods (chocolate cake) or not (soft drink), and whether the choice was hypothetical or not. The effects were as strong for the last choice as for the first choice, and showed no evidence of compensation from the first choice to the later ones.

Because children in both experimental conditions engaged in forming a mental image of pleasurable activities, the results of Study 1 cannot be attributed to differences in mood, mental resources or the fact that choice is made in an affective mindset (Hsee and Rottenstreich 2004). In the following study we sought to replicate the experiment among adults and to collect additional evidence about subsequent food compensation. Study 2 also allowed us to test our hypothesis that multisensory imagery reduces the influence of hunger on portion choice, leading hungry (but not sated) adults to choose smaller portions, and to rule out the alternative explanation of simulated satiation (Morewedge et al. 2010) by analyzing the effect of multisensory imagery on expected enjoyment.

**STUDY 2: EFFECTS OF SENSORY IMAGERY, SIMULATED SATIATION, AND HUNGER ON ADULTS’ PORTION SIZE CHOICES AND EXPECTED ENJOYMENT.**

**Method**

Two hundred American online panelists (Amazon Mechanical Turk, mean age=34, 62% female) were assigned to one of three between-subject conditions: sensory imagery, simulated
satiation, and control. We first asked participants how hungry they felt (from 1=“not hungry at all” to 9=“extremely hungry”) and when was the last time they ate. In the sensory imagery condition, we showed three pictures of hedonic desserts (a strawberry pie, vanilla ice-cream, and chocolate mousse) and asked the participants to imagine as vividly as possible the taste, smell and texture in mouth of each dessert. We used a different control condition from that in Study 1: instead of engaging in non-food mental imagery, participants were showed the same three pictures of hedonic desserts as in the sensory imagery condition, but were merely asked to look at them (Papies et al. 2014). The simulated satiation condition was a close replication of the intervention developed by Morewedge et al. (2010). Participants saw a picture of a bite-size piece of chocolate cake and were asked to imagine eating it, and this task was repeated 30 times.

In a second task, participants were asked to choose a portion size of chocolate cake. To give the impression that all the portions were cut from the same cake, we selected (after pre-testing) a slice of delicious-looking chocolate cake and created five other portion sizes with Photoshop (See Figure 1). We showed the six portions in increasing order of size and asked participants to choose the portion that they would like to eat. On the next page we showed the photo of the chosen portion and asked participants to estimate how much they expected to enjoy eating it, ranging from 1 (“I would not enjoy eating it at all”) to 9 (“I would enjoy eating it a lot”).

We then asked participants to imagine that they had eaten their chosen portion, that four hours had passed, and that they had the option to eat vanilla ice cream. We asked them how many scoops – from 0 to 10 – they would eat (the photo of a scoop of vanilla ice cream was shown). At the end of the study we asked about participants’ height and weight in order to compute their body mass index.

Results and Discussion
There were two attention checks used in all studies: participants were asked how often they listen to classical music (toward the beginning of the questionnaire) and to choose a specific number of cake slices (toward the end of the questionnaire). Each time, the participants were instructed to show that they had carefully read the question by selecting a specific answer. In Study 2, 14 participants failed these tests and were excluded from further analysis. We also excluded 5 participants who reported that they had not eaten for a full day before the study because such prolonged fasting is symptomatic of eating disorders (Fairburn 2008; Hilbert et al. 2012; Lavender et al. 2010). This exclusion criterion was applied to all studies.² Average hunger was 3.49 (on a 1 to 9 scale) with a large standard deviation (2.05). We used spotlight analyses (Irwin and McClelland 2001) to observe the effects of our manipulations in sated (one standard deviation below the average level of hunger, M=1.44 on the 1-9 hunger scale) and hungry (one standard deviation above, M=5.64) participants.

Portion Size Choice. We first analyzed portion size choice with an ordered logit model. We used contrast-coded independent variables capturing the effect of multisensory imagery (vs. control) and of simulated satiation (vs. control), gender, and continuous variables for hunger and body mass index. The results are reported in Figure 2.

---Insert Figure 2 about here---

There was no significant main effect of multisensory imagery (vs. control) on portion choice (z=-1.32, p=.19), but a positive main effect of hunger (z=2.21, p=.03) and, more importantly, a significant interaction between hunger and multisensory imagery (z=-2.05, p=.04). Hunger was a significant predictor of choice in the control condition (z=2.98, p=.003) but not in the sensory

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² In Study 2, Hypotheses 1a, 2a and 2b were supported even when keeping the participants who had fasted for a full day. Hypotheses 2a and 2b, but not 1a, were also supported even when keeping the participants who had failed the attention check.
imagery condition ($z=1.52, p=.13$). As predicted, sensory imagery (vs. control) made hungry participants choose smaller portions ($M=3.54, SD=1.45$ vs. $M=4.70, SD=1.44$; $\beta=-1.56, z=-2.26, p=.02$) but had no significant effect on sated participants ($M=3.51, SD=1.45$ vs. $M=3.12, SD=1.44$; $\beta=.49, z=.85, p=.40$).

There was a main effect of simulated satiation (vs. control) on portion choice ($z=-2.53, p=.01$), qualified by an interaction with hunger ($z=-2.24, p=.03$). As shown in Figure 2, simulated satiation, just like sensory imagery, made hungry participants choose smaller portions than in the control condition ($M=3.37, SD=1.75$ vs. $M=4.70, SD=1.44$; $\beta=-1.82, z=-3.15, p=.002$) but had no effect for sated participants ($M=3.09, SD=1.75$ vs. $M=3.12, SD=1.44$; $\beta=-.09, z=-.17, p=.86$).

*Expected Enjoyment of the Chosen Portion.* We regressed expected enjoyment of the chosen portion on the same independent variables as in the choice analysis. Hunger increased expected enjoyment ($t(179)=2.50, p=.01$) but did not significantly interact with our manipulations ($p’s >.60$). Sensory imagery did not significantly impact expected enjoyment compared to the control condition ($M=7.81, SD=1.47$ vs. $M=7.43, SD=1.83$; $\beta=.38, t(179)=.92, p=.4$). Hence, as predicted and shown on Figure 2, sensory imagery made hungry participants expect at least as much eating enjoyment from their smaller chosen portion as they did from the larger portion chosen in the control condition ($M=8.27, SD=1.47$ vs. $M=7.97, SD=1.83$; $\beta=.30, t(179)=.53, p=.6$). In contrast, simulated satiation significantly decreased expected enjoyment compared to the control condition ($M=6.67, SD=2.77$ vs. $M=7.43, SD=1.83$; $\beta=-.76, t(179)=-2.05, p=.04$). Further analyses showed that simulated satiation also sharply decreased expected enjoyment compared to sensory imagery ($\beta=-1.14, t(179)=-2.74, p=.007$).

*Compensatory choice.* On average, participants chose 2.78 (SD=1.39) scoops of ice cream. We regressed the number of scoops on the same independent variables as in previous analyses.
We found only a marginally significant main effect of hunger \((z=1.83, p=.07)\), but no effect of sensory imagery or of simulation satiation (vs. control), and no interaction with hunger \((p's >.20)\). In other words, consistent with Study 1, we found no evidence that people who had chosen a smaller portion of chocolate cake because of multisensory imagery (or simulated satiation) would compensate this first hypothetical choice by choosing a larger portion of ice cream in a second hypothetical choice.

**Discussion.** Overall, both sensory imagery and simulated satiation reduced the influence of hunger on portion choice and made hungry participants (but not sated participants) choose smaller portions compared to a control condition (Hypothesis 1a). However, sensory imagery and simulated satiation yielded different results regarding expected enjoyment. Consistent with Morewedge et al. (2010), simulated satiation sharply decreased expected enjoyment compared with the other two conditions (Hypothesis 2a). In contrast, sensory imagery made participants expect at least as much enjoyment, even from the smaller portion they had chosen when hungry, compared with the larger portions chosen in the control condition (Hypothesis 2b). These results suggest that the effect of sensory imagery on portion choice could not be attributed to feelings of satiation, which by definition are associated with decreased eating enjoyment expectations.

**STUDY 3: EFFECTS OF SENSORY IMAGERY AND EXPECTATIONS ABOUT SENSORY PLEASURE AND HUNGER SATIATION ON PORTION CHOICE AND WILLINGNESS TO PAY**

The primary goal of Study 3 was to test the proposed mechanism that sensory imagery increases the influence of sensory pleasure expectations over hunger satiation expectations in
portion size choice. To achieve this goal, we measured expectations about sensory pleasure and hunger satiation for each portion size one week before the intervention and examined the explanatory power of these ratings in driving the portion size choices of participants in the sensory imagery vs. in the control condition one week later. Study 3 also allowed us to examine the effects of sensory imagery on the willingness to pay for the chosen portion.

Method

For the first phase of the study we recruited 100 participants on Amazon Mechanical Turk (60% female, mean age=34) and showed them six portion sizes of chocolate cake in increasing order (the same as in Study 2). We asked them to rate how much they agreed that each portion was ‘just right’ in terms of hunger satiation, i.e., to choose a high rating if the size was just right and a lower rating if it was too small or too large. For each of the six portions, expected hunger satiation was measured with three items on a scale ranging from 1 (not at all) to 9 (absolutely): “this portion would be just right for me to feel comfortably full for dessert”, “this portion would be just right for me to be satiated for dessert” and “this portion would be just right to satisfy my appetite for dessert” (Cronbach’s alpha=.92). In a similar manner we asked the participants to rate each portion in terms of sensory pleasure, with three items: “this portion would be just right for me to have a pleasurable sensory experience”, “this portion would be just right for me to enjoy the taste of this cake” and “this portion would be just right for me to savor the cake” (Cronbach’s alpha=.89). The order of the questions was counterbalanced across participants.

One week later we re-contacted all the participants to take part in the main study; 79 participants replied. These participants were not statistically different from those who did not reply in terms of age, gender and food ratings (p’s >.5). We first asked participants how hungry they felt (from 1=“not hungry at all” to 9=“extremely hungry”) and when was the last time they
ate. In the sensory imagery condition, we used the same manipulation as in Study 2. In the control condition we used a nonfood sensory imagery intervention (like in Study 1) by showing pictures of three comfortable armchairs and asking the participants to imagine as vividly as possible how they would feel if they sat on each chair.

Participants were then shown the same six portions of chocolate cake as in the first part of the study. We asked them to choose one portion and indicate the probability of choosing each portion, from 1=highly unlikely to 9=highly likely. We then showed the photo of the chosen portion and asked participants to state the maximum price they would be willing to pay for it.

Finally, as a manipulation check, we asked participants whether they evaluated portion sizes based on expected sensory pleasure or on expected hunger satiation, using three bipolar scales (e.g. “I was thinking of eating this cake as a sensory experience” vs. “I was wondering whether the portion would make me comfortably full”; Cronbach’s alpha=.79). We also asked participants whether they were thinking about their health or weight when evaluating the portions of chocolate cake. At the end of the study we asked about participants’ height and weight in order to compute their body mass index.

Results and Discussion

From the 79 participants who participated in the pre-study and the main study we excluded 4 who failed to pass the attention checks and 6 who had not eaten for a full day before the study. The average hunger in the main study was 4.01 (on a 1 to 9 scale) with a large standard deviation (2.40). As in Study 2, we used spotlight analyses to observe the effects of our manipulations on
sated participants (one standard deviation below the average level of hunger, \( M=1.61 \) on the 1-9 hunger scale) and hungry participants (one standard deviation above, \( M=6.41 \)).

As a manipulation check, we verified that (compared to the control condition) sensory imagery led people to evaluate the portions based on their expected sensory enjoyment rather than on expected hunger satiation (\( M=4.89, \text{SD}=2.48 \) in control vs. \( M=3.63, \text{SD}=2.29 \) in sensory, \( \beta=-1.26, t(67)=-2.17, p=.03 \), on a 0-10 scale, where a lower number indicated evaluation based on sensory enjoyment and a higher number indicated evaluation based on hunger satiation). There were no differences between the control and sensory imagery condition in terms of how much participants thought about their health and weight when evaluating the portions (\( t<1 \)).

*Portion Choice and Willingness to Pay.* We analyzed portion size choice with an ordered logit model with the imagery condition, hunger, gender and BMI as independent variables. There was no main effect of sensory imagery on portion choice (\( z=.15, p=.90 \)), a positive main effect of hunger (\( z=2.30, p=.02 \)), and an interaction of sensory imagery and hunger (\( z=-2.65, p=.008 \)). As shown in Figure 3, hunger was a strong predictor of choice in the control condition (\( z=3.91, p<.001 \)) but not in the sensory imagery condition (\( z=-.03, p>.9 \)). As predicted, sensory imagery made hungry participants choose smaller portions compared to control (\( M=3.55, \text{SD}=.85 \) vs. \( M=4.28, \text{SD}=1.32; \beta=-1.74, z=-2.16, p=.03 \)). However, sensory imagery made sated participants choose significantly larger portions (\( M=3.75, \text{SD}=.85 \) vs. \( M=2.91, \text{SD}=1.32; \beta=1.91, z=2.01, p=.05 \)). The choice probability data yielded similar results.

---Insert Figures 3 and 4 about here---

A regression of willingness to pay revealed a main effect of hunger (\( t(65)=3.35, p=.001 \)) and, more interestingly, a main effect of sensory imagery (\( t(65)=3.26, p=.002 \)) with no interaction between the two (\( t<1, p>.40 \)). On average, sensory imagery increased willingness to pay for
chosen portions, compared with control ($M=4.57$, SD=1.64 vs. $M=3.50$, SD=1.63). As predicted and shown in Figure 3, sensory imagery made hungry participants willing to pay directionally more for their smaller chosen portion than they were willing to pay for the larger portions chosen in the control condition ($M=4.85$, SD=1.64 vs. $M=3.98$, SD=1.63; $\beta=.85$, $t(65)=1.47$, $p=.14$), thus increasing willingness to pay per quantity unit by 47%.

The Role of Sensory Pleasure and Hunger Satiation Expectations. As shown in Figure 4, there was an inverted U–shaped relationship between portion size and both types of expectations. In addition, the three smallest portions were rated more favorably in terms of sensory pleasure than in terms of hunger satiation (respectively, $t(69)=4.21$, $p<.001$; $t(69)=4.18$, $p<.001$; $t(69)=2.66$, $p=.01$). It was the opposite for the larger portions four and five, which were rated more favorably in terms of hunger satiation than in terms of sensory pleasure ($t(69)=-1.97$, $p=.06$; $t(69)=-2.61$, $p=.01$). The largest portion was rated similarly low in both ($p=.33$). As another test, we determined for each participant the portion with the highest rating from either perspective. Across participants, the optimal portion from a sensory perspective was smaller than the optimal portion from a hunger satiation perspective ($M=3.35$, SD=1.47 vs. $M=3.98$, SD=1.29; $\beta=-.61$, $t(69)=-3.86$, $p<.001$). Overall, these results show that sensory pleasure is expected to be higher for smaller portions.

To examine whether sensory pleasure more strongly influence portion size in the multisensory imagery condition, we regressed the choice probability data for each portion (from the main study) on a binary variable measuring the effects of the intervention (sensory imagery vs. control), hunger (measured just before the intervention), expected sensory pleasure and expected hunger satiation (measured in the first phase), and all two-way interactions. The regression (which controlled for the panel structure of the data) showed that both sensory
pleasure expectations ($z=2.58, p=.01$) and hunger satiation expectations ($z=11.9, p<.001$) influenced choice probabilities. Hunger had a negative interaction effect with sensory expectations ($z=-2.18, p=.03$) and a positive interaction effect with hunger satiation expectations ($z=2.72, p=.01$), meaning that on average, hungry people relied less on their own expectations of sensory pleasure, and more on their expectations of hunger satiation. More importantly, the interaction of the multisensory imagery intervention and of sensory pleasure expectations was positive and statistically significant ($z=2.25, p=.02$) whereas the other effects were not ($p$’s > .6). Expected sensory pleasure had a positive impact on portion size choice in the sensory imagery condition ($z=2.96, p=.003$), but a weaker and not statistically significant impact in the control condition ($z=1.48, p=.14$). This means that multisensory imagery increased the importance of sensory pleasure expectations on choice, and explains why it made people choose smaller portions, especially when hungry.

Discussion. Consistent with Study 2, Study 3 showed that multisensory food imagery reduced the influence of hunger on portion choice, made hungry consumers choose smaller portions (Hypothesis 1a, just like in Study 2), yet willing to pay at least as much for these smaller portions than consumers in the control condition were willing to pay for their larger portions (Hypothesis 2b). However, there was a backlash effect among sated consumers for whom sensory imagery increased portion size and willingness to pay.

Study 3 also provides support for the suggested underlying mechanism linking sensory imagery with preference for smaller portions. First, it measured people’s expectations and found that the optimal portion was smaller from a sensory pleasure perspective than from a hunger satiation perspective. Second, it showed that multisensory imagery increased the influence of sensory pleasure expectations on portion size choice probability. This suggests that asking people
to imagine the multisensory sensations of eating hedonic foods makes them more likely to rely on their own expectations of sensory pleasure (rather than on the normally more important expectations of hunger satiation) when choosing portion sizes.

Study 3 had some limitations. First, it did not directly test the effects of multisensory food imagery on the overall enjoyment expected from each portion size, and thus did not test Hypothesis 2a that sensory imagery increases the expected enjoyment from eating smaller (but not larger) portions. Second, it did not measure actual (post-intake) eating enjoyment. Third, it did not examine the hypothesized moderating effects of dieting because there were too few dieters in the sample. These limitations were addressed in study four, in which we also compared the effectiveness of our intervention with that of health imagery.

**STUDY 4: EFFECTS OF SENSORY AND HEALTH IMAGERY ON EXPECTED AND ACTUAL EATING ENJOYMENT FOR ADULT DIETERS AND NORMAL EATERS**

The participants in Study 4 were pre-screened to ensure they would all be hungry, but with high heterogeneity in dieting tendencies. As with hunger, we expected that sensory imagery would reduce the effects of dieting in portion size choice and would lead normal eaters (but not dieters) to choose smaller portions of cake compared with a control condition. Second, given that smaller portions actually maximize enjoyment, we expected sensory imagery to also reduce the gap between expected eating enjoyment (measured in a group of “forecasters”) and actual eating enjoyment (measured in a group of “experiencers”), improving the calibration of enjoyment expectations.
Study 4 also allowed us to compare sensory imagery with the standard health appeals recommended by researchers and used by governments to encourage people to choose smaller food portions. We specifically tested the effects of health imagery by asking some participants to imagine the effects of hedonic foods on their health and weight. We expected health imagery to also lead people to choose smaller portions, but out of a concern for health and not because they anticipated smaller portions to be more enjoyable. Therefore, unlike sensory imagery, health imagery should lead people to choose a smaller portion than the portion they expect to be the most enjoyable to eat.

Method

We recruited 367 young French women (mean age=22) in exchange for €8. This group was chosen because they are generally more receptive than men to health appeals and more likely to diet (Rolls et al. 1991), allowing us to better test our hypotheses. We were careful to recruit only hungry participants: they were asked to refrain from eating for at least one hour before the study. During the pre-study screening, participants who said that they were not hungry were not included (but were compensated for showing up). The study took place between 10.30 AM and 12AM, or between 3PM and 6:30PM (the time of day had no significance on the results). We used a 3 (food sensory imagery, health imagery, control) x 4 (forecasters, experiencers of small portions, experiencers of medium portions, experiencers of large portions) between-subject design.

At the center of the room where participants took the tests, we displayed five portions of the same brownie as in Study 1, in increasing order of size. The five portions respectively contained 70, 140, 210, 280, and 350 calories, but no calorie information was made available. After looking
at the portions, participants sat in front of a computer, reported their hunger (from 1=not hungry at all to 9=extremely hungry), and when they had eaten for the last time.

The sensory imagery manipulation was the same as in Studies 2 and 3. Following the procedure used by Giuliani et al. (2013), participants in the health imagery condition looked at the same three photos of hedonic foods as in the sensory imagery condition and were asked to imagine the negative impact of these foods on their health and body. Participants in the control condition saw pictures of three comfortable office chairs and were asked to imagine sitting on them.

Participants assigned to the “forecaster” condition were then asked to choose one of the five portions of brownies and told that they would be able to take their chosen portion with them at the end of the study. We also measured their expected enjoyment by asking them to rate how enjoyable it would be to eat each of the five portions on scales ranging from 1 (not at all) to 10 (very much). Participants assigned to the three “experiencer” conditions were asked to eat entirely either the smallest (portion 1), the medium (portion 3) or the largest (portion 5). Only two “experiencers” were unable to finish their portion but excluding them from the analyses did not affect the results. We then asked them to rate how much they had enjoyed eating the brownie on the same scale used by forecasters. Finally, we measured dieting tendency with the Dutch Eating Behavior Questionnaire (van Strien et al. 1986) and asked participants’ height and weight in order to compute their BMI.

Results and Discussion

We excluded 11 participants because of an error when cutting the portions on one day, 7 participants who said that they were so full that they could not eat anything (despite the pre-
screen test), and 6 participants who had not eaten since the day before the study\(^4\). The final sample of 343 participants had an average dieting score of 2.8 (SD=.95) on a scale ranging from 1 to 5, with a fairly even distribution between normal eaters and dieters. The average hunger rating was 5.2 on a 1-9 point scale, with a small standard deviation of 1.3, indicating that we succeeded in selecting a sample of only hungry participants.

*Expected Enjoyment.* Consistent with the results of study 3, portion size had an inverted U shape effect on expected eating enjoyment (see Figure 5). In order to test our hypothesis, we analyzed expected enjoyment separately for small portions (portions 1 and 2) and for large portions (4 and 5). The independent variables were contrast-coded variables measuring the effects of food sensory imagery (vs. control) and of health imagery (vs. control), dieting tendencies, hunger, and body mass index.

As predicted, sensory imagery increased expected eating enjoyment for the smaller two portions ($z=2.25, p=.02$) but not for the larger two portions ($z=.21, p=.80$). In contrast, health imagery had no effect on expected eating enjoyment regardless of portion size ($p$’s>.6). Hunger did not influence the expected enjoyment of smaller portions ($p>.70$) but increased the expected enjoyment of larger portions ($z=4.51, p<.001$), even though all participants were hungry, with little variance in hunger level. Both sensory imagery and health imagery decreased the influence of hunger on expected enjoyment for larger portions (respectively $z=-2.49, p=.01$ and $z=-1.96, p=.05$). None of the other effects was statistically significant ($p$’s>.40).

---Insert Figure 5 about here---

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\(^4\) In Study 4, Hypotheses 2a and 3 were supported but H1b became only marginally significant when keeping the participants who had fasted for a full day.
**Actual Enjoyment.** As shown in Figure 5, portion size had a monotonically negative effect on the actual eating enjoyment reported by the experiencers. We regressed actual eating enjoyment on portion size (using a linear coding), the same two binary variables capturing the interventions, dieting tendencies, hunger, and body mass index. Actual eating enjoyment sharply decreased with portion size ($t(240)=-4.68, p<.001$). The only other significant effect was hunger, which increased actual eating enjoyment ($t(240)=5.05, p<.001$). None of the other effects was statistically significant ($p's>.10$). In particular, actual eating enjoyment, unlike expected eating enjoyment, was unaffected by the sensory and health imagery interventions.

**Calibration of Expected and Actual Enjoyment.** We now analyze how well forecasters were able to predict that enjoyment would decrease with portion size. Recall that the expected enjoyment of five portion sizes was measured within participants assigned to the “forecaster” condition, whereas the actual enjoyment of portion size 1, 3 and 5 was measured between participants assigned to the three “experiencer” conditions. A mixed design was necessary in order to test our hypothesis regarding the expected enjoyment of small vs. large portions across imagery conditions. Such a design replicates real-life evaluations when consumers first estimate their expected enjoyment of different portions and only evaluate the actual enjoyment of eating the portion that they have chosen.

As shown earlier, among “experiencers”, actual enjoyment decreased with portion size (i.e. Portion 1 was the most enjoyed, then Portion 3, then Portion 5) in all conditions. A good calibration between expected and actual enjoyment means that “forecasters” are able to predict this pattern. We therefore analyzed the expected enjoyment of Portion 1 vs. Portion 3 vs. Portion 5 in each of the three imagery conditions. In the control condition we found a poor calibration between expected and actual eating enjoyment with respect to portion size. As shown in Figure 5,
participants erroneously expected portion 3 to be more enjoyable than portion 1 (M=6.78, SD=2.61 vs. M=5.59, SD=2.72; β=1.20, z=1.93, p=.05) and failed to predict that portion 5 would be significantly less enjoyable than portion 1 (M=4.65, SD=2.56; β=-.93, z=-1.50, p=.13). Sensory imagery was able to reduce the gap between actual and expected eating enjoyment.

Participants in the sensory imagery condition expected to be indifferent between portions 1 and 3 (M=6.11, SD=2.25 vs. M=6.45, SD=2.42; β=.35, z=.53, p=.6) and correctly expected to prefer portion 1 over portion 5 (M=4.42, SD=2.80; β=-1.69, z=-2.56, p=.003). In the health imagery condition, participants expected to be indifferent between portion 1 and 3 (M=5.29, SD=3.02 vs. M=5.83, SD=2.59; β=.63, z=.90, p=.5) and failed to predict that portion 1 would be more enjoyable than portion 5 (M=4.13, SD=2.90; β=-1.09, z=-1.57, p=.12).

Portion Size Choice. We analyzed portion size choice via an ordinal logit model with the same independent variables as for enjoyment expectations. The results, plotted in Figure 6, showed no significant effect of sensory imagery (p >.60) and of dieting tendencies (z=-1.09, p=.27) but a significant interaction between them (z=2.85, p=.004). Dieting tendencies predicted portion choice in the control condition (z=-2.30, p=.02) but not in the sensory imagery condition (z=.05, p=.60). A spotlight analysis revealed that sensory imagery led normal eaters (one standard deviation below the mean dieting score) to choose smaller portions than in the control condition (M=2.17, SD=.89 vs. M=2.85, SD=1.04; β=-1.81, z=-2.23, p=.02), as predicted. Sensory imagery slightly backfired among dieters (one standard deviation above the mean), leading them to choose marginally larger portions (resp. M=2.48, SD=.89 vs. M=1.92, SD=1.04; β=1.36, z=1.77, p=.08).

—Insert Figure 6 about here—
Despite having no effect on enjoyment, health imagery (vs. control) made all participants choose smaller portions ($M=1.90$, $SD=.87$ vs. $M=2.40$, $SD=1.04$; $\beta=-1.34$, $z=-2.27$, $p=.02$), and the effect was marginally stronger among non-dieters (interaction with dieting: $z=1.72$, $p=.09$). Hunger made participants choose larger portions ($z=3.71$, $p<.001$) but it did not interact with any of the two interventions ($p's>.19$), probably because all participants were at least moderately hungry.

*Is Portion Choice based on Expected Enjoyment?* We now test our hypothesis that sensory imagery will make normal eaters choose a smaller portion because they expect it to maximize enjoyment, whereas health imagery makes participants choose smaller portions despite expecting them to be less enjoyable (i.e. a tradeoff between health and expected enjoyment). We used McFadden’s conditional logit model with a binary variable indicating whether the portion had been chosen or not as the dependent variable. The independent variables were the expected enjoyment for each portion, contrast-coded variables capturing the effects of sensory imagery vs. control and of sensory imagery vs. health imagery, and continuous measures of dieting, hunger, and BMI.

Overall, expected enjoyment was strongly predictive of choice ($z=6.41$, $p<.001$). Still, there were significant three-way interactions between expected enjoyment, dieting and sensory imagery vs. control ($z=-2.30$, $p=.02$), and between expected enjoyment, dieting and sensory vs. health imagery ($z=-2.87$, $p=.004$). Among normal eaters, expected enjoyment predicted portion size choice better in the sensory imagery condition (odds ratio=8.19) than in the control condition (odds ratio=1.59) or in in the health imagery condition (odds ratio=.54). In the sensory imagery condition, the portion chosen by normal eaters ($M=2.17$, $SD=.89$) was almost exactly the same as the portion that they expected to enjoy the most ($M=2.21$, $SD=1.15$, computed as the portion size
with the highest expected enjoyment, averaged across participants). In the control condition, normal eaters chose a slightly smaller portion than the one predicted to be most enjoyable (M=2.85, SD=1.04 for the chosen portion vs. M=3.12, SD=1.19 for the portion with the highest expected enjoyment). The gap was even larger in the health imagery condition, in which participants chose a much smaller portion (M=1.88, SD=.87) than the one expected to maximize enjoyment (M=2.61, SD=1.21). Among dieters there were no differences across imagery conditions.

Discussion. In Study 4, all participants were hungry but there was a large heterogeneity in dieting tendencies. We found that sensory imagery reduced the effect of dieting on portion size but still made normal eaters choose smaller portions compared to control (Hypothesis 1b). Sensory imagery made strong dieters choose marginally larger portions (vs. control), suggesting that it made participants choose based on sensory pleasure rather than concerns about body weight.

As for sensory imagery, health imagery made normal eaters choose smaller portions compared to the control condition, but for different reasons. Indeed, sensory imagery increased the expected enjoyment of smaller (but not larger) portions (Hypothesis 2a), making participants more likely to choose the (small) portion expected to maximize enjoyment. In contrast, health imagery did not modify enjoyment expectations and made participants choose a smaller portion than the one they expected to enjoy most – implying a hedonic cost because people traded off enjoyment against health.

Study 4 finally showed that sensory imagery improved participants’ ability to predict that enjoyment actually decreased with portion size. In other words, it improved the calibration between expected and actual eating enjoyment (Hypothesis 3), and it also increased the chance
that a smaller, actually more enjoyable, portion would be chosen. Note however that, although the decrease in actual enjoyment with portion size is consistent with past research on sensory satiation (Rolls et al. 1981), an alternative explanation may be that “experiencers” assigned to eating the largest portion felt compelled; and thus resentful, to eat such a large quantity of cake.

In the final study we examine the applicability of our results for restaurants, school or workplace cafeteria by testing whether simple menu descriptions could create multisensory imagery (Elder and Krishna 2010; Tuorila et al. 1994). We also compare the effectiveness of multisensory labeling to that of nutrition labeling, a much debated intervention aimed at nudging people to choose smaller food portions (Howlett et al. 2009).

**STUDY 5 - SENSORY MENU DESCRIPTIONS AND PORTION CHOICE**

*Method*

One hundred and ninety American online panelists (Amazon MTurk, mean age=37, 60% female) were assigned to one of three between-subject conditions: multisensory labeling, nutrition labeling, and control (no label). We first asked participants how hungry they felt and when was the last time they ate. All participants were shown the six photos of chocolate cake slices used in Studies 2 and 3 (see Figure 1). In the control condition, the cake was simply described as “a chocolate cake”. In the nutrition labeling condition we added information about the calorie and fat content of each portion, ranging from 80 calories and 3g of fat to 570 calories and 23g of fat. In the multisensory labeling condition we added the following description: “The chocolate has a smell of roasted coffee, a bitter-sweet balance taste, with natural aromas of honey and vanilla, and a light aftertaste of blackberry.” Subsequently we asked participants which portion of cake they wanted to eat. On the next page we showed the photo of the chosen portion.
size and asked participants the maximum price they would be willing to pay for it. We finally asked participants’ height and weight in order to compute their BMI.

Results and Discussion

We excluded 13 participants who failed to pass the attention checks and 11 participants who reported not having eaten since the day before the study, yielding a total of 166 valid participants. The average hunger was 3.69 (on a 1-9 scale) with a standard deviation of 2.10. As in studies 2 and 3, we considered participants “sated” at one standard deviation below the average level of hunger (M=1.59), and “hungry” at one standard deviation above the average level of hunger (M=5.79).

We first analyzed the impact of product information and hunger on portion choice with an ordered logit model. The independent variables were a contrast-coded variables capturing the effects of multisensory information (vs. control) and of nutrition information (vs. control), hunger, gender, and body mass index. The results are reported in Figure 7.

—Insert Figure 7 about here—

There was no significant main effect of multisensory information (vs. control) on portion choice ($z=-.43, p=.70$), but a positive main effect of hunger ($z=2.71, p=.007$) and, more importantly, a significant interaction between the two variables ($z=-3.05, p=.002$). Hunger was a significant predictor of choice in the control condition ($z=3.86, p<.001$) but not in the multisensory information condition ($z=.30, p=.80$). As predicted, multisensory menu description made hungry participants choose smaller portions ($M=3.64, SD=1.61$ vs. $M=4.75, SD=1.42$; $β=-$

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5 In Study 5, Hypotheses 1a and 2b were supported even when keeping the participants who failed the attention checks. Hypothesis 2b (but not H1a) was also supported even when keeping the participants who had fasted for a full day. In addition, a meta-analysis of the five studies show that the effects of sensory imagery on portion size choice are statistically significant even when keeping the participants who failed the attention checks and those who had fasted for a full day.
1.45, z=-2.58, p=.01) but made sated participants choose marginally larger portions, (M=3.53
SD=1.61 vs. M=2.66, SD=1.42; β=1.11, z=1.92, p=.054). Health information made all
participants choose smaller portions (M=2.91, SD=1.47 vs. M=3.71, SD=1.42; β=-.96, z=-2.39,
p=.02), especially when participants were hungry (interaction effect: z=-3.21, p=.001). Unlike in
all other studies, multisensory information interacted with BMI (z=1.95, p=.05) and had a
stronger effect on low BMI participants.

Regression analyses of willingness to pay with the same independent variables revealed a
strong main effect of multisensory information (t(156)=4.34, p<.001), a marginal effect of hunger
(t(156)=1.85, p=.07), and a marginal interaction between the two (t(156)=-1.71, p=.09). As
predicted, providing rich sensory information (versus control) marginally increased how much
hungry people were willing to pay for their chosen portion (M=$4.37, SD=1.96 vs. M=$3.24,
SD=1.58; β=.90, t(156)=1.76, p=.08) despite having chosen a significantly smaller portion.
Unsurprisingly, sensory information (versus control) also increased how much sated people were
willing to pay for their (larger) chosen portion (M=$4.36, SD=1.96 vs. M=$2.68, SD=1.58;
β=2.15, t(156)=4.31, p<.001). The main effect and interaction effects of nutrition information (vs.
control) on willingness to pay were not statistically significant (p’s>.30). However, additional
analyses showed that multisensory information increased willingness to pay compared with
health information (t(156)=3.78 ; p<.001), and this effect was not moderated by hunger (p >.20).

In study 5, providing rich and vivid multisensory information decreased the influence of
hunger, made hungry (but not sated) consumers choose a smaller portion (Hypothesis 1a), and
made them willing to pay an actually higher price for their small portion compared to the larger
portion chosen in the control condition (Hypothesis 2b). It could be argued that multisensory
information increased the perceived quality of the cake. In the absence of price information
however, quality perception should have led people to choose a larger (not smaller) portion of cake. Finally, although nutrition information led everybody to choose a smaller portion, it made people willing to pay a lower price than they were willing to pay for similarly small portions in the multisensory labeling condition. Given that margins are typically smaller for smaller portion sizes (Dobson and Gerstner 2010), sensory information achieved the same portion control goals as nutrition information, but without negatively impacting the restaurant’s profitability.

GENERAL DISCUSSION

To counteract the current supersizing of hedonic food portions, research has focused on how people can choose health over eating enjoyment (e.g., Giuliani et al. 2013) or how they can satiate their desire for hedonic foods (Larson et al. 2014; Morewedge et al. 2010). Unfortunately these strategies both undermine eating pleasure and go against the economic interest of food marketers who extract higher profits from supersized portions.

This study offers suggestive support for an alternative pleasure-based approach which may prompt hungry non-dieters to choose and actually prefer less food without making a hedonic trade-off or hurting food manufacturers’ profitability. Insofar as this intervention leads to the same effect sizes in more naturalistic settings than in our studies, this would constitute a triple win for consumers, marketers and public health. The pleasure-based approach to portion control builds on the fact that – counter-intuitively – larger portions are not more pleasurable than smaller ones because sensory enjoyment peaks at the first mouthful and declines with each additional one (Garbinsky et al. 2014; Rode et al. 2007; Rolls et al. 1981; van Kleef et al. 2013).
Drawing on mental imagery research (Barsalou 1999; Krishna and Schwarz 2014), we tested a new intervention, “multisensory imagery”, which consists of prompting people to vividly imagine the pleasant multisensory features of hedonic foods, either through direct instructions or simply by using vivid multisensory product descriptions on menus. Across five studies we found that multisensory imagery made consumers (as long as they were neither sated nor dieting) choose smaller portions, regardless of their cultural background (French in Studies 1 and 4, Americans in studies 2, 3 and 5) and age (children in Study 1, young adults in Study 4, adults in Studies 2, 3 and 5). Remarkably, we found that multisensory imagery made people willing to pay at least as much (Studies 3 and 5), and expect at least as much eating enjoyment (Studies 2 and 4) from a portion smaller than the one that they would otherwise choose. Multisensory imagery also reduced the gap between enjoyment expectations and actual enjoyment and made people choose the smaller portions that provided the best actual eating experience (Study 4).

We suggest a possible underlying mechanism in Studies 3 and 4. In Study 3, people recognized that smaller portions were better than larger ones from a pure sensory pleasure perspective, although larger portions were better for hunger satiation. Multisensory imagery also increased the relative influence of sensory pleasure over hunger satiation on portion size choice. These results were confirmed in Study 4, in which multisensory imagery increased the overall enjoyment expected from eating small portions but not large portions. Although these findings are consistent with research suggesting that mental imagery helps people anticipate more accurately future experiences (Hoeffler 2003; Moulton and Kosslyn 2009), we acknowledge that our studies do not provide definite evidence about the cognitive or affective processes by which sensory imagery helps people better anticipate that smaller portions will be more pleasant.
It is also possible that our findings are driven by demand effects. However, two results mitigate this risk. First, Study 1 showed that multisensory imagery was effective with five-year-old children who are unlikely to have the sophisticated reasoning required for this kind of demand responses. Second, we investigated demand by measuring the lay intuitions about the effect sensory imagery on portion size choice among 49 Amazon Mechanical Turk participants similar to those in studies 2 and 3. The scenario involved John and Jim, two hungry non-dieters about to choose a slice of chocolate cake. The scenario then described the sensory imagery intervention as follows: “Before making their choice, John (but not Jim) is shown pictures of desserts and asked to imagine vividly the taste, the smell and the texture in mouth of these desserts”. The vast majority of the participants (67%) erroneously predicted that John (the character who engaged in sensory imagery) would choose a larger slice than Jim. This suggests that demand effects would lead to the opposite results of what was found in studies 1-5. Thus, although people expect that focusing on sensory pleasure leads to smaller cake portions (as shown in Study 2), they do not make the association between the sensory imagery manipulation and focusing on sensory pleasure, which speaks against demand effects.

As a benchmark, we examined the effects of alternative interventions aimed at encouraging people to choose smaller portions of hedonic foods: Simulated satiation (imagining eating 30 times the same food, in Study 2), health imagery (imagining the negative impact of hedonic foods on health and body, in Study 4) and nutrition labeling (information about calories and fat content; Study 5). Although these also made people choose smaller portions, their choices were either hedonically costly for the consumer, economically costly for business, or both. Simulated satiation reduced the anticipated eating enjoyment of any portion of food. Health appeals led people to sacrifice pleasure and choose portions that were smaller than the ones that they
expected to enjoy the most. Nutrition labelling reduced the willingness to pay for the food compared with multisensory imagery.

There are boundary conditions to the effects of sensory imagery. By increasing the importance of sensory pleasure and decreasing the importance of hunger or dieting considerations as drivers of portion size choice, sensory imagery backfired (although not consistently and not significantly across studies) among sated consumers and dieters who would have otherwise chosen small portions. We acknowledge that leading sated people to choose larger portions is indeed a problem from a healthy eating standpoint. For dieters, however, the fact that sensory imagery leads them to choose larger (but still reasonable) portions of hedonic food may actually be less problematic than it sounds. There is much evidence that most dieters eventually fail to follow their dieting regime, and that when that happens the backlash negates the benefits of their previous sacrifices (Bublitz et al. 2010; Fedoroff et al. 1997; Stroebe et al. 2013). Choosing moderate portions of hedonic food, especially when done out of pleasure expectations, may therefore be more conducive to a healthier diet in the long run than strict but unsustainable cognitive restraint followed by extreme overeating. To that point, Studies 1 and 2 provided preliminary evidence that pleasure-based choices of smaller portions do not lead to subsequent compensation, at least in a second hypothetical choices. Although prior research has studied compensation effects in food choices using consecutive hypothetical choices (e.g., Laran 2010) more research is needed to study compensation effects after actual intake and over the long term. Further, chronic dieting is associated with feelings of anxiety, and of less well-being and happiness in general (Block et al. 2011; Coveney 2006), whereas a tendency to value the sensory pleasure of eating is associated with higher well-being and happiness (Jose et al. 2012; Quoidbach et al. 2010). This suggests that pleasure-based arguments can be an effective
alternative to health or dieting arguments to achieve healthy eating and contribute to overall “food well-being” (Block et al. 2011).

**Implications for Future Research**

Our research opens new avenues for future research. First, our focus was on portion size choice, conditional on people having decided to eat. It would be important to examine the effects of multisensory food imagery on consumption incidence (when to eat) and food choice (what to eat). This would indicate whether, from a public health perspective, multisensory imagery interventions are only warranted when people have already decided to eat (e.g., while waiting at a restaurant or sitting down at the family table) or if they can also be used in situations when people have not yet decided what and when to eat (e.g., in supermarkets). In the latter cases, it is possible that multisensory imagery, by emphasizing sensory pleasure, may lead people to choose tastier over healthier foods, which may partially or totally negate the health benefits of choosing smaller portions. The overall effect of sensory imagery on healthy eating (the combination of what, when and how much to eat) is therefore uncertain and open to further investigations.

Further, we compared the effect of multisensory imagery among hungry vs. sated people who were all normal eaters (Studies 2, 3 and 5) and among normal eaters vs. dieters who were all hungry (Study 4). We found a moderate backlash effect among hungry dieters and among non-dieting sated people, who naturally tended to choose small portions in the control condition and who tended to choose larger portions sizes in the multisensory imagery condition. It would be interesting to study the effect of multisensory imagery when both hunger and dieting vary, and in particular the extent of the backlash effect among sated dieters. More importantly, future research should aim to better understand this backlash effect. We suggested that multisensory imagery negates the impact of being sated or of being dieting by making people choose portions based on
sensory pleasure expectations rather than based on how hungry they are or on their dietary goals. Another explanation, especially regarding the backlash effect among dieters, may be that sensory imagery creates ambivalent attitudes and conflicts between hedonic goals and dieting goals, resulting in self-control failure (Cornil et al. 2014; Stroebe et al. 2013).

In this paper, we focus on hedonic calorie-dense foods because of their negative impact on health. From a theoretical perspective we would expect multisensory imagery to have a lower effect on staple foods like bread or rice or on healthy snacks like cereals, which exhibit less sensory-specific satiation (Redden and Haws 2013; Sorensen et al. 2003). Future research should test whether multisensory imagery has the dual advantage of limiting the intake of hedonic foods but not of healthier foods. It would also be useful to test our interventions when a variety of food is available – such as served buffet-style – given that people exhibit less sensory satiation when food is varied (Rolls et al. 1981). Similarly, it would be interesting to explore the impact of multisensory imagery on nonfood experiential consumption (e.g., music). In many instances pleasure diminishes with repetition yet people generally fail to predict this hedonic adaptation effect (Wang et al. 2009).

It would be also interesting to explore other consequences of multisensory imagery. For example, training children to focus on the multisensory experiences of eating may encourage them to approach novel foods or to learn to appreciate the hedonic value of eating fruits and vegetables (Hong et al. 2011). Finally, multisensory imagery could be extended to non-sensory aspects of eating pleasure, say by prompting people to consider the aesthetic and symbolic dimensions of eating pleasure, such as the pleasure derived from beautifully presented dishes and tables (Hoyer and Stokburger-Sauer 2012; Zellner et al. 2014) or learning about the food’s origin and preparation (Korsmeyer 1999).
To conclude, our results question a rich cultural and philosophical tradition that considers sensory pleasure as immoral, and taste as an impoverished sense responsible for bodily intemperance (Cornil and Chandon 2015; Coveney 2006; Korsmeyer 1999). Alba and Williams (2013) observe that this tradition is perpetuated in modern research on consumer behavior, for example when food choices are framed as vices or virtues. Our findings suggest that it is time to stop caricaturing eating enjoyment as the simple fulfillment of visceral impulses and to rehabilitate the pleasure of eating, as experienced in countries such as France, Italy, Japan and South Korea, where the prevalence of obesity and eating disorders is noticeably lower (Rozin et al. 2003; Rozin et al. 2011).

**ADDITIONAL STATEMENT**

The authors have reported the total number of observations which were excluded, the criteria for doing so and all experimental conditions. They have also reported all measures, except for demographic data (age, income, and education) which were not used in the analyses. They aimed for large sample sizes (>50) per condition in studies ran on Amazon Mechanical Turk (Studies 2, 3 and 5). In Study 1, they only had access to two classes of children, for a total of 21 participants per condition. In Study 4, they were also constrained by the limited number of female participants in the subject pool interested in a study involving actual consumption of commercial chocolate cake and reached 30 participants in each of the 12 conditions.
REFERENCES


Brunstrom, Jeffrey M and Nicholas G Shakeshaft (2009), "Measuring affective (liking) and non-affective (expected satiety) determinants of portion size and food reward," *Appetite*, 52 (1), 108-14.


Fairburn, Christopher G (2008), *Cognitive behavior therapy and eating disorders*: Guilford Press.


Garbinsky, Emily, Carey K. Morewedge, and Baba Shiv (2014), "Interference of the end: Why recency bias in memory determines when a food is consumed again," *Psychological Science*, In press.


Laran, Juliano (2010), Choosing Your Future: Temporal Distance and the Balance between Self-Control and Indulgence.


Moulton, Samuel T and Stephen M Kosslyn (2009), "Imagining predictions: mental imagery as mental emulation," Philosophical Transactions of the Royal Society B: Biological Sciences, 364 (1521), 1273-80.


Patterson, Ruth E, Jessie A Satia, Alan R Kristal, Marian L Neuhausser, and Adam Drewnowski (2001), "Is there a consumer backlash against the diet and health message?," *Journal of the American Dietetic Association*, 101 (1), 37-41.


Rode, Elizabeth, Paul Rozin, and Paula Durlach (2007), "Experienced and remembered pleasure for meals: Duration neglect but minimal peak, end (recency) or primacy effects," *Appetite*, 49 (1), 18-29.


Zellner, Debra A., Christopher R. Loss, Jonathan Zearfoss, and Sergio Remolina (2014), "It Tastes As Good As It Looks! The Effect of Food Presentation on Liking for the Flavor of Food," *Appetite*, 77 (C), 31-35.

FIGURE 1
STIMULI FOR STUDY 1 (TOP) AND STUDIES 2 AND 4 (BOTTOM)
FIGURE 2

STUDY 2: EFFECTS OF MULTISENSORY IMAGERY AND SIMULATED SATIATION ON PORTION SIZE CHOICE AND EXPECTED ENJOYMENT OF CHOSEN PORTION
FIGURE 3

STUDY 3: PORTION SIZE CHOICE AND WILLINGNESS TO PAY FOR CHOSEN PORTION
FIGURE 4

STUDY 3: PRE-INTERVENTION EVALUATIONS OF PORTIONS BASED ON EXPECTED SENSORY PLEASURE AND HUNGER SATIATION

“Just right for sensory pleasure”

“Just right for hunger satiation”
FIGURE 5

STUDY 4: EFFECTS OF SENSORY IMAGERY AND HEALTH IMAGERY ON EXPECTED AND ACTUAL EATING ENJOYMENT

- Actual enjoyment (all conditions)
- Expected enjoyment (sensory imagery condition)
- Expected enjoyment (control condition)
- Expected enjoyment (health imagery condition)

Eating Enjoyment (1-10 scale)

Portion 1  Portion 2  Portion 3  Portion 4  Portion 5
FIGURE 6

STUDY 4: EFFECTS OF SENSORY AND HEALTH IMAGERY ON PORTION SIZES CHOSEN BY DIETERS AND NORMAL EATERS

Portion Size Choice

Dieting Score (reversed)

- Control
- Multisensory imagery
- Health imagery

Dieters
Normal Eaters
FIGURE 7

STUDY 5: EFFECT OF MULTISENSORY INFORMATION AND NUTRITION INFORMATION ON PORTION SIZE CHOICE AND WILLINGNESS TO PAY FOR CHOSEN PORTION