Can Smaller Meals Make You Happy?
Behavioral, Neurophysiological, and Psychological Insights Into Motivating Smaller Portion Choice

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AUTHORS' NOTE

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ABSTRACT

Can smaller meals make you happy? Four studies show that offering consumers the choice between a full-sized food portion alone and a half-sized food portion paired with a small nonfood premium (e.g., a small Happy Meal toy or the mere possibility of winning frequent flyer miles) motivates smaller portion choice. Importantly, we investigate why this is the case and find that both food and the prospect of receiving a nonfood premium activate a common area of the brain (the striatum), which is associated with reward, desire, and motivation. Finally, we show that the choice results are mediated by a psychological desire for, but not by liking of, the premium. Notably, we find that choice of the smaller food portion is most pronounced when the probability of obtaining the premium is not disclosed compared to when the probability is disclosed or when the receipt of the same premium is stated as being certain. Taken together, motivating choice and consumption of less food may be successful if smaller portions are accompanied by an incentive.

Keywords: redesign of portion size preferences, food choice, toy premiums, small monetary premiums, fMRI, consumer neuroscience, neuromarketing.

Marketers in the fast food industry appear to motivate food choice by providing toy premiums as psychological rewards, as evidenced by the popularity of the McDonald's Happy Meal. In fact, a recent study of a nationally representative sample of fast food restaurants calculated that over 54% of the 6,716 restaurants studied offer and actively promote kids' meals to children (Ohri-Vachaspati et al. 2015). Relatedly, an analysis of all nationally televised ads by the top 25 fast food restaurants in the United States found that 69% of the ads directed at children featured toy premiums or giveaways (Bernhardt et al. 2013). This marketing strategy appears to be effective; a recent study found that children's desire for visiting fast food restaurants was motivated more by the toy than by the food (Henry and Borzekowski 2015). At the same time, the use of toy premiums has received extensive criticism because they sway visits to fast food restaurants, whose energy-dense, low-nutrition meals (Hobin et al. 2012; McAlister and Cornwell 2012) could contribute to weight gain and obesity (Swinburn et al. 2015).

In this research, we ask whether such premiums can be used as a "force for good" by motivating smaller-sized portion choice. In four studies, we show that consumers are motivated to choose a smaller-sized food portion over its larger-sized counterpart when the smaller-sized portion is paired with a nonfood premium (toy premium or monetary premium). Motivation is observed using behavioral, neurophysiological, and psychological indicators. Motivation is also detected using different nonfood premiums (toys, lottery tickets, frequent flyer miles), in different populations (children, adults), and with premiums whose receipt is certain versus uncertain.

Our findings contribute managerially to premiums like Happy Meal toys and how their use might benefit children. Findings also contribute to research on smaller-sized portion choice and portion control (e.g., van Ittersum and Wansink 2012; Wansink and van Ittersum 2003, 2007; Wansink, van Ittersum, and Painter 2006; Zlatevska, Holden, and Dubelaar 2016) by identifying a novel determinant of smaller portion choice: nonfood premiums. Our findings also contribute theoretically to work on commensuration (Espeland and Stevens 1998) and choice substitution effects between money and food (e.g., Kim, Shimojo, and O'Doherty 2011; Reimann, Bechara, and MacInnis 2015; Valentin and O'Doherty 2009). Prior research has studied the commensurability of different stimuli (food and money) that are *certain* to occur (e.g., Kim et al. 2011; Nunes and Park 2003). Augmenting this work by also examining premiums whose receipt is *uncertain*, we find that nonfood premiums appear to be most motivating when they are framed as possible versus probable or certain. Beyond contributing to the literature on commensuration and choice substitution, these novel findings also speak to emerging research on the motivational impact of uncertainty (Goldsmith and Amir 2010; Shen, Fishbach, and Hsee 2015). Below, we review the conceptual logic driving the aforementioned ideas.

COMMENSURATION AND CHOICE SUBSTITUTION

Recent research has asked whether and to what extent food might be processed similarly compared to appealing nonfood stimuli such as money (e.g., Kim et al. 2011; Valentin and O'Doherty 2009). To the extent that this is the case, food and money may be behaviorally, neurophysiologically, and psychologically tied to a “common currency” (Montague and Berns 2002; Reimann 2016; Schultz, Dayan, and Montague 1997), such that they are measured by the same standards (e.g., their motivational impact) and made commensurable (Espeland and Stevens 1998).

Some prior consumer research supports the idea that food and money are behaviorally intertwined. For example, hungry consumers are less likely to donate money to charity than are satiated consumers (Briers et al. 2006). Money also stimulates salivary secretion in a manner similar to the response to food (Gal 2012). In addition to these behavioral studies, independent neuroscientific research found that both food (Berridge 1996) and money (Knutson et al. 2001) activate the brain's striatum, whose reception and processing of the neurochemical dopamine is behaviorally linked to desire and motivation as well as to self-reports of being rewarded (e.g., Reimann et al. 2010). Activation of the striatum has also been found in response to appealing stimuli other than food and money, including beautiful artwork (Vartanian and Goel 2004) and preferred products (Knutson et al. 2007). To date, no study has yet examined how and why commensurability between food and appealing nonfood stimuli would impact food choices; specifically, the question of how and why consumers are motivated to forgo food for nonfood premiums, such as toy premiums or monetary premiums, has not yet been answered. The studies we describe next have been designed to examine this question.

The general idea that consumers can be motivated to choose a smaller-sized portion of food when it is accompanied by a nonfood premium requires that we provide evidence for the motivating effects of such premiums. We use behavioral, neurophysiological, and psychological data to indicate motivation. In all of our studies, motivational impact is indicated *behaviorally*, showing that children and adults choose a smaller portion over a larger portion when it is accompanied by a premium. Motivational impact is also indicated *neurophysiologically* (in Experiment 1) by observing that a smaller food portion coupled with a monetary premium (a half-sized sandwich and the prospect of winning a $10 premium) activates the same brain area (the striatum) as a large food portion alone (in this case, a full-sized sandwich). Our research thus builds on the idea of a common neurophysiological currency—specifically, the neurochemical dopamine (e.g., Montague and Berns 2002; Schultz et al. 1997; Wise and Rompre 1989)—in investigating whether the combination of a smaller-sized food portion plus a small monetary premium results in striatal activation (or, indirectly, mesolimbic dopamine) equivalent to that of a larger-sized food portion alone. Finally, motivational impact is observed *psychologically* (in Experiment 3) by showing that motivational desirability mediates the choice effect.

PILOT STUDY:
CHILDREN PREFER SMALLER PORTIONS WHEN THEY INCLUDE TOYS

Method

Design and Participants. The Pilot Study used a binary choice task to test whether nonfood premiums can motivate smaller-sized portion choice. Typically, toy premiums are used to sway children to choose entire meals. Here, we explored the effect of including the toy with the half-sized portion, but not the full-sized portion, on portion size choice. Seventy children from an elementary school (54% female; M_{age} = 7.69 years) made different food choices with parental disclosure and teacher approval. The sample size was determined by the number of children attending school on the day of the study. Data from the entire sample was usable. Two children did not make choices on all food items.

Procedures. Each participant was shown two photos side by side. One photo depicted a submarine sandwich. The other depicted exactly half of that submarine sandwich and a small toy similar to those found in McDonald's Happy Meals (toys shown were a minature animal for female participants and a plastic car for male participants). We asked participants to choose the option they preferred. Choice served as the primary dependent variable. Half-sized portion choices were coded as 0, and full-sized portion choices were coded as 1. We repeated this procedure using four other entrees (mini pizza, small hamburger, small bag of French fries, and chicken nuggets) and a small dessert (chocolate chip cookie). Gender and age were recorded but did not affect the results here or in subsequent studies and hence are not reported further.[1]

Results

Choice results for the submarine sandwich showed that the half-sized sandwich paired with a toy premium was chosen significantly more often (72%) than the full-sized sandwich alone (28%), $\chi^2 = 12.55$, $p < .001$. The children's greater preference for the smaller food portion paired with the toy was also found for the other foods (64% over 36% chose two instead of four slices of the mini pizza, $\chi^2 = 5.71$, $p < .05$; 70% over 30% chose the half burger, $\chi^2 = 11.20$, $p < .01$; and 64% over 36% chose the smaller portion of French fries, $\chi^2 = 5.23$, $p < .05$), except for the nuggets (47% versus 53%, $\chi^2 = .23$, *n.s.*) and the cookie (48.5% versus 51.5%, $\chi^2 = .06$, *n.s.*). Aggregated over the six different foods, the half-sized portions coupled with the toy were chosen significantly more often compared to the full-sized portions alone (61% vs. 39% on average).

[1] Data on other variables was also collected, and analyses are briefly discussed here. Children reported hunger before and after making their choice (1—not at all; 5—very strong). Average hunger was calculated across the two data points. For each full-sized portion and bundle of half-sized portion and toy, children reported valence (1—very bad; very good) and arousal (1—boring; 5—exciting). Averages valence and arousal were calculated. Children were asked whether they always eat their plate empty (1—no, never; 5—yes, always completely). Height and weight were measured and the age-adjusted body-mass-index (BMI) was calculated. Data were entered into binary logistic regressions with gender (female), age, average hunger, average valence full-sized portion, average valence half-sized portion, average arousal full-sized portion, average arousal half-sized portion, empty plate, and BMI as independent variables and choice (separately for each of the six different foods) as dependent variables. Only gender (female) had a significant negative effect on choice of the hamburger ($B = -1.26$, SE = .59, Wald = 4.49, $p < .05$). All other variables had nonsignificant effects.

Discussion

The Pilot Study results show that the majority of children chose a half-sized portion paired with a toy premium over a full-sized portion without a toy premium. These findings are consistent with our idea that nonfood premiums may be commensurable with and hence substitute for food. Our findings also imply that children can possibly be motivated to choose a smaller-sized portion if it is accompanied by a toy premium. However, we also found interesting differences between food types. The full-sized portions of both chicken nuggets and cookie and the bundle of their half-sized portion equivalents and toy were almost equally preferred. One explanation for this finding could be that both nuggets and cookies have a higher perceived sugar content than the other foods (submarine sandwich, mini pizza, burger, fries), which in turn may have increased the saliency of the full-sized portion to children. Clearly, a cookie is a sugary desert. Arguably, chicken nuggets, especially the BBQ sauce that often comes with it, contain sugar. As such, maybe both foods are more salient, which may have impacted children's choice.

The following Experiment 1 extends the Pilot Study results in several ways. First, we collected not only choice data (as in the Pilot Study) but also neuroimaging data, so as to assess whether the bundle of half-sized portion and nonfood premium activate similar areas of the brain (specifically, areas linked to reward, desire, and motivation) as the full-sized portion alone. Second, Experiment 1 includes a control condition in which participants choose between a full-sized portion and a half-sized portion, both offered without a premium. Third, we assess whether the Pilot Study results replicate for adults. Fourth, Experiment 1 also differs from the Pilot Study by using a different type of premium—one framed as uncertain. We explain this manipulation next.

When providing nonfood premiums, marketers might incentivize the choice of smaller-sized portions by giving consumers a premium every time they choose a smaller-sized option. This product bundle would be closest to the Happy Meal-type bundle used in the Pilot Study, where a toy premium is offered with each purchase. An alternative to this approach is to pair a smaller-sized food choice with the uncertain receipt of a premium. It is common for marketers to offer deals for which the prospect of premium receipt is uncertain. For example, instant win games, sweepstakes, contests, and mystery deals suggest to consumers that they *might* receive the premium, but premium receipt is not guaranteed (Kalra and Shi 2010; Zichermann and Linder 2010). Uncertain premiums have some economic appeal to marketers, since they need not be paid out for each smaller-sized portion choice. However, prior research on the commensurability of food with nonfood resources has focused only on premiums whose receipt is *certain* to occur (e.g., Kim et al. 2011; Valentin and O'Doherty 2009). Observing that the Pilot Study results are replicated when the receipt of the premium is uncertain would thus add to this literature.

EXPERIMENT 1: NEUROPHYSIOLOGY AND CHOICES WHEN SMALLER PORTIONS INCLUDE MONETARY PREMIUMS

Method

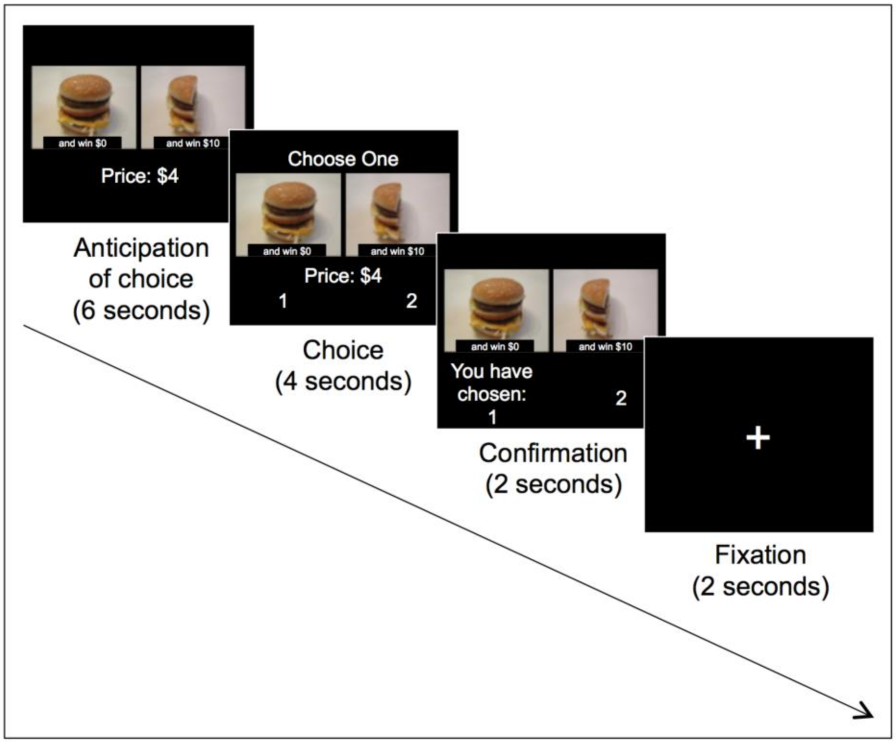
Design and Participants. Experiment 1 employed a 4 (magnitude of the uncertain monetary premium: $0 [no premium], $10, $50, $100) × 12 (food type) within-subjects experimental design, with the magnitude of the uncertain monetary premium as the within-subjects independent variable and full-sized portion choices as the dependent variable. Twenty-three adult students from a large university (57% female; M_{age} = 21.40 years) returned complete survey responses, made food choices at the four different monetary magnitudes ($0, $10, $50, and $100), and underwent functional magnetic resonance imaging (fMRI) for monetary compensation, a copy of their anatomical scan, and/or course credit. Our sample size is similar to those of other consumer research using fMRI data (e.g., Hedgcock, Vohs, and Rao 2012; Yoon et al. 2006).

Procedures. Participants were checked for medical eligibility to participate in an fMRI experiment and, if eligible, gave written informed consent to participate. Participants were placed inside a full-body 3.0 Tesla Siemens Magnetom scanner fitted with a 12-channel matrix head coil. We assessed blood-oxygen-level-dependent (BOLD) responses in various parts of participants' brains while participants made their choices, following pertinent measurement guidelines established for fMRI research (e.g., Poldrack et al. 2008; Reimann et al. 2011).

Food Choice Task. Participants were first told that their choices were real and that they would receive a coupon for their two most preferred food items. Participants were also told that their name would be included in a raffle for the amount of monetary premium they chose most of often. Participants were further instructed that the cost of their two preferred food items ($4 × 2 = $8) would be deducted from their monetary compensation. After reading the instructions, participants were offered binary choices between photos of full-sized and half-sized food portions (e.g., a Subway's Footlong sandwich measuring twelve inches vs. half of the same sandwich measuring six inches). The complete set of food stimuli is shown in the Appendix Figure. Three premiums that offered the prospect of winning one of three different amounts ($10, $50, or $100) or no premium ($0) were paired with each food item's half-sized portion. The odds of winning the premium were deliberately kept undisclosed to serve as a more conservative test of our hypothesis (note that Experiment 3 includes a condition with disclosed winning probabilities). The full-sized portion was always offered without a premium. The price of the two choice options was purposely kept the same at $4. Participants were asked to choose between the full-sized portion and the half-sized portion with either no premium or three different uncertain premiums ($10, $50, or $100). The four possible amounts of the monetary premium multiplied by the twelve different food items resulted in 48 pseudo-randomized trials. As shown in Figure 1, each trial had four distinct phases: anticipation of choice, choice, confirmation, and fixation. During the anticipation-of-choice phase, participants were given some time to consider whether to choose the full-sized or the half-sized portion. They were then prompted to make their choice by pressing either 1 or 2 on a button box they held in both hands. Participants then received a confirmation of their choice. After completing the 48 choice trials while undergoing fMRI, participants exited the scanner. Gender, age, and hunger level (1—a little; 9—a lot) were recorded, none of which altered the results and are hence not discussed further. Participants were then debriefed and received full compensation.

Neuroimaging Data Collection and Analyses. The Appendix provides a detailed technical report of the fMRI data collection and analyses. Neuroimaging data were preprocessed and analyzed using the BrainVoyager QX 2.20 analyses software (Goebel, Esposito, and Formisano 2006), which provides various views of the brain for each participant (e.g., Hedgcock and Rao 2009; Hedgcock et al. 2012). We measured changes in BOLD responses for each voxel using the volume map of each participant (i.e., the map of brain function over the course of the 48 trials of the food choice task). The Appendix describes how such responses were calculated.

Figure 1: Experiment 1: Consumers repeatedly made choices between full-sized and half-sized food portions while undergoing functional magnetic resonance imaging

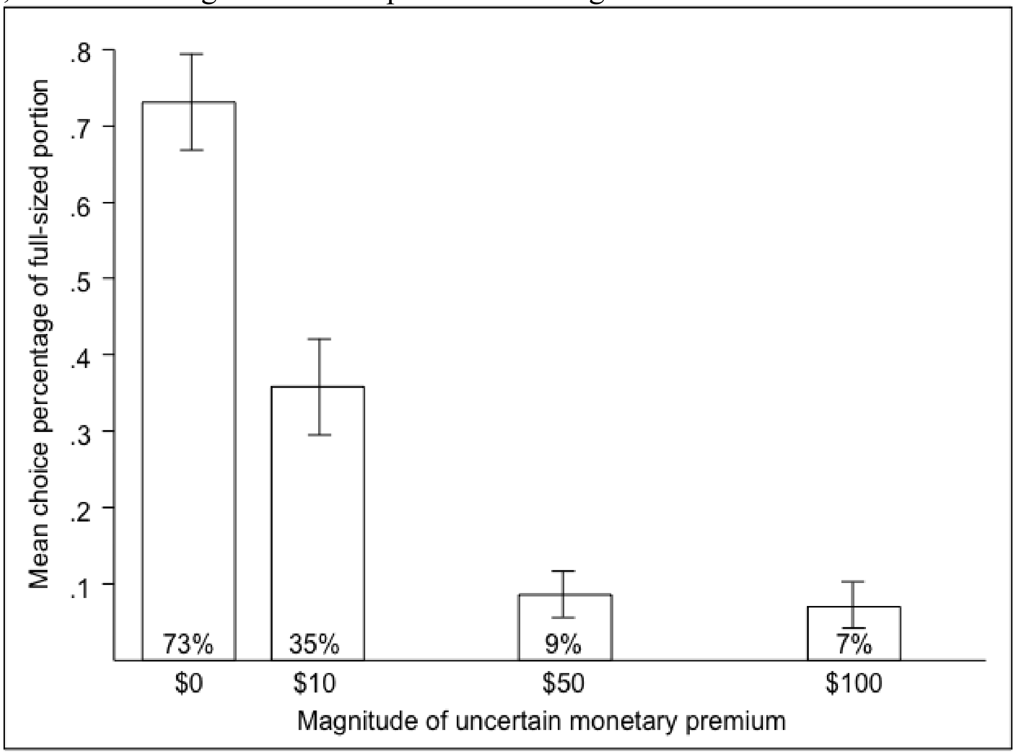


Results

Behavioral Results. Experiment 1 replicated the choice results of the Pilot Study using adults (vs. children) and an uncertain monetary premium (vs. a certain non-monetary toy premium). Data were entered into a random-intercept logistic regression model with actual choice response (half-sized portion choice = 0; full-sized portion choice = 1) as the dependent variable, magnitude of the uncertain monetary premium ($0; $10; $50; $100) as the independent variable, and subject as clustering variable (Rabe-Hesketh and Skrondal 2012). Full-sized portion choices decreased significantly as monetary premium amounts increased (b = -.043, SE = .003, z = -12.95, p < .001). These results show that participants can be motivated to choose a smaller portion size when the half-sized portion is paired with a premium that offers the prospect of winning a monetary premium.

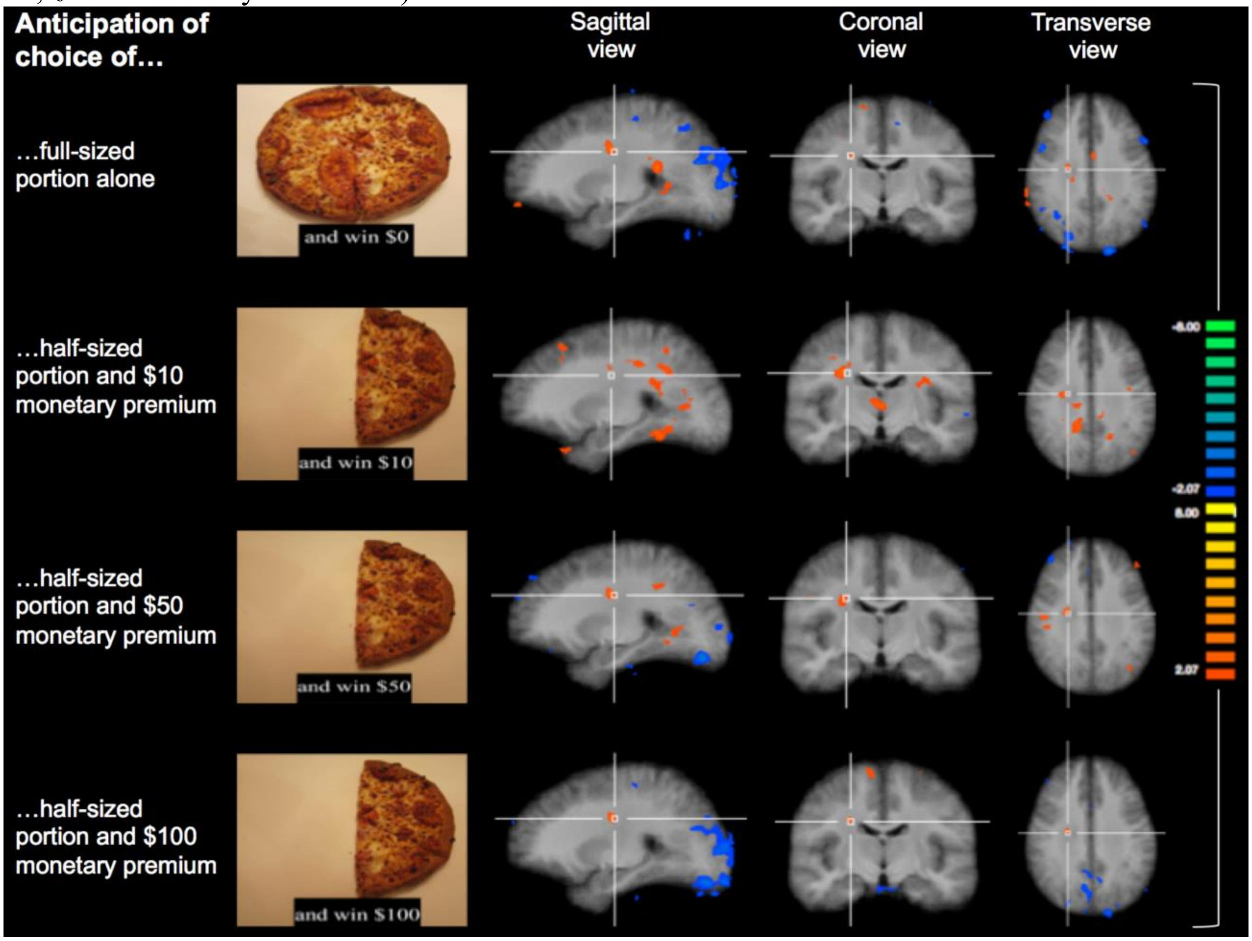
To illustrate this finding, we calculated a mean percentage of full-sized portion choices across the 12 food types for each of the four magnitude conditions ($0; $10; $50; $100) and for each participant. The overall mean percentage of full-sized portion choices was then calculated for all 23 participants, resulting in four mean percentages. Three separate paired-samples *t* tests were run to compare these four percentages: participants chose the full-sized portions most often when the half-sized portions were offered without a monetary premium (mean [*M*] percentage of full-sized portion choices: $M = .73$, SD = .29) and less frequently when the half-sized portions were paired with a premium that offered the prospect of winning $10 ($M = .35$, SD = .26), $50 ($M = .09$, SD = .15), or $100 ($M = .07$, SD = .12). The mean percentage of full-sized portion choices was significantly lower when the half-sized portions were paired with the prospect of winning $10 versus when they were paired with no premium, $t(22) = 5.82$, $p < .001$, $d = 1.38$. The mean percentage of full-sized portion choices was significantly lower when the half-sized portions were offered with a premium that offered the prospect of winning $50 compared to $10, $t(22) = 4.48$, $p < .001$, $d = 1.23$, but not with a premium that offered the prospect of winning $100 compared to $50, $t(22) = 1.07$, n.s., $d = .15$. Figure 2 illustrates these results.

Figure 2: Experiment 1: Consumers are more likely to choose half-sized portions over full-sized portions when the half-sized portions are paired with monetary premiums whose receipt is uncertain, even if the magnitude of the possible winning is small



Neurophysiological Results. Neuroimaging data revealed increased BOLD responses in the dorsal striatum (specifically the caudate nucleus and putamen) for both anticipation of choice of full-sized portions alone *and* anticipation of choice of half-sized portions paired with a monetary premium whose receipt is uncertain (compared to baseline brain activation at $p < .05$). Figure 3 illustrates this finding. On the color bar, warmer colors (red) indicate increased brain activation, while cooler colors (blue) indicate decreased brain activation.

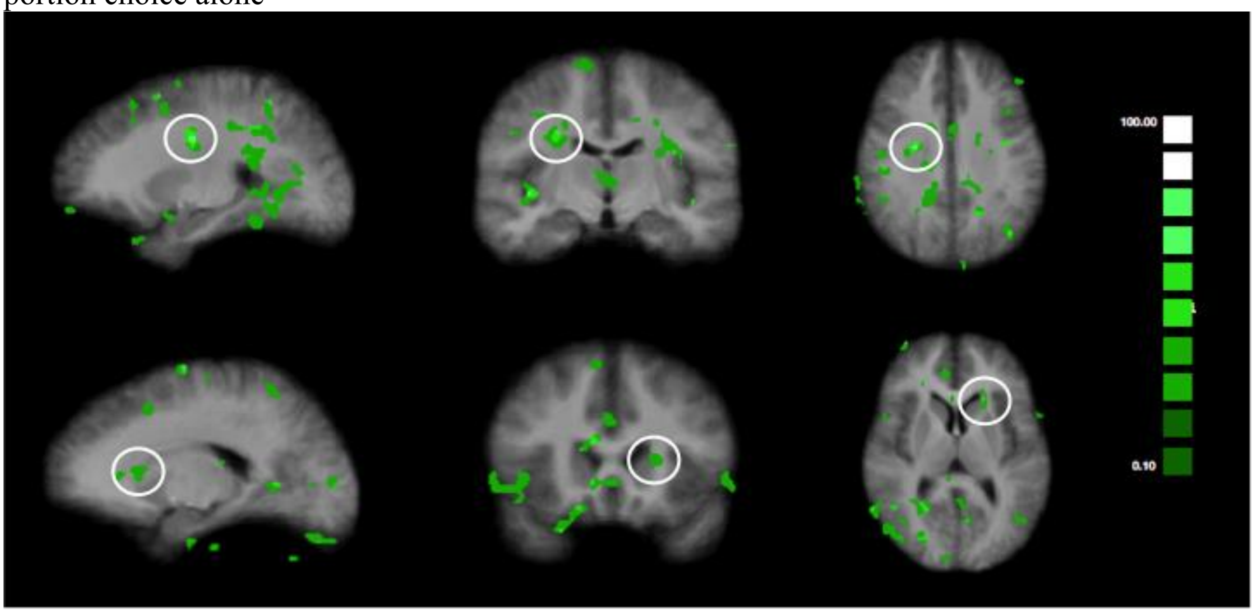
Figure 3: Experiment 1: Significant increase in brain activation in the caudate nucleus and putamen for the anticipation of choice of full-sized portions alone *and* half-sized food portions paired with an uncertain monetary premium compared to baseline (BOLD response at *x*: 23, *y*: -12, *z*: 30 marked by cross hairs)



Note.—The pizza is shown as exemplary stimulus here and was one of twelve different food items for which average brain activation was calculated (for the complete overview of food stimuli see the Appendix Figure).

To substantiate our claim that the bundles of half-sized portion and monetary premium recruit the same brain system than full-sized portions alone, we calculated a probability map across the four different conditions, which shows the percentage-wise overlap of brain activation. As shown in Figure 4, we found significantly overlapping BOLD responses in the striatum in anticipation of choosing full-sized food portions alone compared to anticipation of choosing half-sized food portions paired with an uncertain monetary premium ($10; $50; $100). The lighter the color, the higher the percentage-wise overlap. Specifically, BOLD responses common to all four conditions were found in the striatum in the right hemisphere (at and around Talairach coordinates of *x*: 20, *y*: -18, *z*: 30; *x*: 8, *y*: 23, *z*: 0; and *x*: 23, *y*: -12, *z*: 30) as well as in the left hemisphere (*x*: -18, *y*: 19, *z*: 9; *x*: -8, *y*: 1, *z*: 21; *x*: -19, *y*: -8, *z*: 23; and *x*: -37, *y*: -38, *z*: -3). Figure 4 illustrates two of the identified areas. The circles highlight the location of the striatum at Talairach coordinates of *x*: 23, *y*: -12, *z*: 30 (top row) of *x*: -18, *y*: 19, *z*: 9 (bottom row).

Figure 4: Experiment 1: Overlapping BOLD responses in the striatum for half-sized food portions paired with a uncertain monetary premium ($10; $50; $100) compared to full-sized portion choice alone



These results provide evidence of commensuration and speak to the motivational potency of combining smaller-sized food portions with monetary premiums in the quest to alter portion choice. Specifically, half-sized food portions, when coupled with an uncertain monetary premium, add up to levels of striatal activation akin to those found for full-sized portions alone. According to extant neuroscience research, such striatal activation is indicative of the release of the neurochemical dopamine from the brain stem to the striatum (D'Ardenne et al. 2008; Schott et al. 2008). Previous neuroscientific research suggests that striatal activation can be interpreted as a reward response (e.g., Berridge 1996) and that increased activation within the striatum is associated with self-reported measures of feeling rewarded (e.g., Reimann et al. 2010).

Meta-Analytic Interpretation of Underlying Psychological Process. Like much prior research using fMRI, the present study relies on reverse-inferring in that activation of a particular brain area (e.g., striatum) is interpreted as support for engagement of a particular psychological process (e.g., reward processing). In dealing with this controversial issue, pertinent recommendations are closely followed (Poldrack 2006). First, rather than pursuing an exploratory approach that would rely on post-hoc explanation of a particular result, Experiment 1 was set up to test a very specific prediction pertaining to activation in the striatum that prior research has linked to the related concept of reward processing. Second, we obtained an estimate for the degree to which the overlapping brain areas identified in the present research are activated by "reward." If selectivity was relatively high, one can infer with greater confidence that a reward-related process is involved given activation in the striatum. Using the neurosynth.org database (Yarkoni et al. 2011), we found that, of the striatal regions identified in the present research, several areas appeared to be selective for processing reward (see Table 1). These meta-analytic results indicate the two regions as most appropriate regions of interest for our purposes.

Table 1: A meta-analysis on the basis of the neurosynth.org database (Yarkoni et al. 2011) reveals that striatal regions are selective for reward processing

Brain area	**Functional process implied (keyword entered in database)**	**Talairach coordinates of the region of interest (nearest in database)**			**Reverse inference *z*-score**	**Posterior probability**
		x	***y***	***z***		
Striatum (including caudate and putamen)	Reward	8 (8)	23 (24)	0 (0)	2.93	.69
		-18 (-18)	19 (20)	9 (10)	2.86	.71
		20 (20)	-18 (-18)	30 (30)	1.96	.73
		23 (24)	-12 (-12)	30 (30)	1.89	.73
		-8 (-8)	1 (2)	21 (22)	1.37	.63
		-19 (-20)	-8 (-8)	23 (24)	n/a	n/a
		-37 (-38)	-38 (-36)	-3 (-4)	n/a	n/a

Note.— "n/a" stands for "not applicable" and refers to the fact that no data was found for this location in the neurosynth.org database as of April 28, 2015.

Overlapping Activation in Other Brain Areas. Results also revealed overlapping activation in other parts of the brain (as seen in Figure 4). Although we did not have a-priori hypotheses on the involvement of these areas, we briefly report them here. As a word of caution, we are entering speculative terrain here (Craig et al. 2012; Yoon, Gonzalez, and Bettman 2009) by trying to conceptually link possible psychological functions of these brain areas to our account. Such an approach bears a higher risk of inappropriate reverse-inferring, because these brain areas could also ascribe to psychological functions unrelated to commensuration. Overlapping activation was found in the *medial prefrontal cortex* (Brodmann area [BA] 10), which could be explained by this brain area's role in processing judgments (Dubé et al. 2008; Kober et al. 2010) and modulating self-control (e.g., Bechara et al. 1994; Bechara et al. 1998; Bechara et al. 1997; Tabibnia et al. 2011). This effect may be rooted in increased dopaminergic projections to the prefrontal cortex, because the brainstem projects not only to striatal areas but also to prefrontal regions (Carr et al. 1999; Wise 1978, 2002), leading to a dopamine-induced disinhibition of this higher-order control region while processing these self-regulatory judgments (Bechara 2005). Further, results revealed the *anterior cingulate cortex* and *posterior cingulate cortex* (BA 32 and 30), previously associated with reward-based decision making (Bush et al. 2002) and delayed rewards (Peters and Buechel 2009). Results also revealed the *insula* (BA 13), which most generally is a translator of sensations that arise in the body (Mesulam and Mufson 1982). Finally, results revealed the *temporal lobe*, which has been related to emotional processing and decision making (Naqvi, Shiv, and Bechara 2006), and the *occipital lobe*, the primary vision cortex (Clarke and Miklossy 1990).

Discussion

Experiment 1 suggests that providing a monetary premium, even one whose magnitude is relatively small and whose receipt is uncertain, significantly motivates smaller-sized portion choice. The fact that participants were willing to substitute part of a tangible food item for the *mere prospect* of a relatively small monetary premium (e.g., $50) is intriguing.

Experiment 1 also shows that a smaller food item paired with an uncertain monetary premium produced striatal activation comparable to that produced by the larger food portion alone, in line with the notion of a common currency for food and money (e.g., Montague and Berns 2002; Schultz et al. 1997; Wise and Rompre 1989).

While the behavioral and neurophysiological results from the Pilot Study and Experiment 1 thus far are consistent with the idea that both toy premiums and uncertain monetary premiums can motivate smaller-sized portion choice, we conducted Experiment 2 to see whether our results would be replicated when respondents were hungry and hence more motivated to choose a larger-sized portion. Experiment 2 thus aimed to provide additional support for reward-related and motivational processes serving as underlying explanations.

EXPERIMENT 2: CHOICES WHEN SMALLER PORTIONS INCLUDE MONETARY PREMIUMS AND THE MOTIVATION TO OBTAIN FOOD IS MANIPULATED

Method

Design and Participants. Experiment 2 employed a 2 (motivation to obtain food: low, high) × 4 (magnitude of the uncertain monetary premium: \$0 [no premium], \$10, \$50, \$100) × 12 (food type) mixed experimental design, with motivation to obtain food as the between-subjects independent variable, the magnitude of the uncertain monetary premium as the within-subjects independent variable, and full-sized portion choices as the dependent variable. The motivation to obtain food was operationalized by manipulating participants' hunger levels such that one part of the participants was hungry and the other part was satiated. Participants in the satiated condition were asked to eat a regular meal right before the experiment, while participants in the hungry condition were asked to refrain from eating prior to the experiment. One hundred eighty-three adults from a paid national consumer panel (52% female; $M_{age} = 43.69$ years) returned complete responses and made food choices for monetary compensation, and also matched our inclusion criteria regarding pre-study food intake. We checked whether participants followed our instructions: participants in the satiated condition were asked whether they ate 30 minutes or less ago, one hour or less ago, or more than one hour ago; participants in the hungry condition were asked whether they ate between five and twelve or more hours ago. Initially, 231 individuals returned complete responses; however, 48 that were assigned to the satiated condition stated that they had not eaten for more than one hour and thus did match our study criteria and were excluded from further analyses. The sample size had previously been set to at least 100 participants in each of the two conditions, and the final number was determined by the panel provider.

Procedures. Participants were randomly assigned to the two hunger conditions. Participants engaged in an online version of the food choice task described in Experiment 1. The procedures and design of the choice task were otherwise identical. Gender, age, and hunger level (1—a little; 9—a lot) were recorded. Participants were then debriefed and received full compensation.

Results

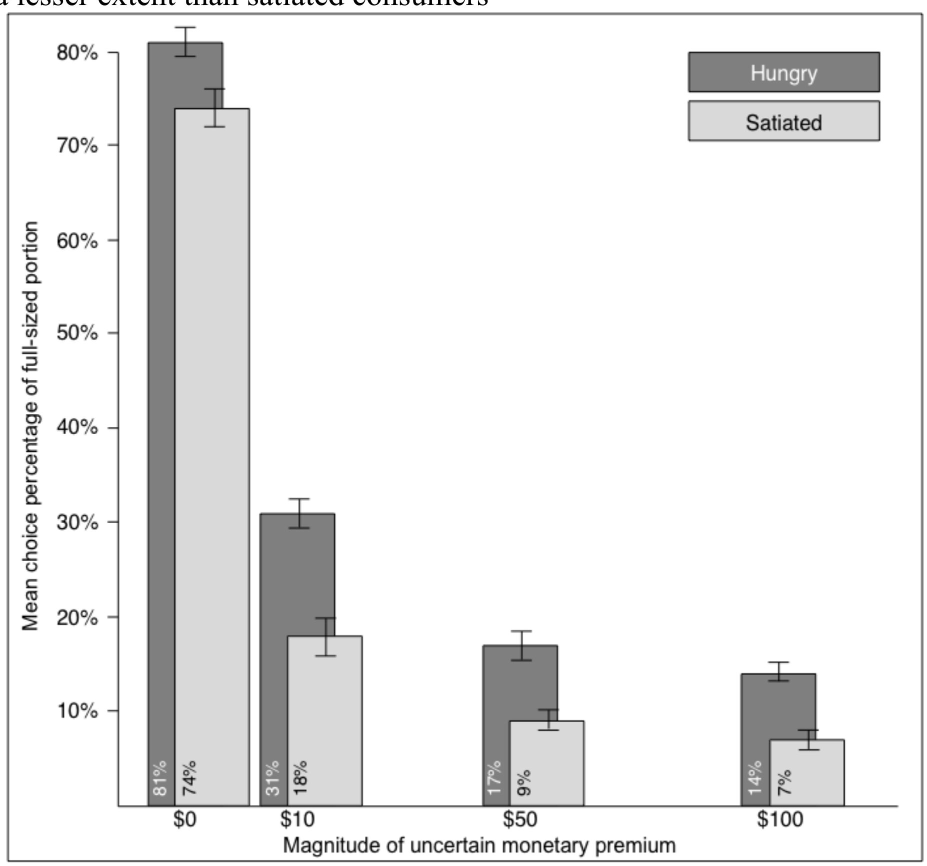
Manipulation Check. An independent-samples *t* test showed that the manipulation of the motivation to obtain food was successful: participants in the high motivation condition reported significantly higher levels of hunger ($M = 5.50$, SD = 2.93) than did participants in the low motivation condition ($M = 1.47$, SD = .99), $t(181) = 10.68$, $p < .001$, $d = 1.84$. On average, participants in the satiated condition ate approximately 38 minutes prior to the study, while participants in the hungry condition ate ten or more hours prior to the study.

Effect of the Uncertain Monetary Premium on Full-Size Portion Choices. Experiment 2 replicated the behavioral findings from the Pilot Study and Experiment 1. Data were entered into a random-intercept logistic regression model with actual choice response (half-sized portion choice = 0; full-sized portion choice = 1) as the dependent variable, magnitude of the uncertain monetary premium ($0; $10; $50; $100) as the independent variable, and subject as clustering variable (Rabe-Hesketh and Skrondal 2012). This logistic regression replicated the predicted negative main effect of magnitude on full-sized portion choice ($b = -.041$, SE = .001, $z = -33.87$, $p < .001$), showing that full-sized portion choice decreases significantly as the magnitude of the uncertain monetary premium increases.

Motivation to Obtain Food as Moderator (But Not Boundary Condition). To test whether the results are significantly moderated by the motivation to obtain food, we regressed full-sized portion choice on magnitude, hunger (low = 0; high = 1), and their interaction term. Results again showed the predicted main effect of magnitude on full-sized portion choice ($p < .001$).

Further, we observed a significant positive main effect of hunger on full-sized portion choice ($p < .05$). We also observed that the effect of magnitude on full-sized portion choice was moderated by hunger; there was a significant positive interaction between magnitude and motivation ($b = .008$, SE = .003, $z = 2.91$, $p < .01$). In order to explore this interaction in more detail, we examined the slopes of magnitude at both levels of motivation (e.g., Aiken and West 1991; McFerran et al. 2010). The slope of magnitude was comparatively less negative in the high hunger ($b = -.039$, SE = .001, $z = -28.00$, $p < .001$) than in the low hunger condition ($b = -.047$, SE = .002, $z = -19.52$, $p < .001$), suggesting that the magnitude of the uncertain premium reduces full-sized portion choice relatively less when consumers are hungry than when they are satiated. Figure 5 illustrates the results for the hungry group and the satiated group separately.

Figure 5: Experiment 2: Hungry consumers can also be motivated to choose more half-sized portions over full-sized portions when the half-sized portions are paired with monetary premiums, although to a lesser extent than satiated consumers



Role of the $0 Condition. We further explored whether including the $0 condition was driving the significant regression results. To do so, we allowed for a non-linear effect of magnitude on choice by estimating a spline specification (a fit analysis revealed the spline to be more adequate than a polynomial specification). A spline is a continuous function formed by connecting linear segments, and the points where the segments connect are called knots. When running our regression, we broke magnitude into two linear splines knotted at $10. Effects were negative and strongly significant for both splines, albeit considerably larger in magnitude for the first spline (b = -.345, SE = .010, z = -34.17, $p < .001$) than the second spline (b = -.018, SE = .001, z = -14.28, $p < .001$). This finding is consistent with our account of the large difference between the $0 and $10 condition, with the prospect of winning larger amounts thereafter having a still noticeable but comparatively smaller effect.

Discussion

Experiment 2 replicates and extends the behavioral results of both the Pilot Study and Experiment 1 using a larger sample and manipulating the motivation to obtain food. Both satiated and hungry consumers were more likely to choose a half-sized portion over its full-sized counterpart when the half-sized portion was paired with the prospect of receiving even a small monetary premium. Results from Experiment 2 also support our neuroimaging findings by further highlighting that reward, desire, and motivation are at play as underlying mechanisms: in Experiment 2 we altered the motivation to obtain food and showed that average full-size portion choices changed accordingly.

Surprisingly, hunger moderated but did not mute the effect of the monetary premium on choice of the smaller-sized option. This finding is interesting. Although hunger is a powerful motivational state in its own right (Gal 2016; Piech, Pastorino, and Zald 2010), it did not eliminate the impact of the uncertain monetary premium on smaller-sized portion choice.

Results from Experiment 2 also replicate and extend recent research on uncertainty. Whereas prior research suggests that uncertainty regarding the value of monetary premiums may be motivating (Goldsmith and Amir 2010; Shen et al. 2015), our results suggest that the mere prospect of winning any monetary premium (even a small one) can motivate smaller portion choice. This finding also implies that exorbitant monetary premiums (which might be costly to food providers) may not be necessary to motivate consumers to choose less; even premiums that provide the possibility of winning $10, $50, or $100 motivate consumers to choose less food.

Because none of our previous studies included a *psychological* measure of motivation, the following Experiment 3 aimed to assess motivation by asking participants to evaluate the motivational desirability of the monetary premium. In addition, we wanted to assess the generalizability of our findings, as the impact of our results would be broader if we could show that they generalize to different monetary premium types. For this reason, Experiment 3 used a different type of monetary premium: frequent flyer miles. Although frequent flyer miles can be accumulated like cash and can be exchanged for goods and services, they are a somewhat different form of currency; frequent flyer equivalents are not always easy to calculate, they are not always exchangeable for cash, and the contexts in which they have exchange value are often limited. Finally, Experiment 3 delves more deeply into issues surrounding the premium uncertainty by manipulating it.

EXPERIMENT 3: CHOICES WHEN SMALLER PORTIONS INCLUDE POSSIBLE VERSUS PROBABLE VERSUS CERTAIN MONETARY PREMIUMS

Method

Whereas the Pilot Study involved premiums whose receipt was framed as certain, receipt of the monetary premium was uncertain in Experiments 1 and 2. Experiment 3 examines the role of certainty more directly by comparing the efficacy of premiums framed as certain with two distinct types of uncertain premiums: those framed as possible and those framed in terms of their probability. Premiums framed as possible suggest that receipt of the monetary premium could occur, but the likelihood of winning is not disclosed. Premiums framed as possible (i.e., "you could win!") are thus distinguished from those that are also uncertain but are characterized in terms of their probability (e.g., "you have a 1 in 50 chance of winning"). Premiums stated in probabilistic terms emphasize not what might or could happen but what is likely to happen given certain odds; thus, these premiums carry explicit likelihood information that specifies the odds of occurrence. For simplicity, we use the terms *probabilistic* and *possible* to describe uncertain premiums whose probability of occurrence is versus is not explicitly stated, respectively. We expect that uncertain premiums are more effective in motivating smaller portion choice than certainty-framed ones, an idea that builds on recent research (Goldsmith and Amir 2010; Shen et al. 2015).

Design and Participants. Experiment 3 employed a 3 (receipt of the monetary premium: *possible* [where receipt is uncertain and probabilistic estimates are absent]; *probable* [where receipt is uncertain but is stated in probabilistic terms]; *certain* [where receipt of the monetary premium is guaranteed]) × 2 (monetary premium: absent, present) × 12 (food type) mixed experimental design. Receipt of the monetary premium served as the between-subjects independent variable, monetary premium served as the within-subjects independent variable, and percentage of full-sized portion choices across the 12 food types served as the dependent variable. Three hundred ninety-nine adults from a paid national consumer panel (52% female; M_{age} = 40.58 years) returned complete survey responses for monetary compensation. Initially, 431 individuals returned complete survey responses; however, 32 did not make food choices and were thus excluded from further analyses. The sample size had previously been set to 100 participants in each of the three conditions, and the final number was determined by the panel provider.

Procedures. Participants were randomly assigned to one of three conditions: (1) the possibility-framed condition, in which participants were told that they could possibly win 10,000 frequent flyer miles without any disclosed winning probability; (2) the probability-framed condition, in which participants were told that they could win 10,000 frequent flyer miles with a disclosed 1:50 winning probability; and (3) the certainty-framed condition, in which participants were told they would definitely receive 200 frequent flyer miles. The expected values of the probability-framed and certainty-framed monetary premiums were equal (10,000 × 1/50 = 200). Participants were told that any frequent flyer program would accept the miles. The two magnitudes of the monetary premium (absent, present) multiplied by the twelve different food items resulted in 24 pseudo-randomized choice trials in this repeated-measures choice task. Otherwise, the trial structure was identical to the one reported for Experiments 1 and 2.

For each food and each food/premium bundle (presented in pseudo-random order as was done in Experiments 1 and 2), we asked participants to report the motivational desirability (hereafter "desirability" for short). We operationalized desirability using the items attractive, desirable, important, and motivating, and we also asked participants whether they wanted or whether they rejected (reverse-coded) the food or food/premium bundle. Items were presented on nine-point scales (1—least; 9—most). Desirability items were averaged across the twelve different foods. The six-item scale yielded satisfactory reliability ($\alpha \geq .94$). These items reflect the extent to which consumers desire the stimulus and are thus motivated to obtain it. Desirability would provide additional (here, psychological) evidence that consumers can be motivated to choose smaller-sized portions through the use of nonfood premiums. More specifically, we predict that desirability mediates the relationship between the possibility-framed premium and choice.

We also assessed whether choices are impacted less by the desirability of the choice option (i.e., its motivational impact) than by the fact that it is merely likable. Attitudinal liking (hereinafter "likability") reflects how much consumers regard the premium as likable, positive, and pleasant. It represents a conscious, subjective value rating (Berridge and Robinson 2003). To indicate stimulus likeability, we asked participants to rate how much they liked each food or food/premium bundle. Participants used nine-point semantic differential rating scales (-4; 4), displaying the poles dislike/like, negative/positive, bad/good, disagreeable/agreeable, unpleasant/pleasant, and not acceptable/acceptable (Schmitt, Pan, and Tavassoli 1994). We also added unpleasurable/pleasurable to the list of differentials. Likeability items were averaged across the twelve different foods. The seven-item scale yielded satisfactory reliability ($\alpha \geq .95$).

Given the results of our previous studies, we expected that desirability would mediate the relationship between receipt of the monetary premium and food portion choice. The potential impact of likability, however, was unclear. Whereas one stream of research argues that likability is a key predictor of choice (e.g., Ajzen and Fishbein 1970), another indicates that this may not be the case (Berridge 1996; Dai, Brendl, and Ariely 2010). Indeed, prior research suggests that attitudes do not precisely predict willingness to engage in effortful, goal-directed behavior (Bagozzi, Dholakia, and Basuroy 2003). Furthermore, consumers can make product choices based on implicit, possibly conditioned affective reactions of desirability without necessarily valuating them subjectively and forming a conscious attitude about them (Berridge and Robinson 2003). Moreover, it has been argued that, in the absence of desirability, likability is simply a hedonic state that lacks motivational significance. However, without likability, desirability still motivates choice despite the absence of the pleasure of likability (Berridge 1996). Following this notion, desirability may be a necessary predictor, whereas likability may be just a sufficient predictor, of stimulus-directed choice behavior. Accordingly, we propose that consumers will not choose a smaller portion over a larger one unless the premium is desirable, even in situations where likability exists.

For manipulation check purposes, we asked participants to rate the certainty of receiving the frequent flyer miles, operationalized on a nine-point scale (1—not at all; 9—very much) and using the item "I am sure that I would receive frequent flyer points through this offering." Gender and age were recorded.

Results

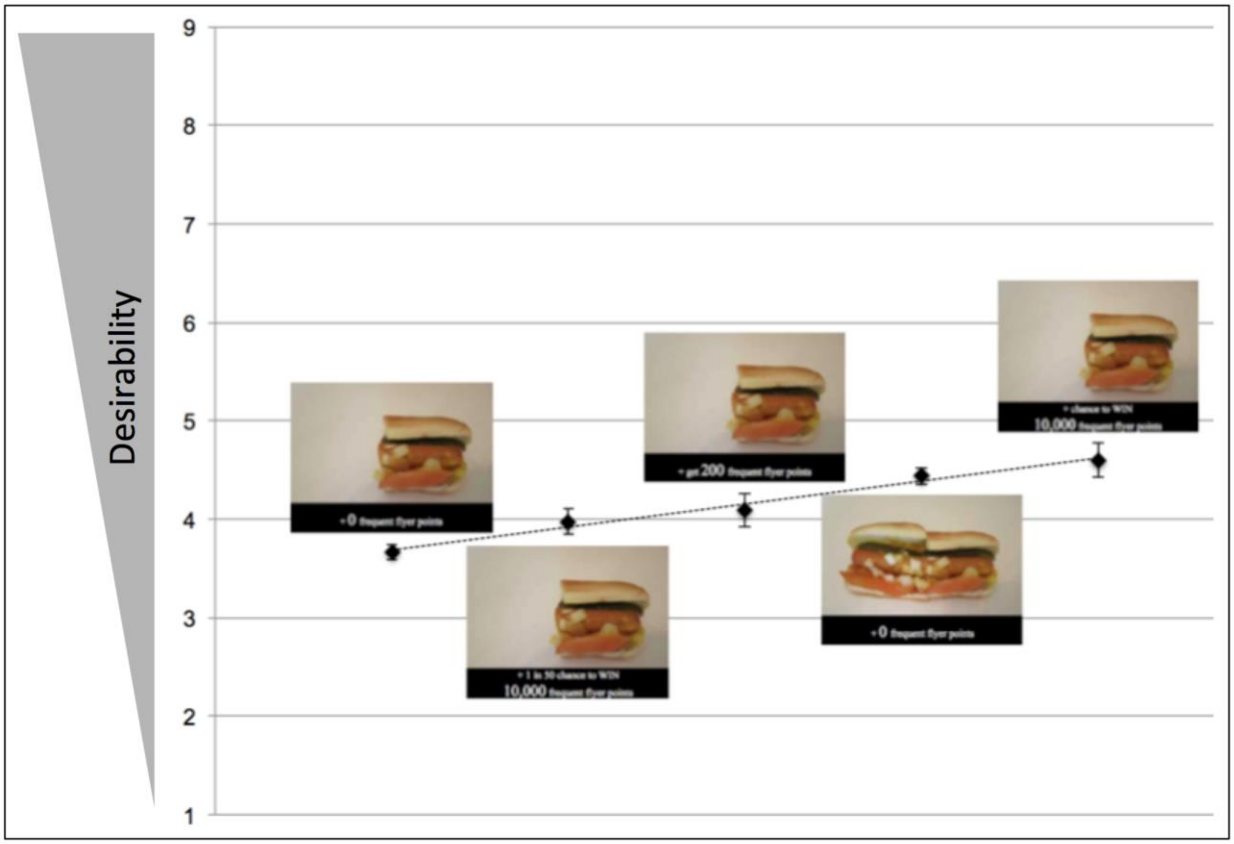
Manipulation Check. A one-way ANOVA showed that the manipulation of the extent to which participants regarded the acquisition of the frequent flyer miles as certain showed a significant main effect of the receipt of the monetary premium on certainty, $F(2, 396) = 6.09$, p

< .01, *r* = .17. Post hoc tests revealed that participants in the probability-framed condition were significantly less certain about receiving the monetary premium (*M* = 3.48, SD = 2.04) than were participants in both the possibility-framed condition (*M* = 4.01, SD = 2.35), *t*(396) = 2.01, *p* < .05, *d* = .24, and the certainty-framed condition (*M* = 4.44, SD = 2.41), *t*(396) = 3.43, *p* < .01, *d* = .43. The difference between the possibility-framed and certainty-framed conditions was non-significant, *t*(396) = 1.46, *n.s*.

Effect of Receipt of the Monetary Premium on Percentage of Full-Sized Portion Choices. We replicated the behavioral choice results found in our earlier studies. Specifically, a one-way ANOVA, using receipt of the monetary premium as the independent variable and percentage of full-sized portion choices as the dependent variable, revealed a significant main effect of receipt on the percentage of full-sized portion choices, *F*(2, 396) = 3.51, *p* < .05, *r* = .13. Post hoc tests confirmed that participants in the possibility-framed condition chose full-sized portions to a significantly lesser extent (*M* = .52, SD = .31) than did participants in both the probability-framed condition (*M* = .59, SD = .28), *t*(396) = -2.08, *p* < .05, *d* = .24, and the certainty-framed condition (*M* = .61, SD = .29), *t*(396) = -2.47, *p* < .05, *d* = .30. On average, participants in the possibility-framed condition chose full-sized portions 7% less frequently than did participants in the probability-framed condition and 9% less frequently than did participants in the certainty-framed condition. The difference between the probability-framed and certainty-framed conditions was non-significant, *t*(396) = .62, *n.s*.

Desirability But Not Likeability Mediates the Link Between Receipt of the Monetary Premium and Percentage of Full-Sized Portion Choices. Figure 6 shows that the perceived desirability of half-sized portions paired with a possibility-framed monetary premium (*M* = 4.60, SD = 1.71) is greater than that of full-sized portions alone (*M* = 4.44, SD = 1.95), indicating that the desirability from food and money accumulate psychologically.

Figure 6: Experiment 3: Half-sized portions paired with a possibility-framed monetary premium were perceived to be most desirable

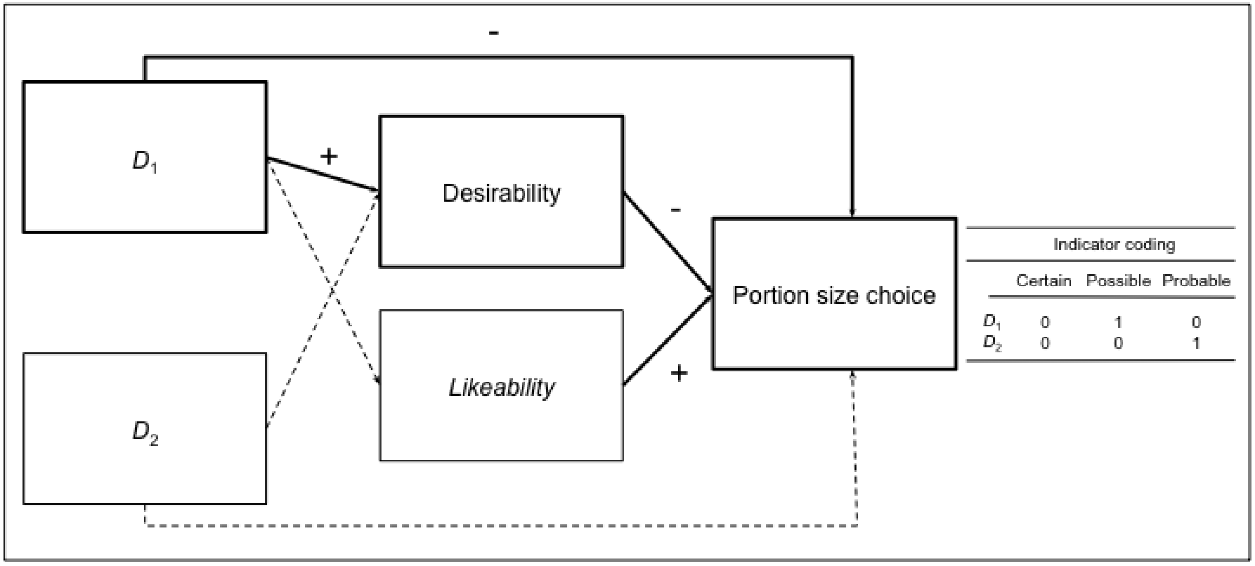


Note.—The hotdog is shown as exemplary stimulus here and was one of twelve different food items for which average perceived desirability was calculated (for the complete overview of food stimuli see the Appendix Figure). The five different choice options were sorted from lower to higher desirability and are from left to right: half-sized portions alone, half-sized portions and 10,000 miles at 1:50 winning probability, half-sized portions with 200 sure miles, full-sized portions alone, and half-sized portions with 10,000 miles but undisclosed winning probability. Means and standard errors are shown.

A mediation analysis revealed that desirability explains why consumers are willing to substitute part of their food for a possibility-framed monetary premium. To test for mediation, we applied a mediational analysis approach that allows the independent variable to be multicategorical (i.e., to feature three or more experimental conditions) (Hayes and Preacher

2014). As shown in Figure 7, D_1 codes the possibility-framed condition and D_2 codes the probability-framed condition, with the certainty-framed condition serving as the reference group coded as 0 on D_1 and D_2 (Hayes and Preacher 2014, p. 457). The mediation analysis revealed that desirability but not likeability explains the link between monetary premiums and the percentage of full-sized portion choices, $F(4, 394) = 9.01$, $p < .001$, with 1,000 bootstrap samples and a confidence level of 95%. Specifically, results revealed significant effects of the receipt of the *possibility-framed* monetary premium (D_1) on desirability (path $a_{1,\text{ Desirability}}$: $b = .510$, SE = .23, $t = 2.21$, $p < .05$) and on the percentage of full-sized portion choices (path c_1: $b = -.094$, SE = .04, $t = -2.47$, $p < .05$) but not on likeability (path $a_{1,\text{ Likeability}}$: *n.s.*). Results further revealed non-significant effects of the receipt of the *probability-framed* monetary premium (D_2) on desirability (path $a_{2,\text{ Desirability}}$: *n.s.*), likeability (path $a_{2,\text{ Likeability}}$: *n.s.*), and on the percentage of full-sized portion choices (path c_2: *n.s.*). The full model with D_1, D_2, desirability, and likeability as independent variables revealed a significant negative effect of desirability on the percentage of full-sized portion choices (path $b_{\text{Desirability}}$: $b = -.061$, SE = .01, $t = -5.07$, $p < .001$) and a significant positive effect of likeability on the percentage of full-sized portion choices (path $b_{\text{Likeaability}}$: $b = .057$, SE = .01, $t = 4.92$, $p < .001$). Results also showed that the effect of the *possibility-framed* monetary premium (D_1) on the percentage of full-sized portion choices was smaller in both magnitude and significance (path c'_1: $b = -.087$, SE = .04, $t = -2.34$, $p < .05$) compared to path c_1, suggesting partial mediation by desirability. However, the effect of the *probability-framed* monetary premium (D_2) on the percentage of full-sized portion choices (path c'_2: *n.s.*) was non-significant, suggesting that the possibility-framed premium compared to the certainty-framed premium (but not the probability-framed premium compared to the certain premium) drives the effect on portion choice through desirability in this analysis.

Figure 7: Experiment 3: Receipt of a possibility-framed monetary premium explains portion size choice through motivational desirability but not through likeability



Note.— Solid lines denote significant paths and dashed lines denote non-significant paths.

Discussion

Experiment 3 replicates Experiments 1 and 2 while using a different type of monetary premium: frequent flyer miles. It also expands on the previous two experiments by showing that the impact of monetary premiums on half-sized portion choice is greatest when premium receipt is framed as merely possible than when it is framed as certain or when the probability of winning is explicitly stated. The half-sized version was also regarded as more desirable when paired with the possible premium than in conditions where the premium was certainty-framed or when winning probabilities were explicitly stated. Finally, consistent with expectations, desirability (but nor likability) mediated the effect of the premium receipt on portion choice.

Several factors may explain why consumers may be more motivated to choose a smaller-sized portion over a larger one when the smaller-sized option is paired with a possible versus a certainty-framed premium. First, researchers have speculated that the uncertainty associated with obtaining a stimulus (e.g., a possible premium) promotes attention to that stimulus (Cooper and Knutson 2008). Such attention may make the premium more psychologically salient and hence more important than certainty-framed premiums.

Second, premiums framed as possible may be more emotionally evocative than certainty-famed premiums. Such emotional evocation associated with possibility is clearly present in gambling or sports contexts, where the uncertainty of winning provides added attraction and desirability through emotional “rushes” and “thrills.” The possibility of receiving a premium is also goal-congruent. Possible and desirable goal-congruent outcomes have been found to evoke a state of hope (MacInnis and De Mello 2005; Reimann et al. 2014) for the premium’s receipt—a state that is in itself psychologically rewarding.

Third, consumers might imagine (anticipate) the happiness and joy they would experience from obtaining the uncertain premium, which should add emotional potency to the value of the premium itself. Forfeiting an uncertain premium can also evoke anticipated regret from having made the wrong choice once the possible premium’s outcome is revealed (Crawford et al. 2002). Indeed, consumers are reluctant to exchange a lottery ticket they are given with a different one (Bar-Hillel and Neter 1996), because they anticipate ex-post regret if they exchange their original ticket with another and the original ticket turns out to be a winning one.

Fourth, specific and desirable future states (like receiving a possible premium) are also highly imaginable, with consumers anchoring on the best-case scenario, as well as their anticipated emotional reactions to that scenario. Consumers may thus be overly optimistic about the acquisition of the possibility-framed premium, because mental imagery enhances expectations that the desired outcome will indeed occur (Anderson 1983; Carroll 1978).

Fifth, uncertain premiums framed in terms of probabilities may be less motivating than premiums framed as possible because the probabilistic nature of the premium creates a more rational mindset that tempers the emotions evoked by premiums stated as merely possible (e.g., hope, excitement, anticipated happiness). When probabilities are stated, the premium is described in base-rate versus case-rate terms, which should hinder mental imagery of oneself receiving the premium. Reduced imagery processing should temper expectations of premium receipt. Rather than anchoring on what is possible, premiums stated in probabilistic terms reflect not only desirable outcomes ("you could win…") but also undesirable ones ("…but it's likely that you won't"). Considering the likelihood that one will not win makes the premium less motivating.

GENERAL DISCUSSION

The present research aimed to assess whether consumers can be motivated to choose smaller-sized food portions (over larger-sized ones) when the smaller-sized portion is paired with the receipt of a nonfood premium. In four studies, we showed that consumers are indeed motivated to choose a half-sized portion versus a full-sized food portion when the former is paired with a nonfood premium (toy, monetary premium). Motivation was revealed behaviorally (through food choice) in all four studies. Motivation was also revealed neurophysiologically in Experiment 1, which shows that food and possible monetary premiums are processed in a common area of the brain associated with reward, desire, and motivation. Finally, motivation was revealed psychologically in Experiment 3, by showing that self-reported desirability (but not likeability) mediates the results. Significantly, we find that possibility-framed premiums are more motivating than either certainty-framed premiums or probability-framed premiums, an effect we demonstrated in Experiment 3.

The present research contributes to several research streams. First, we provide novel insight into how consumers can be motivated to choose smaller-sized portions. Such insight contributes to prior work on portion size (e.g., Block, Williamson, and Keller 2016; Davis, Payne, and Bui 2016; van Ittersum and Wansink 2012; Wansink and van Ittersum 2003, 2007; Wansink et al. 2006) by introducing a novel *motivational* factor of smaller portion choice: nonfood premiums. Our findings imply that food providers may consider offering possibility-framed monetary premiums to stimulate consumers to choose less food. This is an important insight, as it denotes that monetary premiums to redesign food portion choice need *not* involve payouts for each smaller-sized portion choice. Instead, marketers could provide incentives with uncertain outcomes—outcomes where a win is merely possible—which consumers find desirable. An open question is whether this effect holds over time. Future research could thus investigate whether consumers compensate for lower consumption in the focal meal during subsequent meals.

Second, our research contributes to a set of studies suggesting that uncertainty may have motivational significance (Goldsmith and Amir 2010; Shen et al. 2015). Our work expands on this prior research to suggest that there might be a psychological differentiation between uncertainties when the probability of outcomes is explicitly stated versus when it is not (i.e., probability-framed vs. possibility-framed uncertainty). Our theoretical account emphasizes that possibility-framed premiums might have stronger motivational value because they activate emotions like excitement, anticipated happiness, and hope while certainty-framed premiums or those stated in probabilistic terms are not predicted to be as emotionally evocative. Because we did not measure emotional states directly, future research might examine empirically whether such emotions are responsible for the motivational effects we observe.

Third, this research also highlights that consumers psychologically assign similar, if not higher, economic utility to the bundle of half-sized portion and nonfood premium compared to the full-sized portion similar alone, ceteris paribus. This finding is interesting as it shows that consumers translate items from different categories into one single currency to facility their substitution and exchange. As such, money is not just a simple counter—as traditionally assumed by classical economics—but can be traced back to dopaminergic reward and, thus, exchanged for other items (food).

Fourth, this research makes a methodological contribution to consumer neuroscience and neuromarketing. In Experiment 1, we identified activation within the striatum when participants anticipated different premiums. But what is the psychological meaning of striatal activation? To answer this question, we conducted two additional studies. In Experiment 2, we found moderation by the motivation to obtain food (or, in other words, being satiated vs. hungry). This moderation effect provided a hint for a possible mediator. In Experiment 3, we followed-up on this indication and found that motivational desirability underlies the effect of premium on choice. These insights helped us to address the methodological issue of "reverse inference," which states that the activation of a particular brain area (e.g., the striatum) cannot clearly be interpreted as support for engagement of a particular psychological process (Poldrack 2006). By conducting a neuroimaging experiment including a meta-analysis on the psychological function (Experiment 1), a behavioral experiment (Experiment 2), and a psychometric experiment (Experiment 3) to investigate the underlying process, this research "triangulates" (Homburg et al. 2012) the motivational mechanism on which the substitutability between food and money may be based.

Fifth, for consumers, our work implies that individuals can reward themselves for choosing less food with nonfood items, which helps offset the “lost” reward that was coming from food with that coming from nonfood items. This substitution of rewards assists consumers in staying happy and satisfied. Individuals could also reward other achievements (e.g., a job promotion) with nonfood items instead of a celebration with food and still be happy. Similarly, we recommend that parents could reward and, thus, reinforce their children’s achievements with nonfood incentives, even uncertain ones, rather than with food. As such, parents lessen the likelihood of linking good behavior to food intake, but instead link good behavior to the receipt of a nonfood incentive and, thus, avoid overeating.

Finally, our research suggests a win-win solution for both consumers and firms. Clearly, restaurants and food manufacturers are, more often than not, interested in selling more food, not less. Although consumers are typically more attracted by larger than by smaller food portions, when asked to eat less, many consumers actually do so (Schwartz et al. 2012). Our research provides a simple but powerful solution to unite these two, seemingly contradictory goals of selling more (firms) versus eating less (consumers). Firms may not be economically disadvantaged when premiums are limited in terms of cost and implementation effort, as is true with possibility-framed premiums. Such premiums might also enhance food choice without hurting bottom-line profitability, as indicated by our experimental design: the prices of the full-sized portion and combination of half-sized portion and monetary premium were kept deliberately constant (at $4) in all of our studies. Importantly, consumers tend to be better off when choosing a half-sized portion, because choice of a small portion is often healthier and may lead to better societal outcomes as a result of improved health consequences. We acknowledge that the choices in our research were hypothetical (despite the fact that consumers were asked to imagine that the choices were real and were expecting food coupons and payment for their participation). As such, and because of the potentially important practical contributions of our research, field testing of our findings should be conducted in future research to see whether actual restaurant patrons choose smaller portions if those smaller portions are paired with a nonfood premium.

THE BIGGER THEME: THE COMMENSURATION OF HAPPINESS

Undeniably, in their pursuit of happiness, consumers often seek pleasure and satisfaction in *freely* choosing and consuming products. Indeed, longitudinal data collected in dozens of nations around the globe over several decades suggest that rises in perceived freedom of choice lead to higher happiness levels (Inglehart et al. 2008). Yet, other research exposes a dark side to happiness (Gruber, Mauss, and Tamir 2011; Schwartz 2004)—from freedom of choice. That dark side is revealed by repeated overconsumption, desires for more, addiction, and a never-ending chase to be happy.

In food consumption, overweight and obesity are the direct result of that chase: as consumers' freedom of choice increases, so oftentimes do their waistlines, as was seen during the *wirtschaftswunder* of West Germany in the 1950s and as is observable in today's Mexico and other countries. Analogous observations can be made in other consumption domains, as evidenced by compulsive buying (e.g., Ridgway, Kukar-Kinney, and Monroe 2008), hoarding (e.g., Grisham and Barlow 2005), and binge-drinking (e.g., Courtney and Polich 2009), binge-gaming, or more recently "binge-netflexing" (i.e., watching multiple TV show episodes one after another). Notably, all of these states can lead to considerable states of *un*happiness in light of their personal, social, and health consequences (O'Guinn and Faber 1989).

In the domain of food consumption, overconsumption of fatty and sugary foods has given rise to desired or implemented government regulations that restrict food production and/or consumption. These regulations include taxes on “junk food” (Mexico), sweetened drinks (France), and salty and sugary foods (Hungary) (WHO 2015) or banning certain high-calorie foods or sizes altogether (United States) (Bernstein 2010; Lipka 2014). Yet, government regulations restrict consumers’ freedom of choice and, following the logic and findings of Inglehart et al. (2008), could lower happiness and cause consumer resistance.

This research suggests a novel method in the domain of food consumption that can affect happiness while maintaining freedom of choice. It also gives rise to a novel theoretical idea: the *commensuration of happiness*. Integrating theories on commensuration (Espeland and Stevens 1998) and subjective well-being (Diener 1984; Diener et al. 1985; Diener et al. 1999), we define the commensuration of happiness as conversion of different sources of positive life satisfaction into one common measure (Reimann 2016).

At first sight, the notion of commensurable happiness is implausible, because our general understanding of happiness is per definition highly subjective (Diener 1984) and, therefore, more likely to be incommensurable. Indeed, consumers’ understanding and experience of happiness varies greatly, depending on the source of happiness such as material goods (houses, cars) versus experiences (vacations) (Van Boven 2005). For example, when asked to remember spending $300 either on a tangible object one still owns or on an intangible experience only left in memory, consumers reported higher happiness for the experience compared to the object (Nicolao, Irwin, and Goodman 2009). To add complexity to the subject matter, consumers’ definition of happiness can vary even further, depending on their temporal focus (Mogilner, Aaker, and Kamvar 2012), personality (Richins 2013), age (Bhattacharjee and Mogilner 2014), and other situational and dispositional factors (cf. Diener et al. 1999; Lyubomirsky, Sheldon, and Schkade 2005 for comprehensive reviews). If happiness is truly as subjective as observed in much prior research, then it is a valid question to ask why happiness from one source (e.g., experience) would ever be commensurable with happiness from a different source (e.g., material possession)? In other words, spending $300 on experiences appears to be inequivalent to spending $300 on material possessions when it comes to happiness.

The notion of commensurable happiness suggests a focus on different sources of happiness to investigate the least common denominator(s) that enable the conversion of different qualities of positive life satisfaction. Money, price, or utility, although typical examples of commensuration metrics (Espeland and Stevens 1998), may not accurately convert to subjective states of happiness. At the same time, using only measures of pleasure, liking, and attitudes to assess and compare happiness sources overlooks what we believe is an important enabler of the commensuration of happiness: desire, dopaminergic reward, and motivation. Indeed, earlier views postulate happiness to be "harmonious satisfaction of one's *desires* and *goals*" (Chekola 1974, p. 12) and that "the fulfillment of *needs*, *goals*, and *desires* is somehow related to happiness" (Diener 1984, p. 562). These desires can be both shorter-term (e.g., to have fun) and longer-term (e.g., to eat less, to loose weight, to be healthier, to look better) and possibly be rooted in a common neurophysiological currency: the neurochemical dopamine (e.g., Montague and Berns 2002; Schultz et al. 1997; Wise and Rompre 1989).

Commensurating experiential and material sources of happiness. The theoretical and empirical work presented in this paper highlights different sources of happiness—both experiential (consuming food) and material (toy, money)—that speak to both shorter-term, more accessible desires (having fun) and longer-term, less accessible desires (loosing weight). Clearly, eating less is *not* fun for many people (and may even be a source of short-term *un*happiness), as portion size restriction requires discipline and self-control. Yet, by combining one shorter-term desire (to eat) with another shorter-term desire (to play) that in combination also address a longer-term desire (to be healthy), different sources of happiness become commensurable.

Commensurating "good" and "bad" sources of happiness. This research also highlights that "bad" sources of happiness (consuming fatty foods) can be thought of being commensurable with "good" sources of happiness. In the domain of health and food consumption, a good source of happiness might be diet and physical exercise to loose weight and be healthy. However, choosing and activating these sources requires discipline and self-control, and food-related reminders to consume less can backfire on those trying to exercise discipline and self-control such as dieters (Pham, Mandel, and Morales 2016). Bad sources of happiness, like fatty foods, which provide immediate gratification, are oftentimes more effective in pursuing and activating happiness; their choice does not require or even disinhibits discipline and self-control. At the brain level, the brain stem releases dopamine not only to the striatum but also to the prefrontal cortex upon expectation and/or reception of the happiness source (Volkow and Wise 2005). Since dopamine is a disinhibiting neurochemical, its release to the prefrontal cortex "disinhibits the inhibitor": in other words, the executive control functions of the prefrontal cortex such as weighing future consequences (Bechara et al. 1994) and differentiating between "good" and "bad" alternatives (Bechara et al. 1997) are diminished, thus facilitating an easy choice of the bad happiness source. Our research suggests that certain good sources of happiness (e.g., experiencing the thrill and excitement of uncertainty from the possibility of winning money or frequent flyer miles) can counterbalance the bad source (eating fatty food) and, therefore, facilitates *free* choice of the combination of “lesser evil” (half pizza) and good nonfood happiness source. This is where we believe the freedom of choice is maintained.

While some headway has been made in studying the commensuration of happiness, much more work needs to be done. We hope that future researchers are as excited as we are about the possibilities of disentangling desire/wanting from pleasure/liking, experientialism from materialism, and shorter-term from longer-term desires in the commensuration of happiness.

APPENDIX

FMRI Data Collection

For structural imaging, we obtained a high-resolution image of the brain using a 3D T1-weighted MPRAGE sequence (echo time (TE) / repetition time (TR) / inversion time = 3.1 / 2,530 / 800ms, flip angle = 10°, matrix = 256 × 256, field of view (FOV) = 256mm, slice thickness = 1mm without gap). For functional imaging, a time series of 261 volumes, with 41 slices in the transverse plane, was obtained using single shot gradient-echo planar imaging (TR = 2,000ms, TE = 25ms, flip angle = 90°, resolution = 3.0mm × 3.0mm × 2.5mm, and FOV = 192mm).

FMRI Data Analyses

Data Pre-Processing. For each participant, linear image realignment, co-registration, piecewise linear normalization to stereotactic anatomical space (Hedgcock et al. 2010), slice-scan time correction, motion correction, spatial smoothing with a three-dimensional Gaussian kernel, 4mm full-width at half maximum, and temporal high-pass filtering were performed.

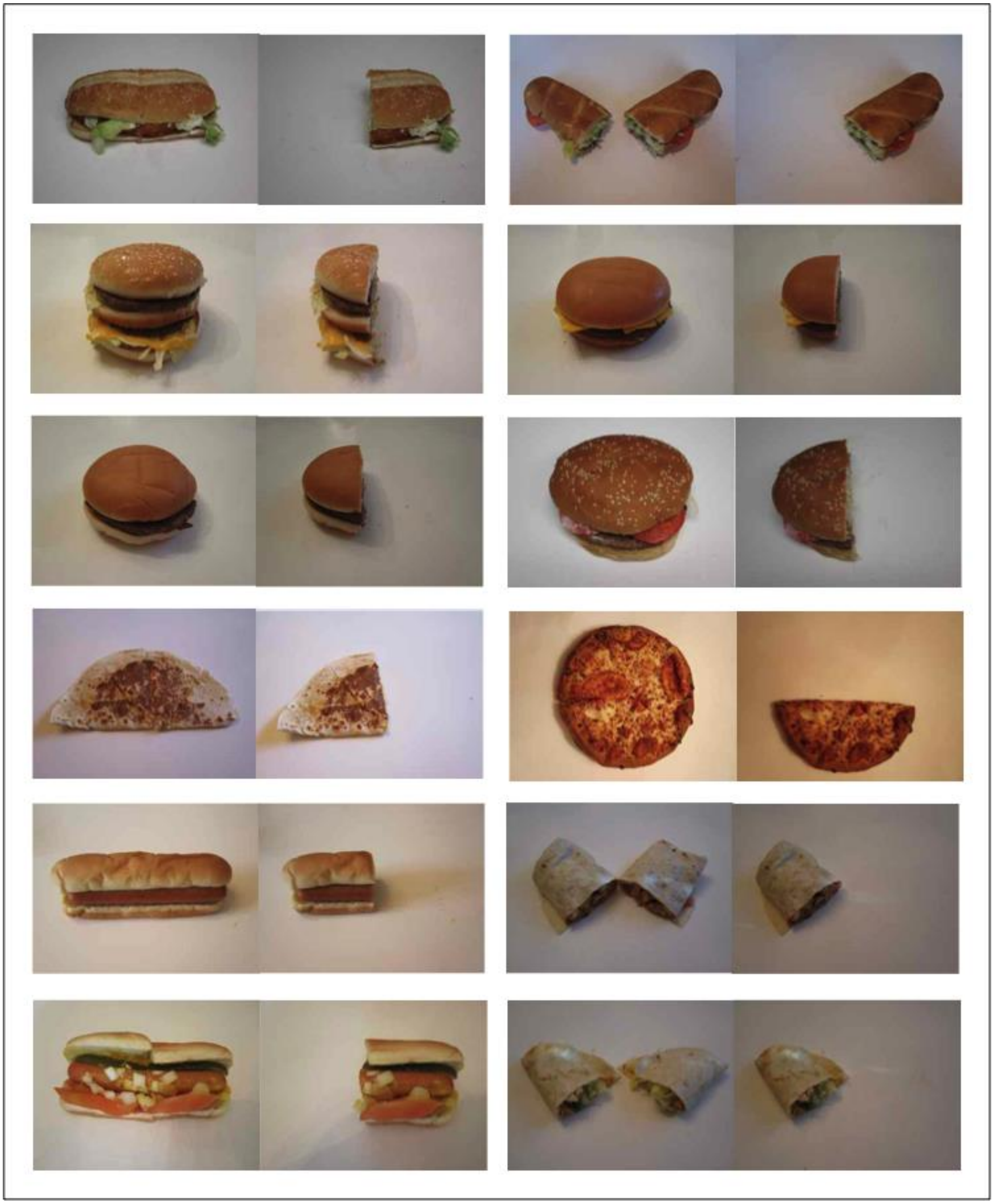
Stimulus Protocol. Next, for each participant, individual time course protocols were created. The dataset was then subdivided into ten two-second intervals, starting at the onset of each trial. For each two-second interval, eight unique predictors were created: (1) the instructions to participants regarding the task ("*Front*"), (2) the anticipation phase of choosing the full-sized portion when the half-sized portion was paired with no monetary premium (i.e., $0 premium, "*FullChoice_Half$0*"), (3) the anticipation phase of choosing the full-sized portion when the half-sized portion was paired with a $10 premium ("*FullChoice_Half$10*"), (4) the anticipation phase of choosing the half-sized portion when the half-sized portion was paired with a $10 premium ("*HalfChoice_Half$10*"), (5) the anticipation phase of choosing the half-sized portion when the half-sized portion was paired with a $50 premium ("*HalfChoice_Half$50*"), (6) the anticipation phase of choosing the half-sized portion when the half-sized portion was paired with a $100 premium ("*HalfChoice_Half$100*"), (7) the actual choice phase ("*Choice*"), and (8) the confirmation phase ("*Confirmation*"). The onset of each predictor was convolved with a finite impulse response function (FIRF) and modeled to identify voxels with blood flow that correlated with the predictors, resulting in a single-design matrix for each participant. This FIRF approach makes no assumptions about the specific details of the hemodynamic response function (HRF). It is significantly more sensitive than the HRF approach and is particularly suitable for event-related fMRI (Talairach and Tournoux 1988).

Design Matrix. Next, a multi-subject-design matrix was created, which included all 23 single-participant design matrices, and data were submitted to a random-effects, *z*-transformed, deconvoluted general linear model (GLM) with motion predictor. In line with previous research in decision neuroscience (e.g., Bechara et al. 1997) finding that the brain responds in anticipation to a subsequent choice, the analyses focused on the comparison of the six-second anticipation phases leading up to one of four specific choices: (1) the anticipation phase before making a full-sized portion choice when the half-sized portion is paired with no premium (i.e., $0 premium, "*FullChoice_Half$0*"); (2) the anticipation phase before making a half-sized portion choice when the half-sized portion is paired with a $10 premium ("*HalfChoice_Half$10*"); (3) the anticipation phase before making a half-sized portion choice when the half-sized portion is paired with a $50 premium ("*HalfChoice_Half$50*"); and (4) the anticipation phase before making a half-sized portion choice when the half-sized portion is paired with a $100 premium ("*HalfChoice_Half$100*").

Dependent Variables. We used the neuroimaging data to create two dependent variables. First, in line with prior consumer research (e.g., Knutson et al. 2007; Reimann et al. 2010), data were sorted according to each participant's actual choices. As such, each identified *change in BOLD responses* immediately preceded the subsequent behavioral choice. Contrasts were run against the baseline condition, which was modeled by the BrainVoyager software based on all neuroimages taken during the food choice task with the effect of all model predictors subtracted (Goebel 2010). The baseline condition in our analysis represents an approximated average activation state from which an increase or decrease in brain activation can be calculated. By subtracting all model predictor effects, we aimed to compensate for the ambiguous baseline condition problem in fMRI data (e.g., Stark and Squire 2001) by modeling a "true" baseline condition. The changes in BOLD responses during the anticipation of choice (compared to the baseline) served as the dependent variable. As such, the four experimental conditions (i.e., anticipation of full-sized portion choices when the half-sized portion was paired with a $0—no premium, $10, $50, or $100 premium) were not compared with each other directly but rather were each contrasted with the baseline condition.

Second, we examined the *degree of overlap in BOLD responses* (e.g., Kim et al. 2011) between the four conditions and the baseline (i.e., contrast 1: anticipation of half-sized portion choices paired with a $0 premium > baseline; contrast 2: anticipation of half-sized portion choices paired with a $10 premium > baseline; contrast 3: anticipation of half-sized portion choices paired with a $50 premium > baseline; and contrast 4: anticipation of half-sized portion choices paired with a $100 premium > baseline). A significant overlap between these four contrasts would indicate that common brain systems are involved in each condition (e.g., Montague and Berns 2002; Schultz et al. 1997; Wise and Rompre 1989). Limited overlap would link the food and monetary premium types to separate brain systems. In order to analyze the overlapping BOLD responses between the four contrasts, we created probabilistic overlap maps in BrainVoyager. Once the probabilistic maps were created, we converted the voxel clusters to volumes of interest in BrainVoyager.

Appendix Figure: Experiments 1-3: Food stimuli



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