The Journal of Nutrition. First published ahead of print August 24, 2016 as doi: 10.3945/jn.116.235184.

The Journal of Nutrition
Ingestive Behavior and Neurosciences

Large Portions Encourage the Selection of Palatable Rather Than Filling Foods[1–3]

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Abstract

Background: Portion size is an important driver of larger meals. However, effects on food choice remain unclear.

Objective: Our aim was to identify how portion size influences the effect of palatability and expected satiety on choice.

Methods: In Study 1, adult participants (n = 24, 87.5% women) evaluated the palatability and expected satiety of 5 lunchtime meals and ranked them in order of preference. Separate ranks were elicited for equicaloric portions from 100 to 800 kcal (100-kcal steps). In Study 2, adult participants (n = 24, 75% women) evaluated 9 meals and ranked 100–600 kcal portions in 3 contexts (scenarios), believing that *1*) the next meal would be at 1900, *2*) they would receive only a bite of one food, and *3*) a favorite dish would be offered immediately afterwards. Regression analysis was used to quantify predictors of choice.

Results: In Study 1, the extent to which expected satiety and palatability predicted choice was highly dependent on portion size ($P < 0.001$). With smaller portions, expected satiety was a positive predictor, playing a role equal to palatability (100-kcal portions: expected satiety, β: 0.42; palatability, β: 0.46). With larger portions, palatability was a strong predictor (600-kcal portions: β: 0.53), and expected satiety was a poor or negative predictor (600-kcal portions: β: −0.42). In Study 2, this pattern was moderated by context ($P = 0.024$). Results from scenario *1* replicated Study 1. However, expected satiety was a poor predictor in both scenario *2* (expected satiety was irrelevant) and scenario *3* (satiety was guaranteed), and palatability was the primary driver of choice across all portions.

Conclusions: In adults, expected satiety influences food choice, but only when small equicaloric portions are compared. Larger portions not only promote the consumption of larger meals, but they encourage the adoption of food choice strategies motivated solely by palatability. *J Nutr* doi: 10.3945/jn.116.235184.

Keywords: portion size, expected satiety, food choice, dietary decisions, palatability, unhealthy, obesogenic

Introduction

The term "unhealthy" often is applied to energy-rich foods that increase both energy intake (1) and the risk of obesity (2). Studies also have shown that dietary decisions are affected by emotions (3) and that social and contextual factors affect people in different ways (4, 5). These observations highlight potential triggers that can inform targeted strategies to promote healthier dietary choices (6). The study of unhealthy dietary choices also has benefited from the introduction of various imaging technologies. These advances are important because they can help to expose underlying neurobiological processes (7, 8). In other studies, researchers have focused on specific affective and orosensory characteristics of foods. Palatability is often considered, and particular emphasis has been placed on the role of fats, sugars, and salt, because these ingredients are associated with foods that are especially energy dense (9, 10). One possibility is that humans are drawn to energy-dense foods because they offer protection from starvation. However, energy density is not the sole determinant of energy content; amount or portion size also plays a role. This distinction between total calories and energy density is critical, yet very often these variables are confused or conflated in studies suggesting that energy-dense or high-calorie foods promote unhealthy dietary decisions (11, 12).

The term "food choice" can refer to what and how much a person goes on to consume. Here, it is used to refer to the type of food that is chosen rather than its quantity. Two previous studies have considered whether energy density remains a predictor of food choice after controlling for the energy content of foods. Remarkably, when relatively small (≤400 kcal) equicaloric portions were compared at lunchtime, low energy–dense foods

[1] Supported by the European Union Seventh Framework Programme [FP7/2007–2013 under Grant Agreement 607310 (Nudge-it)].

[2] Author disclosures: JM Brunstrom, A Jarvstad, RL Griggs, C Potter, NR Evans, AA Martin, JCW Brooks, and PJ Rogers, no conflicts of interest.

[3] Supplemental Tables 1–3 are available from the "Online Supporting Material" link in the online posting of the article and from the same link in the online table of contents at http://jn.nutrition.org.

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Manuscript received April 27, 2016. Initial review completed June 9, 2016. Revision accepted August 1, 2016.
doi: 10.3945/jn.116.235184.

were chosen over those with a higher energy density (13, 14). This appears to be because, calorie-for-calorie, lower energy–dense foods are expected to deliver a far greater reduction in our desire for food between meals (hereafter referred to as "expected satiety") (15). Evidence that nonhuman animals find satiation and satiety reinforcing is generally weak (16) [although low doses of cholecystokinin may condition flavor preferences (17)]. The reason for this discrepancy remains unclear, but it may be linked to an ability to plan for the future that is especially evident in humans.

Here, the objective was to determine whether portion size moderates the role of expected satiety in food choice. Specifically, we reasoned that the attraction of foods with high expected satiety might diminish when larger energy-matched portions are compared. This is because at larger portion sizes all foods would be expected to reduce the desire to eat between meals, even those that have low expected satiety. Results from 2 studies are reported that were designed to quantify and expose a potential trade-off between portion size, palatability (participants' acceptance of the taste of the food in question), and expected satiety in food choice. In so doing, our objective was to determine whether larger portions promote the selection of foods based on their hedonic properties, even after controlling for their energy content.

Methods

Participants. Based on an earlier study (15), in both Study 1 and in Study 2, we recruited 24 participants (**Table 1**) drawn from the staff and student populations of the University of Bristol (United Kingdom). To reduce demand awareness, participants were told that the purpose of the study was to explore "The effects of mood on appetite ratings, taste perception, and cognitive performance." Participants were excluded if they were *1*) vegetarian or vegan, *2*) not fluent in English, *3*) taking any medication that might influence appetite or metabolism (with the exception of oral contraceptive pills), or *4*) allergic or intolerant to any foods. In remuneration for their assistance, all were offered a financial reward or course credits upon completion of the study. Both studies were approved by the University of Bristol Faculty of Science Human Research Ethics Committee.

Stimuli. In Study 1, participants assessed 5 different meals that are commonly consumed for lunch or at an evening meal in the United Kingdom. To extend this range, 9 meals were assessed in Study 2. The macronutrient composition of these meals was taken from food packaging and is provided in **Supplemental Table 1**. All meals were purchased as pre-prepared "ready meals," and they were sourced from local supermarkets.

For each meal, a set of photographs was taken with the use of a high-resolution digital camera. Each meal was photographed on the same white plate (255-mm diameter). Particular care was taken to maintain constant lighting conditions and plate position in each photograph. For each food, picture no. 1 showed a 20-kcal portion. With increasing picture number, the portion shown increased by 20 kcal (i.e., picture 2 = 40 kcal, picture 3 = 60 kcal, et cetera). Each food was photographed 50 times (i.e., maximum portion = 1000 kcal). With meals that comprised >1 food item (e.g., lasagna and peas) the relative ratio of each component of each meal (by weight) was maintained, thereby preserving the same overall macronutrient composition within each set of images. The name of the food was included in the top left-hand corner of every image.

TABLE 1 Characteristics of participants in Study 1 and Study 2[1]

	Study 1 (*n* = 23)	Study 2 (*n* = 23)
F/M, *n*/*n*	20/3	18/5
BMI, kg/m^2	22.2 ± 1.9	22.6 ± 2.2
Age, y	19.3 ± 1.2	24.5 ± 3.5

[1] Values are means ± SDs, unless otherwise indicated.

Expected satiety. In each trial, one of the test foods was displayed (size = 229 × 200 mm). Depressing the left or right keyboard arrow key caused the portion size to decrease or increase, respectively. The pictures were loaded with sufficient speed that continuous key depression gave the appearance that the change in portion size was animated. Each trial started with a different and randomly selected portion size. In Study 1, participants were given 2 instructions: "1. You will be shown some food. Imagine it is lunchtime and no other foods are available. You won't be eating again until 7 pm." (i.e., no other food is available, either for lunch or between lunchtime and 1900 later that day); and "2. Use the left and right arrow keys to select the portion size that you would need to stave off hunger until 7 pm."

One possibility was that participants would find this task difficult if they routinely ate earlier or later than 1900. To address this potential concern, we adopted an alternative approach in Study 2. On the basis of an earlier study (13), participants were asked to match a common comparison food to each test food. In each trial, a fixed 300-kcal portion of a test food was displayed on the left-hand side of the screen. Next to this standard, a comparison food was presented. During each trial, the participant changed the amount of the comparison food. For each standard–comparison pair, the participant was asked to "change the size of the portion on the right so that both foods will keep you feeling satisfied (stave off hunger) for the same amount of time." We selected pasta and tomato sauce as a common comparison because pilot work indicated that this food was likely to be highly familiar. In both studies, the order of the trials was randomized across participants. Expected satiety and all other measures (described below) were obtained with the use of custom software written in Visual Basic 6.0.

Food choice. At the beginning of each trial, equal-calorie portions of the test foods were positioned randomly at the bottom of the screen. In Study 1, 5 boxes were shown that spanned the width of the monitor and aligned horizontally in the upper section. From left to right, the boxes were labeled 1, 2, 3, 4, and 5, and the following instruction was presented at the top of the screen: "Would you choose this meal for lunch? Place the foods in order of preference (1 = Worst/5 = Best)." In Study 1, the participants were given the following instructions: "Imagine it is lunchtime. You will not eat until 7 pm and no other foods will be available. You MUST choose one of these meals for lunch. You MUST eat ALL of this food." Participants completed their ranking by using the mouse to move the foods into separate boxes. In the first trial, 100-kcal portions of the test foods were shown. In subsequent trials, the portions increased incrementally by 100 kcal until 800-kcal portions had been evaluated.

In Study 2, we repeated this procedure under a "standard condition" with a broader range of 9 test foods. With the inclusion of extra test foods, we were concerned about the extra burden that this might place on participants. Therefore, the maximum portion size was limited to 600 kcal. A further possibility was that the meals would differ in their perceived energy content (even though these were matched in each trial). To address this concern, in Study 2, explicit labeling was incorporated that informed the participants that in each ranking task all of the foods contained the same number of calories. Under an otherwise identical "bite condition," participants were told, "You are only allowed to taste one food (just a small taster on a teaspoon!). You are not allowed to eat the whole portion." Finally, under a "fullness condition," they were told, "You MUST eat ALL of this food. But IMMEDIATELY after you know you are going to be eating one of your favorite foods." We reasoned that if expected satiety played a causal role in food choice, then the pattern of results from Study 1 should be preserved under the standard condition, but should be modified by the instructions under the bite and the fullness conditions. This is because fullness could never be achieved under the bite condition and because knowledge that a highly palatable food was available would address concerns about hunger under the fullness condition. The order of these conditions was counterbalanced across participants. After they completed each set of rankings, the participants

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also were asked to provide a rationale for their choices. Specifically, in response to the instruction, "In this previous section, which of the following statements best describes your approach to food choice?" they were asked to select one of the following options: *1*) "I always selected foods based on how tasty they would be to eat," *2*) "I always selected foods based on how filling they would be," *3*) "I started thinking about how tasty they would be to eat but then with larger portions I thought about fullness," *4*) "I started thinking about fullness but then with larger portions I thought about how tasty they would be to eat," or *5*) "None of the above."

Expected palatability. Participants rated the palatability of the test meals in a randomized order. In each trial, a visual analogue rating scale was presented above a picture of a 300-kcal portion. The rating was headed "How much do you like the taste of this food?" with end anchor points "I hate it" and "I love it." Responses were scored in the range 1–100.

Familiarity. Participants were shown 300-kcal portions of each test food in a randomized order. In each trial, they selected 1 of 2 buttons labeled "No" and "Yes" in response to the question, "Have you ever eaten this food before?"

Procedure. All data were collected in the Nutrition and Behaviour Unit at the University of Bristol (United Kingdom). Test sessions were scheduled between 1000 and 1600. In both studies, participants completed the measure of food choice, followed by measures of familiarity, palatability, and expected satiety. To characterize trait dietary behaviors, the participants were then asked to complete the 3-Factor Eating Questionnaire (18). Finally, the height and weight of the participants were measured and they were debriefed and thanked for their assistance with the study.

Data analysis. Following a similar strategy (14), for each participant, portion size, and condition (Study 2 only), simultaneous linear regression was used to calculate separate standardized β coefficients to quantify the role of expected satiety and palatability as independent predictors of ranked food choice. We assessed expected satiety in different ways in Study 1 and Study 2. In Study 1, larger selected portions indicated less expected satiety, whereas in Study 2, larger selected portions suggested greater expected satiety. To promote direct comparison across studies, raw expected satiety values from Study 2 were multiplied by −1, and these transformed values were used in the regression analysis. Accordingly, for both studies, a positive β weight for expected satiety suggested that foods that had high expected satiety also tended to be highly ranked. Similarly, a positive β weight for palatability suggested that palatable foods tended to be ranked higher. Negative β weights suggested the converse. For example, a negative expected satiety β weight suggested that foods that had high expected satiety tended to receive a relatively low ranking. In addition to assessing the independent role of expected satiety and palatability, we also sought to quantify the proportion of variance in food choice that is explained by these variables in combination. Therefore, with the use of data from Study 2, for each portion size and each condition, we averaged across participants to calculate a set of mean R^2 values.

In a second stage of the analysis, β coefficients were submitted to a repeated-measures ANOVA. For Study 1, 2 within-subject factors were explored: portion size and predictor type (expected satiety and palatability). For Study 2, we also included condition (standard, bite, and fullness) as a within-subjects factor. Post hoc, the resulting 3-way interaction was explored by submitting palatability and expected satiety β weights to separate repeated-measures ANOVA, with portion size and condition as within-subject factors. Finally, our null hypothesis was that neither of the predictors played a role in food choice. Therefore, for each portion size, planned *t* tests were conducted to determine whether sets of β values deviated significantly from zero.

Because of a technical fault, measures of expected satiety were not recorded for one participant in Study 1. This participant was removed from the data set. Visual inspection of the data from Study 2 suggested that one participant might be an outlier. Therefore, we converted sets of β values into *z* scores. In a normal distribution, 99.9% of *z* scores should lie between −3.29 and 3.29 (19). On this basis, data from one participant was omitted from Study 2, leaving 23 participants remaining in both studies. Differences were considered to be significant at $P < 0.05$, and all results are reported as means ± SDs. All analyses were conducted with the use of Minitab 16.2.4.

Results

Results from Study 1

Participant characteristics. We were unable to calculate a 3-Factor Eating Questionnaire disinhibition score for 2 participants who did not complete 1 question in the disinhibition subscale. Dietary restraint (n = 24; 10.7 ± 5.2), disinhibited eating (n = 22; 8.0 ± 3.1), and hunger scores (n = 24; 6.8 ± 3.3) were within the normal range (18). Responses in the familiarity task indicated that 4 participants had never eaten 1 of the test foods and 1 had never eaten 2 of the test foods.

Expected satiety and palatability. Summary values for the expected satiety and palatability of the test foods are shown in **Supplemental Table 2**. For each food, expected satiety is represented by the amount (kilocalories) that would be required to stave off hunger. Smaller values indicate greater expected satiety.

Predictors of food choice. Standardized β weights are presented in **Figure 1**. Separate pairs of values are provided for the 8 portion sizes (range: 100–800 kcal). β Coefficients for expected satiety and palatability differed significantly ($P < 0.001$), indicating that these measures assessed different constructs. We also found a main effect of portion size ($P < 0.001$), and a significant interaction between portion size and predictor type ($P < 0.001$). For the smallest portion (100 kcal), palatability and expected satiety were both equally good and positive predictors of choice, as shown in Figure 1. However, with increasing portion size, the role of expected satiety diminished. Indeed, when the largest portions were compared, foods with high expected satiety were less likely to be selected. By contrast, the role of palatability remained reasonably stable across portion sizes. Consistent with this interpretation, for palatability, a significant deviation from zero was observed in β values across all portion sizes. By contrast,

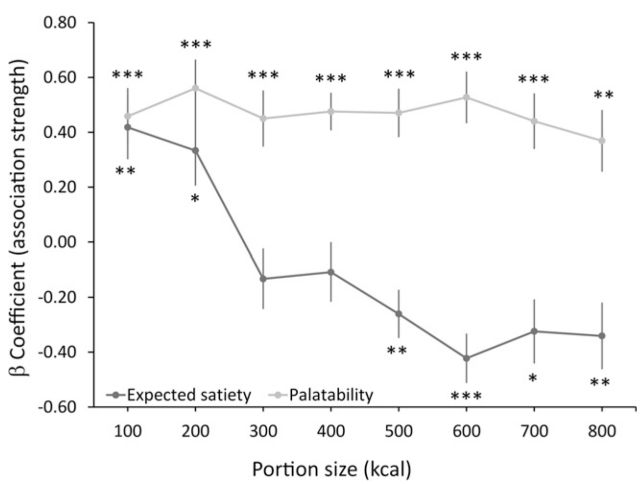

FIGURE 1 Standardized β coefficients for expected satiety and palatability as predictors of the ranked selection of 5 foods (Study 1). Separate values are provided for equicaloric portions in the range 100–800 kcal. Positive values indicate that a predictor promoted the appeal of a meal. A negative value indicates the converse. Values are means ± SEMs, n = 23. *,**,***Significant departure from zero: *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

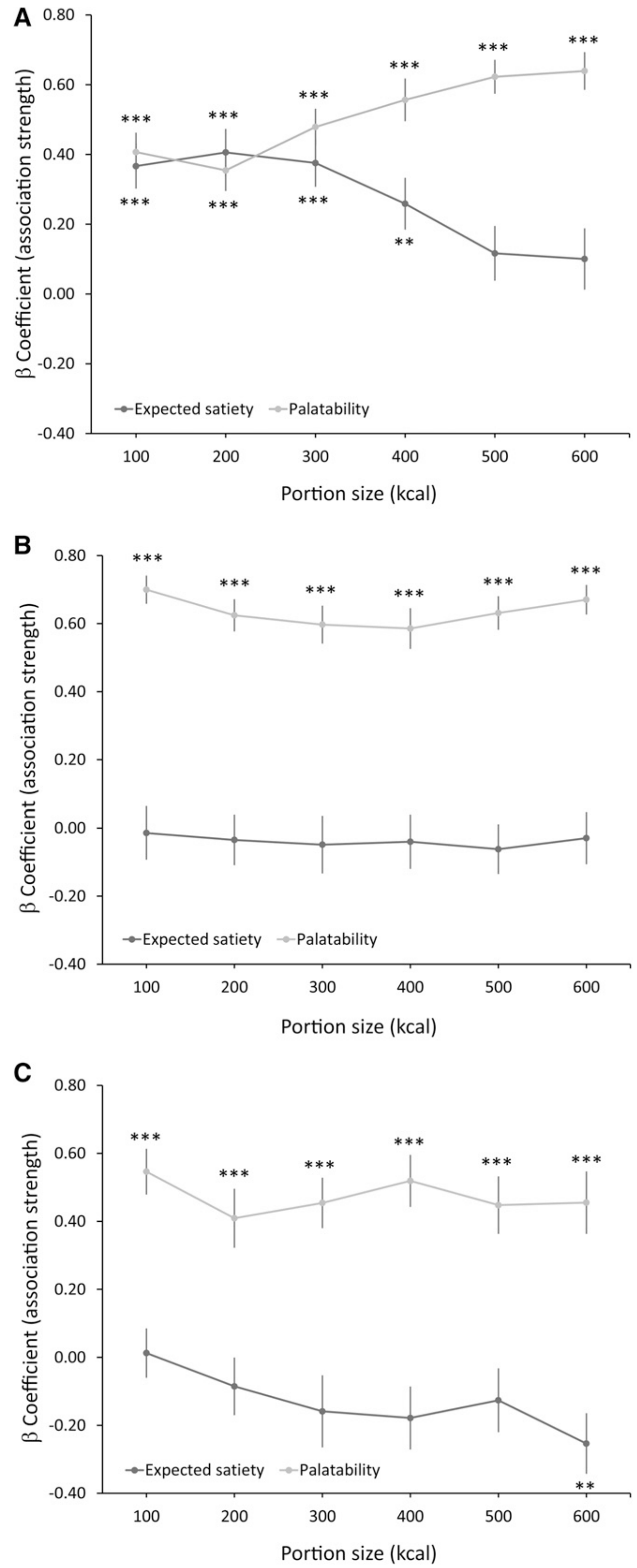

FIGURE 2 Standardized β coefficients for expected satiety and palatability as predictors of the ranked selection of 9 foods (Study 2). The relative importance of expected satiety and palatability when participants were told to assume it was lunchtime and no other food would be available until 1900 (standard condition) (A); participants were told that only a single bite of one test food would be available (bite condition) (B); and participants were told to expect a favorite dish after consuming one of the test foods (fullness condition) (C). Separate values are provided for equicaloric portions in the range 100–600 kcal. Positive values indicate that a predictor promoted the appeal of a meal. A negative value indicates the converse. Values are means ± SEMs, $n = 23$. **,***Significant departure from zero: **$P < 0.01$, ***$P < 0.001$.

values for expected satiety reached significance only for small (100 kcal, $P < 0.01$, and 200 kcal, $P < 0.05$) and larger (500 kcal, $P < 0.01$; 600 kcal, $P < 0.001$; 700 kcal, $P < 0.05$; and 800 kcal, $P < 0.01$) portions. With larger portions, expected satiety became a negative predictor.

Results from Study 2

Participant characteristics. Scores for dietary restraint (8.6 ± 5.9), disinhibited eating (8.9 ± 3.6), and hunger (6.2 ± 2.9) were within the normal range (18). Participants generally were familiar with the test foods. However, a larger proportion in Study 2 expressed unfamiliarity than in Study 1. Five participants were unfamiliar with 1 of the 9 test foods, 3 were unfamiliar with 2 foods, 2 were unfamiliar with 3 foods, and 1 was unfamiliar with 4 of the foods.

Expected satiety and palatability. Summary values for expected satiety and palatability are shown in **Supplemental Table 3**. For expected satiety, each value represents the amount (kilocalories) of comparison food (pasta) that would be needed in order for the test food (300-kcal portion) and the comparison food to have the same expected satiety. Therefore, larger values indicate greater expected satiety.

Predictors of food choice. Our analysis revealed a significant 2-way interaction between predictor type (palatability or expected satiety) and portion size ($P < 0.001$). However, we also found a significant 3-way interaction between predictor type, portion size, and condition ($P = 0.024$), showing that the interaction between predictor type and portion size was moderated by the type of instruction that was given to the participants. Post hoc analyses of expected satiety β weights revealed a main effect of portion ($P < 0.001$) and a main effect of condition ($P < 0.001$). The interaction between portion and condition failed to reach significance ($P = 0.10$). Consistent with our planned analysis, this suggests that the role of expected satiety was moderated by the specific instructions in the ranking tasks.

The same post hoc analysis of palatability β weights revealed a main effect of condition ($P = 0.002$) and a significant interaction between condition and portion size ($P = 0.03$). Again, this showed that the instructions influenced the role of palatability. Standardized β weights are presented in **Figure 2**. Separate values are provided for each condition, with panels A, B, and C showing β weights for the standard, bite, and fullness conditions, respectively.

As in Study 1, we identified mean β values that deviated significantly from zero. The pattern of results in Figure 2 can be interpreted as follows. As in Study 1, when the entire portion was expected and no other food was available (standard condition), expected satiety played a significant role in food choice, but only when smaller portions (≤400 kcal) were compared (panel A). As the role of expected satiety diminished with portion size, the importance of palatability increased. By contrast, when the portion size was restricted (bite condition; panel B) or when the test food was to be followed by a favorite food (fullness condition; panel C), then expected satiety played a minor role in food choice, and, irrespective of portion size, choice was motivated primarily by palatability.

TABLE 2 Variance in food choice explained by a combination of expected satiety and palatability in Study 2[1]

Portion size shown, kcal	Condition		
	Standard[2]	Bite[3]	Fullness[4]
100	0.39 ± 0.19	0.57 ± 0.24	0.46 ± 0.29
200	0.40 ± 0.20	0.55 ± 0.24	0.51 ± 0.27
300	0.50 ± 0.21	0.52 ± 0.22	0.51 ± 0.21
400	0.50 ± 0.21	0.54 ± 0.23	0.58 ± 0.22
500	0.54 ± 0.20	0.52 ± 0.23	0.50 ± 0.26
600	0.58 ± 0.20	0.55 ± 0.22	0.56 ± 0.24

[1] Values are means ± SDs, n = 23. Expected satiety and expected palatability were entered as simultaneous predictors of choice with the use of linear regression. Separate models were calculated for each participant, portion size, and condition.
[2] Test foods were ranked by participants while assuming it was lunchtime and no other food would be available until 1900.
[3] Same as the standard condition, but participants were told that only a single bite of one test food would be available.
[4] Same as the standard condition, but participants were told to expect a favorite dish after consuming one of the test foods.

Finally, we evaluated the extent to which measures of palatability and expected satiety could explain variance in food choice in combination. Separate mean R^2 values are provided in **Table 2**. The variance explained by the regression models is fairly constant, across both conditions and portion sizes, with one exception. Under the standard condition, R^2 values increased from 0.39 to 0.58 across the portions tested. Across conditions, ~50% of the variance in food choices was explained by a combination of variability in palatability and expected satiety.

Self-reported determinants of food choice. A summary of responses is provided in **Table 3**. As anticipated, under the standard condition, most participants (60.9%) reported prioritizing fullness with smaller portions and then palatability with larger portions. However, a modest proportion (34.8%) also indicated the converse. Under the bite condition, the majority of participants prioritized palatability (69.6%). Finally, under the fullness condition, many participants (56.5%) reported that they prioritized palatability with smaller portions and fullness with larger portions. Other participants were distributed relatively evenly across other response options.

Discussion

Together, these findings highlight an added complexity to food choice. In particular, they show how the role of palatability and expected satiety can be isolated and quantified, and how their importance varies with portion size and context. The pattern of results in Study 1 broadly coincides with those under the standard condition of Study 2. Across a range of portion sizes, palatability remained a consistent and positive predictor of food choice. By contrast, expected satiety was favored, but only when small portions were compared.

In these studies, no foods were consumed; choice was based solely on the visual characteristics of the foods. However, this is how decisions are normally made. Rather than opening packets and/or tasting individual foods in a supermarket or restaurant, or even at home, people tend to decide what to eat before a meal begins (20). Brain imaging studies indicate that stimulus value is coordinated in the orbitofrontal cortex (21). In the case of food, short-term interests in palatability (enjoyment) are tempered by cognitive inhibition that takes the form of dietary restraint and longer-term concerns about health (encoded in the dorsolateral prefrontal cortex) (7). This idea extends beyond the neurocognitive domain and is highlighted in numerous studies that focus on the competition between immediate enjoyment and inhibitory control. Accordingly, overeating and making unhealthy food choices are thought to occur when foods are hyperpalatable (22) or because decisions are impulsive (23), or as a result of hyper- (24) or hyposensitivity (25) to the immediate reward experienced by eating. Our data suggest that, in addition to these short- and long-term considerations, choice is also influenced by expected satiety (a medium term meal-to-meal concern)—in other words, the capacity of a food to promote satiety between meals. More generally, and consistent with this proposition, palatability is sometimes a poor predictor of actual food choice (9, 26, 27).

Note that we are not suggesting that the role of expected satiety implies homeostatic regulation of food intake from one meal to the next. The hypothesis that food choice reflects a motivation to address short-term energy depletion is commonplace in scientific discourse. Indeed, this popular belief probably plays an important role in guiding everyday decisions (people claim the need to eat in order to keep going or to maintain energy levels). In reality, food choice is unlikely to have a meaningful impact, because the effect of a single decision will be trivial compared with total energy stores. In a recent theoretical review, an analogy was drawn between a saucepan and a bathtub (28). The former represented the energy that might be corrected by eating, and the latter, the total energy reservoir held within a typical person. We calculated that if a 65-kg person decided to skip a 500-kcal meal, then this might generate only a 0.4% deficit. Therefore, there is little reason to fine-tune food choice in order to achieve precise energy balance from one meal

TABLE 3 Self-reported strategies in food choice in Study 2[1]

Option	Rationale for choosing	Condition, %		
		Standard[2]	Bite[3]	Fullness[4]
1	Palatability with all portions	0.0	69.6	13.0
2	Fullness with all portions	0.0	4.3	13.0
3	Palatability with smaller portions and fullness with larger portions	34.8	13.0	56.5
4	Fullness with smaller portions and palatability with larger portions	60.9	8.7	8.7
5	None of the above	4.3	4.3	8.7

[1] Values show the percentage of participants (n = 23) who selected a particular rationale in each condition. Responses were elicited with the use of a self-report forced-choice questionnaire with 5 options.
[2] Test foods were ranked by participants while assuming it was lunchtime and no other food would be available until 1900.
[3] Same as the standard condition, but participants were told that only a single bite of one test food would be available.
[4] Same as the standard condition, but participants were told to expect a favorite dish after consuming one of the test foods.

to the next. Instead, all else being equal, people eat and experience hunger (desire to eat) primarily in response to emptiness of the gut, and a related capacity to consume more food.

One of the advantages of maintaining substantial energy reserves is that it enables humans to structure their meal pattern (e.g., breakfast, lunch, and dinner) around other activities. The tendency to limit meal size to avoid the acute physiologic and cognitive effects of a large meal [sometimes referred to as an eating paradox (29)] has been explored extensively, both in humans and in animals (30). Our data indicate that food choice is also governed by a further consideration: meal patterns tend to be entrained around daily work and social activities. If a poorly satiating meal is consumed, then this may risk later distraction caused by hunger (a readiness to consume more food), to the detriment of those other activities. When the timing of a following meal is known, and when confronted with smaller-than-normal portions, then foods will be chosen that are particularly satiating, i.e., those that limit the distraction that might otherwise be experienced between meals. When only a bite of food was offered (bite condition, Study 2) or when unlimited access to a favorite food was permitted (fullness condition, Study 2), then expected satiety was found to be a poor predictor of food choice (Figure 2B and C). Thus, it would appear that both an inability to achieve satiety (bite condition) and the certainty that satiety would be achieved (fullness condition) are sufficient to eliminate a role for expected satiety when prioritizing foods to consume at lunchtime. Recently, we used informal and semi-structured interview techniques to assess food choices during snacks and around lunchtime. Reliably, participants referred to fullness and, in particular, the need to ensure the absence of hunger between meals (with a typical response taking the form, "I just want a healthy and tasty lunch that will fill me up until supper"). This strategy was reflected in the self-report questionnaire and appears to indicate an active "defense of meal pattern" that preserves a capacity to fully engage in other nonfood-related behaviors between meals. In relation to this idea, it may be relevant that obesity often is associated with a chaotic eating pattern, and that short periods of chaotic eating produce an impaired insulin response and an increase in fasting total and LDL cholesterol (31, 32).

The findings are also highly relevant to what is commonly referred to as the "portion size effect"—large portions reliably increase food intake, even when the portion that is offered is larger than can be consumed (33). This observation is very robust and has been explored extensively (34, 35). Our findings show that larger portions not only promote increased energy intake, but also encourage a food-choice strategy that promotes the selection of palatable foods. One of the reasons why this relation may have been overlooked is because the portion-size effect has tended to be studied in single-component meals or otherwise with the use of paradigms that are not optimized to detect and quantify the underlying behavioral economics of food utility tradeoffs in comparisons across different types of meals.

Reviews of food portion sizes often highlight a dramatic increase in serving sizes, particularly those found in fast-food restaurants (36). Our findings suggest that larger serving sizes enhance the relative appeal of these foods (for the reasons outlined above). More generally, this trend toward larger portions might represent an example of how food production can become adapted to fundamental principles that govern the economics of food choice [for a related point see Drewnowski and Aliron-Roig (37)]. Of course, the converse also applies. If smaller portions are presented, then this may promote the selection of less palatable lower energy–dense foods [consistent with recommendations (38)], and an awareness of this relation could help to inform the design of diets and commercial products that promote satiety and weight management. Consistent with this proposition, children appear to show a greater preference for lower energy–dense (more satiating) foods when they are presented in smaller portions (39).

Finally, there are 2 broad areas in which our research and methods might be applied. First, an opportunity exists to explore individual differences in food choice. The present paradigm is unusual in that it deconstructs food choice on a calorie-for-calorie basis. In particular, the data indicated that a "satiety-to-palatability switch" occurs as food portions become larger. Although our models accounted for a large proportion of variance in food choice (~50%), other factors, such as perceived healthiness or demographic and economic factors, also are likely to play a role (2, 40). Our psychophysical approach would seem well placed to expose very subtle individual differences that promote a positive energy balance over time. A further possibility is that differences in switch point are governed by a weighing-up of immediate reward (palatability) against medium-term concerns about a defense of meal pattern. This possibility might parallel individual differences in monetary delay discounting (immediate gratification vs. the willingness to wait for a larger reward), a variable that previously has been associated with obesity (41).

Second, broadening this work to incorporate different meals and social contexts could be very informative. In particular, our analysis suggests that eating a 2-course lunch might have a dramatic effect on priorities in food choice (Figure 2C), promoting a strategy based almost entirely on palatability. In the future, it would be interesting to explore how planned intermeal snacks and other variables moderate food choice in this context.

Acknowledgments

JMB, AJ, AAM, JCWB, and PJR designed the research; RLG, CP, and NRE conducted the research; JMB analyzed the data; JMB and PJR wrote the paper; and JMB had primary responsibility for the final content. All authors read and approved the final manuscript.

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