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Meal Size, Not Body Size, Explains Errors in Estimating the Calorie Content of Meals

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Background: Although most people underestimate the calories they consume during a meal or during the day, calorie underestimation is especially extreme among overweight persons. The reason for this systematic bias is unknown.

Objective: To investigate whether the association between calorie underestimation and body mass reflects a tendency for all persons to underestimate calories as the size of a meal increases.

Design: Overweight and normal-weight adults estimated the number of calories of a fast-food meal they had ordered and eaten (study 1) or of 15 fast-food meals that were chosen by the experimenter (study 2) in a randomized, controlled trial. Their estimations were compared with the actual number of calories of the meals.

Setting: Study 1 was a field study conducted in fast-food restaurants in 3 medium-sized midwestern U.S. cities. Study 2 was conducted in a laboratory at a major U.S. research university.

Participants: Study 1 involved 105 lunchtime diners (average body mass index [BMI], 24.2 kg/m^2 [range, 17.2 to 33.5 kg/m^2]). Study 2 involved 40 undergraduate students (average BMI, 23.2 kg/m^2 [range, 16.1 to 32.3 kg/m^2]).

Measurements: Participants were asked to estimate the number of calories in a fast-food meal they had ordered and eaten (study 1) or in 15 sizes of the same fast-food meal (study 2). The actual number of calories in the meals in the field study was obtained by unobtrusively recording the food that was ordered (identified from the wrappings and containers). Weight and height were self-reported.

Results: Although participants strongly underestimated the number of calories in larger meals (by −38.0% in study 1 and by −22.6% in study 2), they almost perfectly estimated the number of calories in smaller meals (by −2.9% in study 1 and by 3.0% in study 2). After the authors controlled for body weight–related differences in meal size, the calorie estimations of normal-weight and overweight participants were identical in both studies.

Limitations: These studies examined fast-food meals. Weight and height were self-reported. There were too few observations to distinguish between obese (BMI ≥30 kg/m^2) and overweight (BMI >25 kg/m^2 but <30 kg/m^2) participants.

Conclusions: Greater underestimation of calories by overweight persons is a consequence of their tendency to consume larger meals. Calorie underestimation is related to meal size, not body size.

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From an energy intake perspective, it has been argued that underestimation of the increasing sizes of restaurant and home-cooked meals is contributing to the rising obesity rates in the United States (1–4). Although nearly all persons underestimate their calorie intake, considerable evidence indicates that the bias is much worse for those who are overweight (5–8). Clinicians and researchers have proposed a wide range of possible reasons, leaving recent reviews to conclude that the cause of this bias is "unclear" (9) and, more fundamentally, that "we still need to understand why people misreport food intake" (6).

In clinical treatments of obese persons, it is often assumed that they intentionally underestimate food intake to improve their self-esteem (self-deception) or the way they are viewed by others (self-presentation) (10). We contend that biases in calorie estimation have a perceptual—not motivational—origin and that meal size, not body size, explains the calorie underestimation of meals. Building on the empirical law of sensations (11, 12), we examine whether subjective estimations of calories, like other perceptual estimations, increase at a slower rate than the actual increase in meal size.

We tested 3 hypotheses: 1) Every person's estimation of calories follows a predictable pattern of diminishing sensitivity to increases in meal sizes; 2) once meal size is controlled for, there are no differences in the estimation biases of overweight and normal-weight persons; and 3) the differences between overweight and normal-weight persons are a result of overweight persons choosing larger meals.

Methods

In study 1, trained interviewers asked overweight and normal-weight persons who had finished eating at fast-food restaurants to estimate the number of calories in their meals and to provide their heights and weights. At the same time, the interviewers unobtrusively recorded the type and size of the food eaten. Although externally valid, study 1 cannot rule out the possibility of self-selection biases (because some people declined to participate in the

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study) and motivational biases (because some people may have been more motivated by fear of embarrassment than by a desire for accuracy). Another limitation is that the meals varied in both size and type of foods.

To overcome these limitations, a second study was conducted in a laboratory ensuring high levels of motivation and no attrition. In study 2, we asked a different group of overweight and normal-weight participants to estimate the calories in 15 experimenter-selected fast-food meals differing only in portion sizes. Whereas study 1 examined postintake, between-participant calorie estimations, study 2 examined preintake, within-participant calorie estimations. The 2 studies combined provide external and internal validity in this investigation.

Study 1 Design: Postintake Calorie Estimation of Self-Selected Fast-Food Meals

Study 1 was conducted in fast-food restaurants on 9 weekdays in 3 medium-sized midwestern U.S. cities during the noon hour. The targeted restaurants were nationwide hamburger and sandwich chains and were located within 150 feet of each other. Trained interviewers approached every fourth person who was finishing a meal and asked whether he or she would answer some brief questions for a survey. The institutional review board at the University of Illinois approved the study.

Persons who agreed to participate in the survey were then asked whether they were 18 years of age or older and whether they ate at this particular fast-food restaurant at least once per month. If participants answered yes to these 2 questions, they were asked to estimate the total number of calories contained in their entire meal, not the number of calories that were consumed. Participants were asked to provide their height (in feet and inches) and weight (in pounds). No data were collected regarding education, age, ethnicity, or income. During this process, the interviewers unobtrusively recorded the type and size of each participant's food and drinks from the packages or wrappings left on the tray. The interviewers had received previous training in container identification and size. In the few cases where identification was impossible (for example, whether the drink was diet or regular), the information was obtained directly from the participants. Nutrition information available on the Web sites of the fast-food restaurants was then used to compute the actual number of calories of each person's meal.

Study 2 Design: Preintake Calorie Estimation of Experimenter-Selected Fast-Food Meals

In study 2, the participants were 40 undergraduate students who participated in the study for course requirements. To examine how increasing meal sizes influence within-individual calorie estimations, overweight and normal-weight participants were asked to estimate the number of calories in the same 15 meals, instead of estimating the calories in the meals that they would have ordered. This procedure makes meal size independent of body size. There should therefore be no differences between the estimations of overweight and normal-weight participants. To reduce social desirability biases, the participants were asked to write down their estimations privately and were told that the most accurate participants would be publicly awarded prizes in the following week.

Participants were shown 15 different meals on unmarked paper plates and were asked to estimate the calories in each. The meals involved combinations of chicken nuggets, fries, and cola, which were purchased at a local fast-food restaurant. Each item was available in 3 sizes, labeled A, B, or C (B = 2 × A and C = 2 × B). Chicken was available in 3, 6, or 12 nuggets; French fries were available in 1.45 oz, 2.90 oz, or 5.8 oz; and the beverage (a regular full-calorie cola) was available in 10 fl oz, 20 fl oz, or 40 fl oz for sizes A, B, and C, respectively.

These 15 meals ranged from 445 to 1780 calories and comprised realistic combinations of each food item. To avoid carryover effects across estimations, the meals were displayed on separate tables, no feedback was provided between estimates, and the order in which the meals were seen was counterbalanced across participants (who were asked to follow 1 of 3 randomly generated sequences). After estimating the caloric content of a trial meal with no feedback, participants were then asked to estimate the caloric content of the 15 meals. Finally, each participant provided his or her height and weight.

Statistical Analyses

Self-reported heights and weights were used to compute the body mass index (BMI) of each participant. Participants were classified as normal weight if their BMI was

Context

The ability to estimate the calorie content of meals is important for reducing food intake.

Contribution

Trained interviewers asked fast-food restaurant customers to estimate the calorie content of their meals. Interviewers counted the empty food containers on each participant's tray and calculated the meal's actual calorie content from the posted calorie content of each item. People, regardless of their weight, estimated normal-sized meals accurately. Likewise, everyone underestimated large meals. Overweight people were more likely to order larger meals and therefore to make larger errors.

Cautions

Participants were young adults.

Implications

Everyone tends to underestimate the calorie content of large meals.

—The Editors

Table 1. **Height, Weight, and Body Mass Index in Participants in Studies 1 and 2***

Study	Participants, *n*	Mean Height (SD), *m*	Mean Weight (SD), *kg*	Mean BMI (SD), *kg/m²*
1. Postintake calorie estimation of self-selected fast-food meals				
Total	105	1.72 (0.10)	72.3 (16.0)	24.2 (3.2)
Women	48	1.65 (0.06)	60.8 (8.5)	22.4 (2.5)
Men	57	1.78 (0.08)	82.0 (14.4)	25.7 (2.9)
2. Preintake calorie estimation of experimenter-selected fast-food meals				
Total	40	1.70 (0.11)	67.6 (14.7)	23.2 (3.3)
Women	26	1.64 (0.07)	59.7 (7.2)	22.2 (2.7)
Men	14	1.82 (0.08)	82.2 (13.9)	24.9 (3.9)

* BMI = body mass index.

less than 25 kg/m^2 and as overweight if their BMI was 25 kg/m^2 or greater, according to the guidelines of the Centers for Disease Control and Prevention and the World Health Organization.

Estimation biases were computed as the percentage deviation: (estimated calories − actual calories)/(actual calories). We used *t*-tests to examine whether mean percentage deviations were statistically different from 0 and whether they differed between small and large meals and between normal-weight and overweight persons.

To determine whether calorie estimation biases are perceptual, not motivational, we examined the relationship between subjective and actual calories using the standard models of psychophysical studies of magnitude estimations (11). These studies have shown that the relationship between subjective estimations (E) and actual intensities (A) across a wide variety of domains is an inelastic power function ($E = a \times I^n$, where $n < 1$). If actual intensity increases by factor r, sensations increase by factor r^n, a lower number. These models can be easily estimated through ordinary least squares after being linearized through a log–log transformation and, when necessary, after controlling for correlated errors due to repeated measures per person (Appendix, available at www.annals.org). These models also allow testing of whether overweight and normal-weight persons follow the same psychophysical curves.

Role of the Funding Source

Both studies were self-funded and were not sponsored. There is no conflict of interest with any company, institution, or funding agency.

RESULTS

Of the 150 adults who were approached in study 1, 105 (70%) agreed to participate. When the 25 kg/m^2 cutoff was used, 62 respondents (59%) were classified as normal weight and 43 respondents (41%) were classified as overweight. Forty-eight respondents (46%) were women, had an average BMI of 22.4 kg/m^2 (range, 17.2 to 29.3 kg/m^2), and had an average age of 20.4 years. Fifty-seven respondents (54%) were men, had an average BMI of 25.7 kg/m^2 (range, 17.3 to 33.5 kg/m^2), and had an average age of 20.6 years. When the 25 kg/m^2 cutoff was used, 28 (70%) of the 40 undergraduate students participating in study 2 were classified as normal weight and 12 (30%) were classified as overweight. Twenty-six participants (65%) were women with an average BMI of 22.2 kg/m^2, and 14 (35%) were men with an average BMI of 24.9 kg/m^2 (**Table 1**).

Is Calorie Underestimation Caused by Meal Size?

There were no statistical differences in calorie estimation between men and women, and their results will be reported in aggregate. Participants in study 1 underestimated the caloric content of their fast-food meal by an average of 23.1% ($t = -5.7$; $P < 0.001$) (**Table 2**). Similarly, participants in study 2 underestimated the caloric content of the 15 experimenter-selected fast-food meals by an average of 9.0% ($t = -6.2$; $P < 0.001$).

These average underestimations hide large differences depending on the size of the meal. In study 1, the mean percentage deviation for the 52 smallest meals was not statistically different from 0 ($M = -7.8\%$; $t = -1.2$; $P = 0.250$), whereas the mean percentage deviation for the 53 largest meals was strongly negative ($M = -38.0\%$; $t = -10.6$; $P < 0.001$). Similarly in study 2, the mean percentage deviation for the 8 smallest meals was not statistically different from 0 ($M = 3.0\%$; $t = 1.43$; $P = 0.152$), whereas the mean percentage deviation for the 7 largest meals was strongly negative ($M = -22.6\%$; $t = -13.2$; $P < 0.001$). These results are shown in **Figure 1**. The scatter plot shows that calorie estimations are close to the line of identity (which indicates estimation accuracy) for small meals but tend to fall below this line as the size of the meal increases.

How severe is the underestimation of large meals compared with small meals? Even when we use the conservative measure of percentage deviation, which expresses biases relative to the actual calories of the meal, the underestimation bias is significantly larger for large meals than for small meals in both studies (**Table 2**) ($t = 4.0$, $P < 0.001$ in study 1; $t = 9.4$, $P < 0.001$ in study 2). Although participants strongly underestimated the number of calories in larger meals (by −38.0% in study 1 and by −22.6% in study 2), they almost perfectly estimated the number of calories in smaller meals (by −2.9% in study 1 and by 3.0% in study 2).

What Is the Relationship between Estimated and Actual Calories?

In both studies, calorie estimations (E) increased at a slower rate than actual calories (A). The exponents of the power models were statistically below 1 in both studies (the best-fitting models are $E = 12.4 \times A^{0.56}$ in study 1 and $E = 10.4 \times A^{0.63}$ in study 2) (Appendix, available at www.annals.org). For example, if actual calories increased by 100% (that is, by a factor of $r = 2$), estimations only increased by 47.4% in study 1 ($2^{0.56} = 1.474$) and by 54.8% in study 2 ($2^{0.63} = 1.548$).

This relationship is shown in **Figure 1** by the concave curves representing the calorie estimations predicted by the power models. After we averaged the estimations across different participants to reduce random errors for small, medium, and large meals, the geometric means for each meal group fell almost exactly on the predicted curves. In addition, the predicted curves allow us to estimate the mean calorie estimate for any given meal size. For example, the model predicts that calorie estimations are within 10% of the true number for meals containing between 286 and 382 calories in study 1 and for meals containing between 494 and 678 calories in study 2.

Is Calorie Underestimation Caused by Body Size?

In study 1, the calorie estimations of overweight participants were not statistically different from those of participants who were of normal weight (570 calories vs. 508 calories [$t = 1.2$; $P = 0.24$]). However, their meals contained significantly more calories (957 calories vs. 683 calories [$t = 3.8$; $P < 0.001$]). Therefore, overweight persons underestimated the calorie content of their meals by a larger mean percentage deviation than did those of normal weight (−33.0% vs. −16.2% [$t = 2.1$; $P < 0.041$]). Does this mean that overweight persons are intrinsically worse estimators? Not necessarily. The differences between overweight and normal-weight persons could be entirely driven by the fact that those who are overweight chose, and thus estimated the calories of, larger meals (**Figure 2**). **Figure 1** suggests that this is the case. Because overweight participants ate larger meals, their estimations of calories tend to be toward the right in the top panel of **Figure 1** compared with those of normal-weight participants. They are therefore on the flatter part of the estimation curve, where estimation biases are strongest. However, the estimations of overweight and normal-weight participants are on the same power curve, suggesting that if the actual number of calories of the meals was the same, overweight persons' estimates of the calorie content would not be statistically different from those of normal-weight persons.

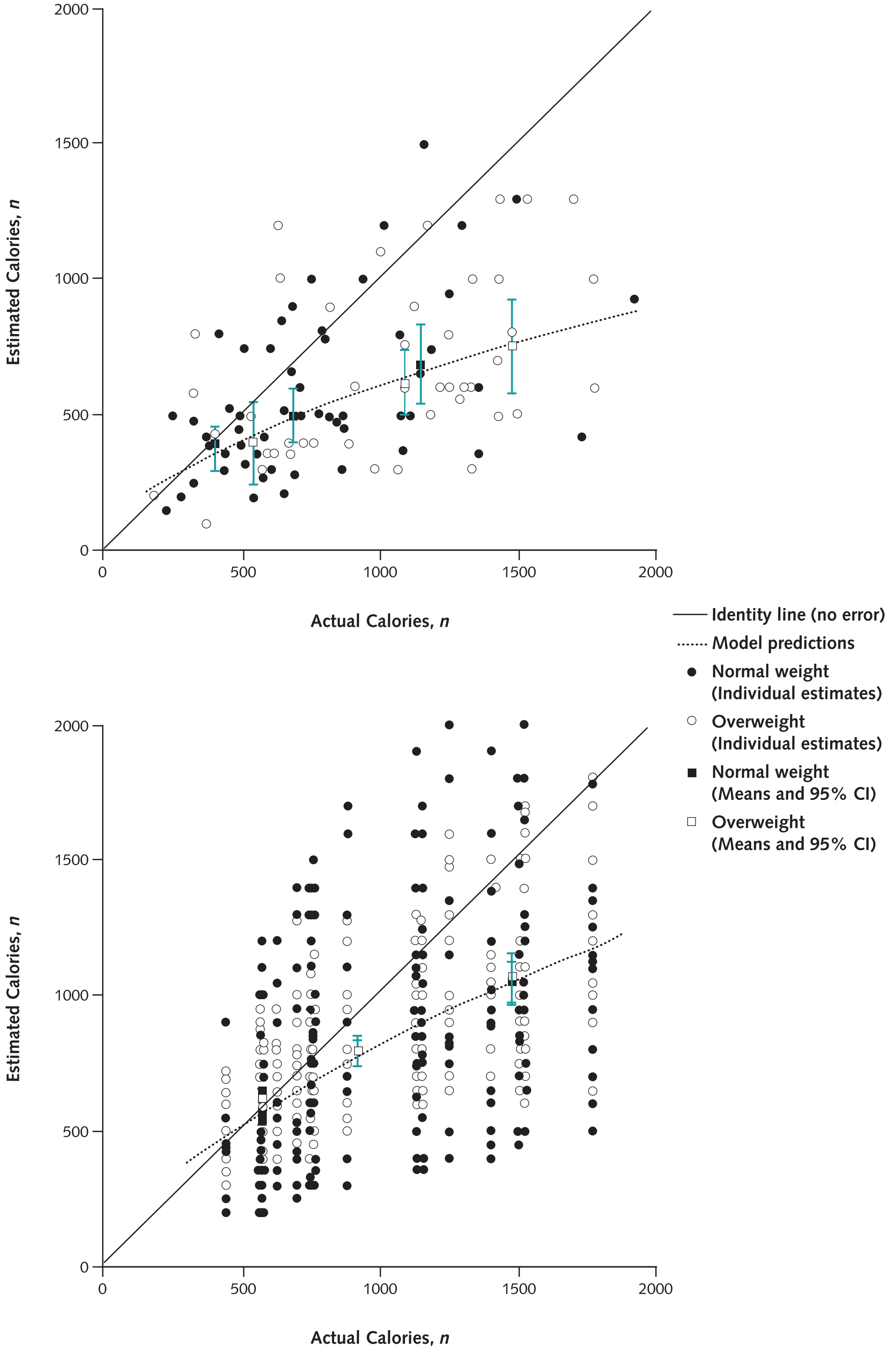
Statistical analyses provide strong support for this argument. Analyses of covariance with estimated calories (or percentage deviations) as the dependent variables and the actual number of calories as a covariate show no difference between overweight and normal-weight persons ($t = 0.78$, $P = 0.44$ for estimated calories; $t = 0.58$, $P = 0.460$ for percentage deviations). Further statistical analyses (Appendix, available at www.annals.org) showed that the estimations of overweight and normal-weight participants followed the same power curve (same exponent and intercept). The results did not change when we accounted

Table 2. **Mean Estimated Calories, Actual Calories, and Error Bias in Studies 1 and 2***

Study	Observations, *n*	Mean Geometric Estimated Calories (95% CI)	Mean Geometric Actual Calories (95% CI)	Mean Arithmetic Percentage Deviation (95% CI)
1. Postintake calorie estimation of self-selected fast-food meals				
Total	105	533 (474 to 592)	784 (707 to 862)	−23.1 (−30.9 to −15.2)*
Small meal	52	419 (353 to 484)	514 (471 to 557)	−7.8 (−20.9 to 5.3)
Large meal	53	675 (590 to 759)†	1188 (1114 to 1262)†	−38.0 (−45.0 to −31.0)*†
Normal-weight participants	62	508 (434 to 583)	683 (592 to 774)	−16.2 (−26.9 to −5.5)*
Overweight participants	43	570 (474 to 666)	957 (836 to 1079)†	−33.0 (−44.0 to −21.9)*
2. Preintake calorie estimation of experimenter-selected fast-food meals				
Total	596	783 (751 to 815)	929 (896 to 961)	−9.0 (−11.9 to −6.2)†
Small meal	317	631 (602 to 660)	655 (640 to 669)	3.0 (−1.1 to 7.0)
Large meal	279	1000 (952 to 1049)	1382 (1357 to 1407)†	−22.6 (−26.0 to −19.2)*
Normal-weight participants	416	775 (735 to 815)	929 (890 to 968)	−9.1 (−12.7 to −5.5)*
Overweight participants	180	801 (752 to 851)	929 (869 to 987)	−8.7 (−13.1 to −4.3)*

* Statistically different from 0 ($P < 0.01$).
† Statistically different from the other subgroup ($P < 0.01$).

Figure 1. **Actual and estimated calories of self-selected (*top*) and experimenter-selected (*bottom*) fast-food meals by normal-weight and overweight participants.**



Circles are individual estimates. Squares are geometric means for small, medium, and large meals, determined by a 3-way split of the meals estimated by overweight or normal-weight participants in each study. The model prediction for the actual (A) and estimated (E) calories was $E = 12.4 \times A^{0.56}$ for self-selected meals and $E = 10.8 \times A^{0.63}$ for experimenter-selected meals.

for possible underestimation of self-reported weights by using a lower threshold of 24 kg/m^2 to categorize persons as being overweight or normal weight.

In study 2, meal size was experimentally manipulated independently of body size. Therefore, the distribution of meal sizes was the same for overweight and normal-weight persons (**Figure 2**). As a result, the estimations and percentage deviations of overweight and normal-weight participants were not statistically different (mean estimations, 801 calories vs. 775 calories [$t < 0.01$; $P = 0.97$]; mean percentage deviations, −8.7% vs. −9.1% [$t = 0.42$; $P = 0.89$]). As in study 1, further analyses showed that overweight and normal-weight participants followed the same power curve. Once overweight and normal-weight persons were asked to estimate the same meals, as opposed to those that they would have consumed, their estimations were indistinguishable.

Discussion

This research was motivated by the often-cited allegation that calorie underestimation, coupled with increasing portion sizes, is an important factor in obesity. In fact, there is considerable evidence that overweight persons are more likely to underestimate their food intake than those of normal weight (5–8). Our results confirm and explain these well-established findings. We show that the larger underestimates of overweight persons can be mathematically and empirically explained by 2 facts: Overweight persons choose and thus estimate the calories of larger meals, and overweight and normal-weight persons have a tendency to underestimate the calories in large meals. What drives the larger disproportionate errors of overweight persons is not intentional misreporting caused by denial or social desirability biases. It is a fundamental perceptual bias shared by persons of normal weight.

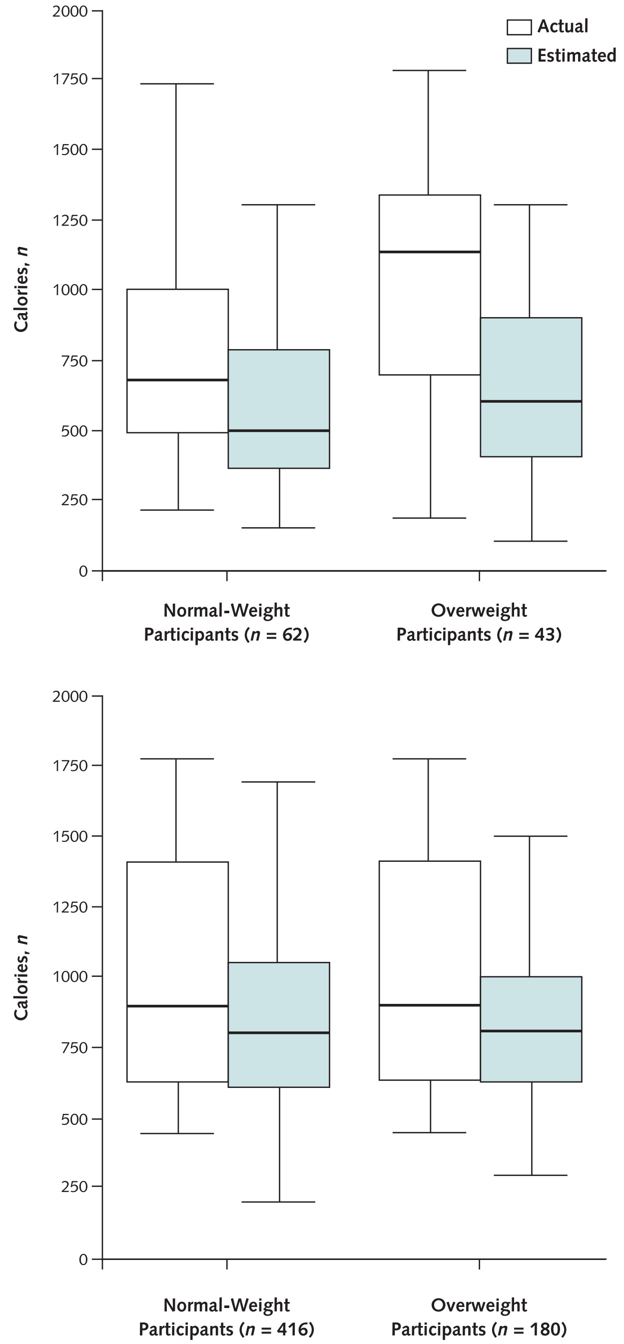
Just as we all underestimate magnitude changes in volume, weight, or brightness, the subjective estimate of an increasing meal or portion size seems much smaller than it really is. We have shown that the relationship between calorie estimations (E) and actual calories (A) follows an inelastic power curve ($E = aI^n$), where a is approximately between 10 and 12 and n is approximately between 0.55 and 0.65. As a result, doubling the size of a fast-food meal only makes it seem 45% to 57% larger.

The strong convergence between the results of study 1 and study 2 suggests that the biases are robust regardless of whether the estimations are made before or after intake or for self-selected or experimenter-selected meals. Because eating is a complex behavior and is strongly influenced by environmental factors (13), a combination of field and laboratory studies is necessary to ensure that what we advise patients is correct and relevant in the real world.

Limitations

One potential threat to the internal validity of these results is reliance on self-reported height and weight. However, a study of 4808 men and women (14) found a very high correlation ($r > 0.9$) between self-reported and measured height and weight. It also found that the underestimation of weight increased with actual weight, so that only 2.9% of persons were reclassified from being normal weight to being overweight when moving from self-reports to actual measures. These findings strengthen our results because they suggest that our overweight group might have contained only persons who were clearly overweight. Our results were unchanged when using a lower threshold of 24 kg/m^2 to categorize participants as being overweight or normal weight. From an external validity standpoint, these studies were conducted in a fast-food context with a target

Figure 2. **Distribution of actual and estimated calories of self-selected (*top*) and experimenter-selected (*bottom*) fast-food meals by normal-weight and overweight participants.**



audience that tends to be younger than the average population. Additional studies are necessary to examine the robustness of our findings for different types of foods and in the context of home-cooked meals. The availability of calorie information on containers of packaged food, for example, should increase the accuracy of calorie estimates. In addition, it will be necessary to examine whether these results are also valid for obese persons. Because of lack of observations, we could not compare the estimations of participants who were obese with those of participants who were only overweight.

Implications

For public health professionals, these results support the argument that the increasing portion sizes of restaurant meals contribute to rising obesity rates in the United States (1–4): The larger a meal people eat, the less they believe they eat (as a percentage of total calories). One potential practical solution would be for restaurants to make calorie content known both at the point of purchase (the menu board) and on the wrapper.

For epidemiology and nutrition researchers, these results provide inexpensive options for improving the accuracy of biased self-reports of food intake. Instead of relying on costly or unavailable biomarker techniques, and rather than applying a correction factor to all observations or to different groups of respondents (such as consumers with a high BMI vs. those with a low BMI), our results suggest that researchers should apply different correction factors for different sizes of meals.

For medical practitioners, these results underscore the fact that all persons strongly underestimate large meals and large portions. Clinicians should realize that overweight patients are no less accurate in their basic estimation ability than persons of normal weight. Exhorting good-faith overweight patients to pay more attention to their meals or to stop lying to themselves and to their physicians is unfounded and probably is counterproductive. Regardless of weight, everyone has the same intrinsic perception of calorie content. Overweight people eat more, so their errors in calorie estimation are larger.

One way to improve a person's calorie estimations might be to emphasize that the amount of calories contained in a large meal is twice that of his or her best guess; however, just informing people about perceptual biases is often ineffective at correcting them (15). A second option is to provide patients with portion-size benchmarks that they can use every day (16, 17). Our results suggest an innovative solution that exploits the shape of the psychophysical curve rather than tries to correct it (18): Ask patients to estimate calories item by item instead of in the aggregate. When estimating the calories in small amounts of food, people are often very accurate. As the effectiveness of food diaries as a weight loss tool suggests (19), an item-by-item decomposition may even have the dual benefits of improving calorie estimations and reducing calorie intake.

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Final approval of the article: B. Wansink, P. Chandon.
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APPENDIX

To examine the relationship between estimated (E) and actual (A) number of calories, we linearized the power model through a log–log transformation: $(\ln(E) = \ln(a) + n \times \ln(A))$. For study 1, in which each participant made 1 estimate, we estimated the linearized model through ordinary least squares using PROC UNIANOVA in SPSS, version 13.0 (SPSS, Inc., Chicago, Illinois). For study 2, in which each participant made 15 estimates, we accounted for correlated errors within participants by using PROC MIXED in SPSS, version 13.0 (SPSS, Inc., Chicago, Illinois), assuming a compound symmetry covariance structure and using restricted maximum likelihood estimation. In study 1, the point estimate and CI of the intercept (ln(a)) and power exponent (n) were 2.517 (95% CI, 1.390 to 3.644) and 0.564 (CI, 0.378 to 0.715), respectively. In study 2, the point estimate and 95% CI of the intercept (ln(a)) and power exponent (n) were 2.383 (CI, 2.153 to 2.613) and 0.627 (CI, 0.597 to 0.657), respectively. In both studies, the power exponent was statistically below 1, indicating that estimations are inelastic. The predicted intersection point at which estimated and actual calories are identical ($A \times = a^{1/(n-1)}$) is 323 calories in study 1 and 591 calories in study 2.

To further test that calorie estimations follow an inelastic power function of actual calories, we compared the fit of the power model with the fit of a linear model ($E = a' + n' \times A$). The power model fit the data better than the linear model in study 1 ($R^2 = 0.30$, $t = 6.6$, $P < 0.001$ for the power model and $R^2 = 0.25$, $t = 5.9$, $P < 0.001$ for the linear model). These results were replicated in study 2 ($R^2 = 0.34$, $t = 17.4$, $P < 0.001$ for the power model and $R^2 = 0.31$, $t = 16.2$, $P < 0.001$ for the linear model. For comparison purposes, both models were estimated through ordinary least squares. Finally, we computed the mean average percentage error for both models. The mean average percentage error was lower for the power model than for the linear model in both studies (0.39 vs. 0.44, $t = 3.9$, $P < 0.01$ in study 1 and 0.30 vs. 0.33, $t = 8.3$, $P < 0.001$ in study 2).

To test whether overweight and normal-weight participants estimate calories differently, we fitted a moderated regression: $(\ln(E) = \alpha + \beta \times \ln(A) + \gamma \times \text{OVERW} + \delta \times \ln(A) \times \text{OVERW})$, where OVERW is a binary variable indicating whether the individual is overweight (OVERW = 1) or is of normal weight (OVERW = 0). Statistical tests of the γ coefficient show whether the estimations of overweight and normal-weight participants are statistically different once the actual size of the meal is controlled for. Statistical tests of the δ coefficient show whether changes in meal size affect the estimations of overweight and normal-weight participants in a statistically different way.

As shown in the **Appendix Table**, the γ coefficient was not statistically different from 0 in both study 1 ($t = -0.59$; $P = 0.55$) and study 2 ($t = 1.16$; $P = 0.28$). This shows that once meal size is controlled for, there are no differences in the mean calorie estimations of overweight and normal-weight participants. The interaction coefficient (δ) was also not statistically different from 0 in study 1 ($t = 0.53$; $P = 0.60$) or in study 2 ($t = -1.08$; $P = 0.28$). This shows that increases in meal size similarly influence overweight and normal-weight participants' estimates.

In a final analysis, we examined the sensitivity of these results to possible misspecifications of the overweight categorization caused by the underestimation of self-reported weights. If people tend to underestimate their weights, we would expect that some of the participants with a self-reported BMI between 24 kg/m^2 and 25 kg/m^2 are actually overweight. We therefore replicated the analyses with a 24-kg/m^2 threshold to categorize people as overweight or normal weight instead of the 25-kg/m^2 threshold that is recommended by the World Health Organization and was used in all other analyses. As the **Appendix Table** shows, our results were very similar in both analyses.

Appendix Table. **Parameter Estimates and Standard Errors in Studies 1 and 2***

Variables	Overweight Threshold, BMI 25 kg/m^2		Overweight Threshold, BMI 24 kg/m^2	
	Study 1	Study 2	Study 1	Study 2
Intercept	2.636 ± 0.781	2.300 ± 0.141	2.288 ± 0.878	2.379 ± 0.144
Actual calories	0.551 ± 0.119	0.637 ± 0.018	0.607 ± 0.134	0.625 ± 0.019
Overweight (1 = yes, 0 = no)	−0.744 ± 1.251	0.277 ± 0.256	0.140 ± 1.198	0.012 ± 0.251
Overweight × actual number of calories	0.098 ± 0.186	−0.036 ± 0.033	−0.035 ± 0.180	0.006 ± 0.033

* All values are reported as mean ± SE. BMI = body mass index.