Research Article

Unit Bias

A New Heuristic That Helps Explain the Effect of Portion Size on Food Intake

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ABSTRACT—*People seem to think that a unit of some entity (with certain constraints) is the appropriate and optimal amount. We refer to this heuristic as unit bias. We illustrate unit bias by demonstrating large effects of unit segmentation, a form of portion control, on food intake. Thus, people choose, and presumably eat, much greater weights of Tootsie Rolls and pretzels when offered a large as opposed to a small unit size (and given the option of taking as many units as they choose at no monetary cost). Additionally, they consume substantially more M&M's when the candies are offered with a large as opposed to a small spoon (again with no limits as to the number of spoonfuls to be taken). We propose that unit bias explains why small portion sizes are effective in controlling consumption; in some cases, people served small portions would simply eat additional portions if it were not for unit bias. We argue that unit bias is a general feature in human choice and discuss possible origins of this bias, including consumption norms.*

In this article, we propose a new heuristic, which we call *unit bias*. Unit bias is a sense that a single entity (within a reasonable range of sizes) is the appropriate amount to engage, consume, or consider. We present evidence in favor of unit bias in the food domain.

We are particularly interested in unit bias in the food domain because it promises to explain the important effect of portion size on food intake. In some situations, as in selecting items in a supermarket or from one's pantry or refrigerator, there are multiple exemplars of a particular entity of interest. Assuming that a single entity is above some minimal size, it is usually the case that one and only one of the entities is selected and consumed. Thus, less will be consumed as the size of the entity decreases. This bias explains, for instance, why the French, who have smaller portion sizes than Americans (e.g., the modal size of an individual portion of yogurt is 125 g in French supermarkets and 227 g in American supermarkets; see Rozin, Kabnick, Pete, Fischler, & Shields, 2003), do not simply compensate for this by eating more portions. The smaller French size would have the effect of reducing food intake only if there were some barrier to consuming more than one portion; because the French do eat less and weigh less than Americans, it appears that something like unit bias is influencing them.

There is good reason to believe that portion size is a major determinant of the amount of food that a person eats (Diliberti, Bordi, Conklin, Roe, & Rolls, 2004; Kral, Roe, & Rolls, 2004; Rolls, Morris, & Roe, 2002; Rozin et al., 2003). It is quite easy to understand this in a restaurant setting, because a diner is served a particular amount (portion) of food, which puts a limit on what can be ingested (unless more is ordered, entailing an imposed expense and waiting period for preparation). However, in a supermarket, drugstore, or fast-food restaurant, there are large numbers of each food or body product readily available, so that there are minimal constraints on purchasing or consuming multiple exemplars of a product. One is a natural unit, and, assuming the unit is of some minimal size (e.g., not a single pea, M&M, or grain of rice), the consumption of a unit seems to inhibit further consumption of the same entity. One interpretation of the unit is that it is perceived as the culturally designated "proper" portion (Herman, Polivy, & Leone, in press), that it represents a consumption norm (Wansink, 2004; Wansink, Painter, & North, 2005). The same forces may be at work in pressure to finish and success at finishing a serving of any food, or even a set of foods (a meal). A "standard" meal can be thought of as the functional unit of eating. That is, we believe that at home or in a restaurant, there is a strong tendency to finish what is served, as that is the effective unit. Siegel (1957) provided evidence indicating that most people consume and complete

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"units" in meals. It is our belief that a small percentage change in portion size would change consumption by the same percentage.

According to a pure form of a regulation model of human food intake, packaging size should be irrelevant to amount consumed. In this view, the amount consumed is determined by caloric intake, or perhaps volume intake. In contrast, a model that emphasizes the importance of environmental features (including palatability, portion size, cost, availability, and ease of consumption) and allows for the operation of a unit-bias heuristic suggests that calories or volume plays a secondary role in amount ingested. Thus, for example, given two sizes of candy bars to be consumed on two separate occasions, in comparable situations and states of deprivation, a one-factor regulation model would predict that the intake weights of the two sizes would be equal. In other words, if the larger candy bar were twice the size of the smaller candy bar, twice as many small bars as large bars would be consumed. In contrast, a model in which unit bias is the only principle of consumption (an unlikely state of affairs) would predict consumption of the same number of entities on the two occasions. Given the complex multidetermination of food intake, in the real world, unit bias would act to increase the amount eaten with the larger as opposed to smaller candy bar.

In the studies we report here, we used three food products in real-world situations to test the predicted influence of unit size on total consumption.

PROCEDURE

In all three studies, we compared intake of snacks offered free and in large numbers in public settings. In two cases, we varied the size of the product unit, and in one case we varied the size of the serving utensil.

Tootsie Roll Study

A large mixing bowl filled with Tootsie Rolls was placed in a high-traffic area on the first floor of an office building. It is customary for there to be snacks in this location; during the experimental period, this was the only snack offered. On alternating days, the bowl was filled with 80 small (3-g) or 20 large (12-g) Tootsie Rolls. Using this formula, we were able to hold the amount (by weight) of food presented at the start of each day constant while we varied the size of the unit by a factor of 4. Each morning, upon the opening of the office building, the bowl was filled with 240 g of the candy. At the close of the day, the remaining pieces were counted to determine the number of candies taken from the bowl during that single day. These measurements were taken for 10 working days (i.e., 5 days each for large and small Tootsie Rolls).

Pretzel Study

At an upscale apartment building, large Philadelphia-style soft pretzels were regularly left for tenants by the management on Mondays, Wednesdays, and Fridays, in an alcove off the lobby. The pretzels were normally served whole (3 oz.). On alternating weeks, we either left them whole (3 oz.) or carefully cut them in half (1.5 oz.), doubling the number offered (60 whole pretzels vs. 120 half pretzels). That is, for one week we would put out 60 whole pretzels on Mondays, Wednesdays, and Fridays, and the following week we would put out 120 half pretzels on the same schedule. We continued this pattern for 12 weeks, accumulating daily intakes for 18 days for each pretzel size. Each day the pretzels were placed in the lobby at 8:00 a.m., and the leftovers were counted at 4:00 p.m.

M&M's Study

A large mixing bowl containing 1 lb. of M&M's was placed on the front desk of the concierge at the same apartment building where the pretzel study took place (but over a different time period). Tethered to the bowl by a chain was either a tablespoon scoop or a quarter-cup scoop, which is four times as large. Directly below the bowl hung a sign that read "Eat Your Fill"; "please use the spoon to serve yourself" was printed in a smaller font at the bottom of the sign. Each day the M&M's were placed on the front desk at 9:00 a.m., and the leftovers were counted at 5:00 p.m. These measurements were taken for 10 working days (Monday through Friday). We alternated between the two scoop sizes from day to day.

RESULTS

In each of the three studies, the basic datum was weight consumed per day. There were 10 data points each for the Tootsie Roll and M&M's studies and 36 for the pretzel study. Figure 1 shows the day-to-day amount consumed in each study. For any particular food, the offerings were made in the same location, so there was an undetermined amount of overlap in participants from day to day. Hence, it is not technically true that the intake on each day was independent from the intake on the other days. However, there was no bias in participants who approached the offerings in one unit-size condition versus the other. In all three studies, with 28 instances of small portion sizes, there was only one case (in the pretzel study) in which the largest daily mean amount selected of the small portion size was bigger than the smallest daily mean amount selected of large portion size (Fig. 1). The probability of this occurring by chance, which would be the prediction of the pure regulation hypothesis, is vanishingly small ($p = .004$ for the Tootsie Roll study, $p = .004$ for the M&M's study, and $p < .001$ for the pretzel study).

A second test, which took into account the actual amount consumed, involved pairing intakes on corresponding days. We computed the ratio of intakes on each day of the week, gener-

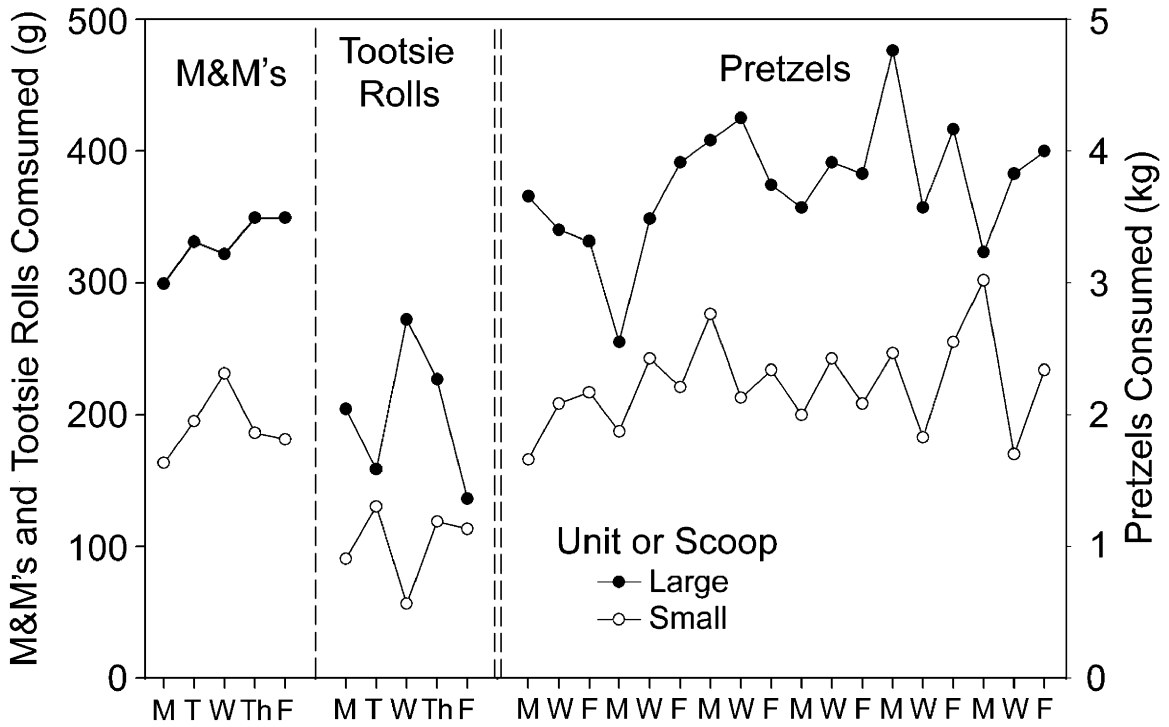

Fig. 1. Mean snack weight consumed by day. The top curves present data for days when the larger unit or scoop was used, and the bottom curves present data for days when the smaller unit or scoop was used. The *y*-axis on the left shows the grams consumed for the M&M's and the Tootsie Rolls, and the *y*-axis on the right shows the kilograms consumed for the pretzels. M = Monday; T = Tuesday; W = Wednesday; Th = Thursday; F = Friday.

ating 5 ratios each for M&M's and Tootsie Rolls and 18 ratios for pretzels (in this case, we compared first Monday with second Monday, third Monday with fourth Monday, etc.). We carried out a one-tailed *t* test on each set of ratios, with 1.00 as the predicted ratio if unit size had no effect. For Tootsie Rolls, for which complete control by unit size would predict an intake ratio of 4.00, the mean value was 2.27, $t(4) = 1.92$, $p = .064$, $d = 0.86$, and all 5 ratios were above 1.00 ($p = .031$, binomial). For pretzels, for which complete control by unit size would predict an intake ratio of 2.00, the mean value was 1.69, $t(17) = 10.21$, $p < .001$, $d = 2.41$, and all 18 ratios were above 1.00 ($p < .001$, binomial). For M&M's, for which complete control by unit size would predict an intake ratio of 4.00, the mean value was 1.67, $t(4) = 7.56$, $p = .001$, $d = 3.38$, and all 5 ratios were above 1.00 ($p = .031$, binomial). The magnitude of the effect was larger for Tootsie Rolls than for M&M's, but because of the much higher variance in ratios for Tootsie Rolls, the magnitude of the effect for Tootsie Rolls did not quite reach statistical significance by the *t* test. That high variance was due to an outlier ratio of 4.8. Ironically, carrying out the *t* test without this one, strongest observation yielded a significant result.

All three of our manipulations produced significant effects in the predicted direction, with the amount consumed being substantially greater for the larger units than the smaller units. Note, though, that the increases fell well short of the value that would be predicted if unit size were the only determinant of selection.

DISCUSSION

Our basic finding is that the amount of food people select increases when the unit presented increases. In the contexts we examined, the food had no cost. In addition, there was an abundance of units, and so no constraint on the number of items potentially selected. Moreover, the additional "work" involved in consuming multiple small units as opposed to a single large unit was trivial. We consider our results evidence for unit bias, and these results were predicted by the unit-bias hypothesis. Despite the substantial increase in intake, the fact that the number of large entities consumed did not equal the number of small entities consumed suggests that factors other than unit bias also influence consumption.

What we actually measured in this study was selection, rather than consumption. We assume most individuals consumed what they selected on the spot or while walking away, but it is possible that some did not consume all that they selected. Some food may have been thrown away, given to another person, or pocketed. The latter is very unlikely for either the pretzels or the M&M's, because putting them in a pocket would be messy and inconvenient. It would have been more likely for the Tootsie Rolls to have been pocketed, as they came with a wrapper. Given American customs for handling food and offering food to other people, we consider it highly unlikely that any of the food was given away. We believe that by far the most reasonable account is

that the food was eaten promptly, and informal observation suggested that this was indeed the case. Other interpretations are particularly unlikely for the M&M's because they are unwrapped and therefore not very portable.

For the pretzels and Tootsie Rolls, it is possible—even likely—that the large portion was more than people would have chosen freely. That is, many individuals who took a whole pretzel might have preferred a half pretzel if they had been given a choice between whole and half pretzels. This is not a possible consideration for the M&M's, because individuals completely determined their own portion size. And of course, even if the large pretzel was "a little too big," insofar as it was consumed, unit bias was still operating.

We believe that unit bias provides the conceptual basis for understanding why portion size influences food intake, and in particular, why smaller portion size may produce lower food intake in the French as opposed to Americans. But why do people tend to stop after eating one entity? One possible reason is social. For example, in the present study, maybe people felt they would either look greedy (because the food was free) or look like they were eating too much (perhaps especially in the case of women) if they took more than one unit. However, given the location of the pretzels, it is likely that no one else was present when participants made their selection. Also, even if the social account were adequate to explain our results, it would devolve into a social form of unit bias—the idea that other people would judge that taking more than one entity (whatever the size) was "too much."

A second account attributes unit bias to cultural norms and learning. That is, cultures package things in natural consumption units. It seems to us that the complete consumption of a unit ("clean your plate") is promoted in three ways: First, the immediate presence of a desirable food provides the temptation to consume it—a Tootsie Roll in the hand is almost a Tootsie Roll in the mouth. Second, for many foods and other products, once one begins consumption, the product is personally contaminated and not appropriate to offer to other people. Third, the culturally induced expectation that one will complete consumption of a unit operates as a norm and discourages such actions as throwing part of the unit away. Consumption norms promote both the tendency to complete eating a unit and the idea that a single unit is the proper portion. Other researchers (Herman et al., in press; Wansink, 2004) have raised the idea that consumption norms are an important determinant of amount eaten. However, although eating a unit can be described as a consumption norm, it is more than that. First, as we just indicated, there are dynamics of the eating situation over and above norms that encourage unit eating (the temptation to eat what is present and the contamination that makes the food unavailable to others). Second, unit bias may itself be a factor in shaping cultural norms—the norm of eating "one" is not arbitrary.

We believe unit bias is related to another phenomenon that we have begun to study. Some companies advertise that their over-the-counter medicines have the same amount of active ingredient as do two pills of their competitor. Because the effort involved in taking two pills is essentially the same as the effort involved in taking one, this apparent selling point would work only if it seemed at least slightly inappropriate to take two pills.

Insofar as unit bias is an operative principle, it would hold only within certain contexts. Most critically, the alternate sizes of the units under consideration would have to fall in the range of "acceptable units." Thus, for example, a single jelly bean or M&M is not large enough to constitute a functional unit, and anything larger than an acceptable portion size would exceed unit size. But we believe there is a substantial range of acceptable units for foods, pills, and, for that matter, movies (double features are rare, but very long movies are not) or amusement-park rides (one ride on a particular attraction is usually enough, whether it takes 1 or 5 min).

In this article, we have introduced the idea of unit bias and provided some evidence for it. We think much more work has to be done to clarify the conditions under which unit bias operates, the domains (e.g., types of products and perhaps activities) in which it operates, and the constraints on its operation. It would also be valuable to get direct measures of intake or use (as opposed to selection), to extend the findings to other cultures, and to explore the degree to which a unit larger than what might be freely chosen by an individual is reliably consumed in full.

We consider this report another effort (along with Herman et al., in press; Hill & Peters, 1998; Rolls, 2003; Rozin et al., 2003; Wansink, 2004) in calling to the attention of psychologists who study food intake and obesity, and, in fact, all research psychologists, that research in our field often suffers from the fundamental attribution error, underestimating the effect of the context and environment.

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