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# Psychologically Informed Implementations of Sugary-Drink Portion Limits

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## Abstract

In 2012, the New York City Board of Health prohibited restaurants from selling sugary drinks in containers that would hold more than 16 oz. Although a state court ruled that the Board of Health did not have the authority to implement such a policy, it remains a legally viable option for governments and a voluntary option for restaurants. However, there is very limited empirical data on how such a policy might affect the purchasing and consumption of sugary drinks. We report four well-powered, incentive-compatible experiments in which we evaluated two possible ways that restaurants might comply with such a policy: bundling (i.e., dividing the contents of oversized cups into two regulation-size cups) and providing free refills (i.e., offering a regulation-size cup with unlimited refills). Bundling caused people to buy less soda. Free refills increased consumption, especially when a waiter served the refills. This perverse effect was reduced in self-service contexts that required walking just a few steps to get a refill.

### Keywords

consumption; purchasing; sugar-sweetened beverage; health; open data; open materials

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In 2012, the New York City Board of Health passed a controversial regulation that restricted the serving containers of sugary drinks to a maximum size of 16 oz at restaurants and other

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food outlets.[1] The proposal was met with backlash from some businesses that argued it would hurt bottom lines and from consumers who argued it would restrict freedom of choice (Roberto & Pomeranz, 2015). Although the policy of the nongoverning board was overturned (New York Statewide Coalition of Hispanic Chambers of Commerce v. New York City Department of Health and Mental Hygiene, 2014), it is a legally viable option if passed by a governing body (Roberto & Pomeranz, 2015), and some restaurants might be interested in limiting portion sizes voluntarily. How might such a policy affect the purchasing and consumption of sugary drinks? Research in psychology and allied fields provides a hint: The answer may lie in understanding the influences of context, social image, and convenience on eating behavior.

Food choices and intake can be affected not only by biological urges but also by subtle contextual cues (Wansink & Chandon, 2014). For example, larger serving dishes, regardless of how much food they contain, lead people to consume more calories (Hollands et al., 2015). This happens in part by shifting consumption norms— that is, people's views of an appropriate serving size (Rolls, Morris, & Roe, 2002; Wansink, Painter, & North, 2005). Such norms can also be affected by the relative size of a serving container: A 20-oz drink seems smaller and more appropriate when it is the second-largest drink in a set as opposed to the largest (Sharpe, Staelin, & Huber, 2008; Simonson & Tversky, 1992). And when large serving sizes are viewed as appropriate, people feel less guilty about consuming them, which can encourage overconsumption (Wansink & Chandon, 2006)—compounded by the tendency to underestimate the size of large serving containers (Chandon & Ordabayeva, 2009).

However, just as contextual influences can drive overeating, they can also provide cues that curb consumption (Polivy, Herman, Hackett, & Kuleshnyk, 1986; Wansink & Chandon, 2014). For example, participants ate fewer chicken wings when the bones were not continually cleared from the table (Wansink & Payne, 2007). Likewise, adding unobtrusive partitions (such as cellophane between cookies stacked inside a package) reduces intake by helping people notice how much they are consuming (Cheema & Soman, 2008; Geier, Wansink, & Rozin, 2012).

In addition to contextual influences, health-related decisions can be affected by social-image concerns. For example, people refrain from buying embarrassing (but important) health products, such as condoms, when they perceive other people to be surrounding them (Dahl, Manchanda, & Argo, 2001). This is compounded by people's tendency to overestimate the extent to which other people are watching and evaluating them (Gilovich, Medvec, & Savitsky, 2000). In the food realm, social-image concerns about appearing gluttonous may reduce overeating.

A third stream of research suggests that food decisions are also affected by convenience considerations. People's tendency to follow the path of least resistance (Johnson & Goldstein, 2003) can be leveraged to promote healthful behaviors. For example, healthier

[1]For reference, a small-sized drink at McDonald's in the United States is currently 16 ounces, whereas a large-sized drink is a whopping 30 ounces.

sandwiches are more likely to be ordered when they are made easily accessible (Wisdom, Downs, & Loewenstein, 2010).

We tested two proposed implementations of a portion limit designed to curb consumption (Grynbaum, 2012) that would preserve businesses' ability to serve large quantities and consumers' freedom of choice. These interventions leveraged contextual cues, social-image motivations, and convenience motivations to reduce purchases and consumption of sugary drinks.

The first intervention was bundling, in which large drinks (e.g., 24 oz) are served as two smaller drinks and sold as a bundle. Dividing the same amount of food into multiple containers reduces consumption (by shifting norms and facilitating monitoring; Cheema & Soman, 2008). Little is known, however, about how bundling affects purchasing, a behavior upstream of consumption. On the one hand, bundling could increase purchasing relative to when the same amount is served in one container by creating the illusion of a better value: a two-for-one deal. Indeed, a prior study found that bundling backfired and led to increased hypothetical purchases of sugary drinks (Wilson, Stolarz-Fantino, & Fantino, 2013). However, the study relied on self-reported hypothetical purchase choices, and the result may simply be an artifact of the way orders were elicited (for details, see the Supplemental Material available online). In addition, a strict (although unlikely) implementation limiting sugary-drink sizes to 16 oz decreased the number of hypothetical calories purchased. These concerns, combined with the extant research on the contextual, social, and convenience factors affecting choice, led us to predict that bundling would not backfire and could even reduce sugary-drink purchases. Indeed, that a single unit (i.e., a cup) is considered a more appropriate serving size than the same quantity divided into two serving containers (Geier, Rozin, & Doros, 2006) suggests that bundling may decrease purchasing.

The second intervention was free refills, in which a 16-oz drink was offered with unlimited refills included in the price. One important question is whether consumers would be as interested in buying a smaller drink with refills as they would a larger drink. It is also important to understand whether offering free refills backfires, potentially by triggering the psychological motive to honor sunk costs (Arkes & Blumer, 1985). Hence, a person ordinarily satisfied with a 16-oz drink might feel compelled to get a refill because he or she has already “paid” for it. However, we predicted this perverse effect would be reduced by the way refills are obtained. Because of social-image and convenience motivations, requiring people to stand up and get their own refills (as opposed to having those refills served to them) may reduce the likelihood of obtaining refills and thereby consumption.

## Overview of the Experiments

In four experiments, we tested the impact of two implementations of a portion limit on behavior. In Experiment 1, we tested the impact of bundling on purchasing and consumption and whether its effect depends on service style (waiter service vs. self-service). In Experiments 2, 3a, and 3b, we tested the impact of free refills on purchasing and consumption, and, again, whether this effect was accentuated by service style.

Each experiment included a control situation representing the typical current, unregulated state of the world and was conducted during 90-min lab sessions in which the participants sat at a cubicle and completed unrelated studies for $25. The participants had the opportunity to buy drinks at the outset of the sessions (Experiments 1, 2, and 3a) and to consume them throughout the sessions (all experiments). After the participants left, a researcher weighed the cups and subtracted the weight of the cups, generating the consumption measure.

We prespecified sample sizes by calculating the sample size required to detect small effects (Cohen's *d* of 0.20) with 90% power in Experiments 1, 2, and 3a and 80% power in Experiment 3b. (Because Experiment 3b was a conceptual replication of Experiment 3a, in which moderate effects were observed, we settled on having 80% power to detect small effects, which represented 97% power to detect medium effects.) We report all manipulations and measures. No data were excluded.

In all the experiments, participants were given a multiple-choice quiz question at the end of the session asking them to identify the condition-specific drink information they had been given. Most participants (at least 80%) answered correctly. As reported in the Supplemental Material, the results typically became stronger when we excluded the participants who failed the comprehension check.

## Experiment 1: Bundles

Experiment 1 was a 2 × 2 between-participants design in which we manipulated the implementation of a portion limit (typical portion vs. portion limit plus bundling) and service style (waiter service vs. self-service).

### Method

Of 623 participants, 45.1% were male. Their mean age was 24.11 years (*SD* = 5.72), and the sample was 50.2% White, 21.3% Asian, 12% Black, 9% Pacific Islander, 6.6% Hispanic, 0.3% American Indian, and 0.2% mixed race; 0.3% did not report their race.

**Purchasing induction and introductory information—**We took a number of steps to maximize the number of participants who bought a drink. First, we sought to induce thirst by giving all the participants a small bag of potato chips. Second, we offered two popular beverage options—iced tea or lemonade, both of which are sugary drinks (Popkin et al., 2006): nonalcoholic, high-energy-density drinks containing added caloric sweetener. We used noncarbonated beverages for ease of pouring and measurement. Third, we priced drinks inexpensively (being careful to keep the pricing ratio between sizes roughly comparable to that used in U.S. fast-food restaurants). Fourth, the participants were given $0.40 to buy the drinks, but could keep any unspent money. Fifth, to prevent the participants from opting out of buying a beverage so they could complete the studies more quickly and leave sooner, we told the participants that the session would not begin until all drink orders had been fulfilled. This procedure was also used in all subsequent experiments except as otherwise noted.

**Purchasing procedure—**At the beginning of the session, a question appearing on the participants' computer screen asked if they wanted to buy a drink and informed them of the beverage options and pricing: $0.20 for a medium drink and $0.30 for a large drink (for all experimental stimuli, see the Supplemental Material). The participants were also told that drinks could not be taken home. Those who elected to buy a drink ($N = 362$) were randomly assigned to one of four experimental conditions.

**Bundling manipulation—**The participants completed an order form that conveyed the bundling information. In the typical-portion condition, the large drink was served in a single 24-oz cup. In the bundled condition, the large drink was served in two 12-oz cups. In both conditions, the medium drink was served in a single 16-oz cup.

**Service-style manipulation—**In the waiter-service condition, a research assistant visited each participant's cubicle to fulfill his or her drink order. In the self-service condition, the participants stood up and walked to a room at the back of the lab, where they bought and obtained their drinks.

In this experiment, we had the participants decide whether to order a drink before randomization because by the time people are reviewing a fast-food restaurant menu, they are likely to have already decided whether to buy a drink. A short online survey administered on Amazon's Mechanical Turk supports this contention: 73% of respondents ($N = 281$; mean age = 34.74 years, $SD = 11.46$; 37.4% female; 76.9% White) said that by the time they are inside a fast-food restaurant (i.e., after they have chosen to buy from the restaurant), they have decided whether to buy a drink, though not necessarily how much to buy. Given this, and that we thought the bundling manipulation would be more likely to affect the choice of how much to buy than whether to buy, the experiment was designed to optimize the internal validity of the former. However, the participants could decide at any time that the bundling was unappealing and renege on their drink purchase (only one person did, and he was from the self-service/bundled condition).

## Results

The likelihood of ordering a large drink was examined in a logistic regression with three independent variables: portion limit (typical portion vs. bundled), service style (waiter service vs. self-service), and their interaction. There was neither a significant main effect of service style, odds ratio (OR) = 0.82, 95% confidence interval (CI) = [0.46, 1.46], $p = .50$, nor a significant interaction of portion limit and service style, OR = 0.75, 95% CI = [0.30, 1.86], $p = .53$. However, the participants were marginally significantly less likely to order large drinks in the bundled condition than in the typical-portion condition, OR = 0.59, 95% CI = [0.32, 1.09], $p = .09$, $d = 0.25$ (Fig. 1). In the results from this full logistic regression model (which included two main effects and an interaction term), there was therefore no evidence that bundling led to a backfire effect (i.e., bundling did not increase purchasing). In fact, the result of a $\chi^2$ test comparing only the bundled and typical-portion conditions, collapsed across serving style, was significant: Drink purchasers were 64.8% less likely to buy a large drink in the bundled condition than in the typical-portion condition (25.6% bought a large drink in the bundled condition, and 39.5% bought a large drink in the typical-portion condition), $\chi^2(1, N = 362) = 7.90$, $p = .005$. The effect of bundling was magnified among the participants restricted to the self-service condition: 20.7% bought large drinks in the bundled condition, compared with 37.1% in the typical-portion condition, $\chi^2(1, N = 179) = 5.72$, $p = .02$.

We conducted a 2 × 2 analysis of variance (ANOVA) with factors of portion limit (typical portion vs. bundled) and service style (waiter service vs. self-service). The findings, directionally consistent with those for purchasing, revealed that the participants in the bundled condition consumed 5.6% fewer calories than those in the typical-portion condition; however, this difference did not reach statistical significance (typical portion: $M = 122.61$ kcal, $SD = 47.92$; bundled: $M = 115.70$ kcal, $SD = 49.77$), $F(1, 358) = 1.67$, $p = .20$. There was no main effect of service style (waiter service: $M = 116.28$ kcal, $SD = 51.73$; self-service: $M = 122.44$ kcal, $SD = 45.68$), $F(1, 358) = 1.43$, $p = .23$, and there was no significant interaction between portion limit and service style, $F(1, 358) = 0.67$, $p = .41$.

Taken together, these results suggest that bundling will not backfire—that is, bundling is unlikely to increase either purchasing or consumption of sugary drinks. In fact, bundling seemed to decrease purchasing.

## Experiment 2: The Peril of Free Refills

In Experiment 2, we tested how purchasing and consumption would be affected by free refills, something restaurants are arguably more likely to implement than bundling. The participants were randomized to a control condition in which typical portion sizes were offered or to an intervention in which sugary drinks were restricted to 16 oz but unlimited refills were included in the price. In both conditions, drinks were served by waiters.

### Method

Of 470 participants, 44.9% were male and 43% were female; 12.1% did not report their gender. Their mean age was 32.74 years ($SD = 14.65$), and the sample was 47% White, 14.3% Asian, 12.1% Black, 7.7% Hispanic, 6.6% Pacific Islander, 0.2% American Indian, and 0.2% mixed race; 11.9% did not report their race. The participants received the same purchasing induction and introductory information as in Experiment 1. Next, the participants were randomized to receive one of two different drink order forms that represented our two experimental conditions. In both conditions, the participants could choose to buy either a medium drink for $0.20 or a large drink for $0.30. Both order forms also included a third option, “I would not like a drink”; thus this design allows for the possibility that free refills could affect whether the participants bought a drink. In both conditions, the medium drink was 16 oz. In the typical-portion condition, the large drink was 24 oz; in the refill condition, the large drink was 16 oz and came with unlimited refills. The participants in the refill condition were told that they could obtain a refill at any point by raising their hand, which would prompt a researcher to deliver a refill. This information was conveyed both on the order form (see the Supplemental Material) as well as on a Post-it note stuck to the computer monitor (so that throughout the entire 90-min session, the participants were reminded that they could obtain refills).

## Results

Overall, 297 participants (63.2%) bought a drink; the number who bought a drink did not significantly differ between conditions, $\chi^2(1, N = 470) = .37$, $p = .57$. The tendency to order a large drink was also similar across conditions: Among those who bought a drink, 39.9% bought a large drink in the typical-portion condition and 36.2% in the refill condition, $\chi^2(1, N = 297) = .41$, $p = .55$. Thus, a 16-oz drink with free refills was as appealing as a 24-oz drink with no refills.

Most participants (79.6%) who ordered a large drink in the refill condition obtained a refill. Because neither the propensity to buy a drink nor drink size differed by condition, we considered all the participants who bought a drink for our primary analysis. We conducted a 2 × 2 ANOVA to assess how portion limit (typical portion vs. refill) and drink size (medium vs. large) predicted consumption. Overall, the participants in the refill condition consumed 20.1% more calories than those in the typical-portion condition (refill: $M = 139.64$ kcal, $SD = 88.10$; typical portion: $M = 116.28$ kcal, $SD = 48.08$), $F(1, 293) = 22.48$, $p < .001$. And, not surprisingly, consumption was higher for the large drink than for the medium drink (large: $M = 174.87$ kcal, $SD = 87.86$; medium: $M = 99.21$ kcal, $SD = 37.96$), $F(1, 293) = 120.10$, $p < .001$.

However, these main effects were qualified by a significant interaction between portion limit and drink size, $F(1, 293) = 18.39$, $p < .001$ (Fig. 2). Follow-up tests revealed that consumption was similar for the medium drink, $t(182) = 0.57$, $p = .57$. For the large drink, however, the participants consumed 44.0% more calories in the refill condition than in the typical-portion condition (refill: $M = 208.05$ kcal, $SD = 106.69$; typical portion: $M = 144.51$ kcal, $SD = 50.43$), $t(111) = 4.10$, $p < .001$, $d = 0.77$. Thus, the increased consumption observed in the refill condition was driven by consumption of large drinks— the only drink size that included free refills.

Although neither purchasing nor drink size was different between conditions, we nonetheless ran an intent-to-treat analysis as a robustness check. This analysis counted the participants who declined to buy a drink as having consumed zero calories (and necessarily collapsed across sizes, because the participants who declined to buy a drink did not go on to specify a drink size). The consumption difference held: The participants in the refill condition consumed 26.1% more calories than those in the typical-portion condition (refill: $M = 9\,0.46$ kcal, $SD = 97.39$; typical portion: $M = 71.71$ kcal, $SD = 68.05$), $t(468) = 2.43$, $p = .016$.

The results for Experiment 2 suggest that restaurants subject to a portion limit could implement free refills without hindering sales of these beverages; the participants were just as likely to buy a 16-oz drink with free refills as they were to buy a 24-oz drink without refills. However, this implementation may have the perverse effect of increasing consumption, which suggests that if this strategy were deployed, the spirit of the policy might not be realized.

## Experiments 3a and 3b: The Peril of Free Refills Mitigated

In Experiments 3a and 3b, we tested a possible antidote to the increased consumption observed in the refill condition of Experiment 2. Given the influence of social and convenience motivations on consumption decisions, we tested whether this pattern could be reduced by introducing a seemingly trivial degree of friction between the person and the refill: requiring people to stand up and walk a few feet to get their own refills. Experiment 3a was the same as Experiment 2, except that we added a self-service refill condition and implemented a few procedural enhancements.

### Experiment 3a

Of 557 participants, 48.5% were male and 46.9% were female; 4.6% did not report their gender. Their mean age was 32.46 years (*SD* = 12.56), and sample was 42.7% White, 24.2% Asian, 17.2% Black, 4.8% Hispanic, 3.4% mixed race, 1.8% Pacific Islander, and 0.5% American Indian; 5.4% did not report their race.

**Method—**In all conditions, the participants chose to buy either no drink, a medium drink (16 oz) for $0.20, or a large drink (16 or 20 oz, depending on the experimental condition) for $0.30. As in Experiment 2, refills were not offered in the typical-portion condition. In the current experiment's typical-portion condition, however, the large drink was 20 oz; that size is more commonly found in U.S. restaurants relative to the 24-oz size used in Experiment 2. In addition, to help the participants understand the size options, we placed two empty cups at each cubicle: a medium cup (always 16 oz) and a large cup (20 oz in the typical-portion condition and 16 oz in the refill conditions), labeled appropriately (see the Supplemental Material).

The participants therefore received a menu offering a 16-oz medium drink with no refills and a large drink that was either (a) 20 oz, (b) 16 oz with waiter-service refills, or (c) 16 oz with self-service refills (i.e., they had to get their own refill from a table approximately 20 feet away). The participants in the self-service condition were instructed to take only one drink cup at a time, and a research assistant unobtrusively replenished the drink station each time a drink was taken. Information on how to obtain a refill was conveyed both on the order form (see the Supplemental Material) and on a Post-it note stuck to the computer monitor (so that throughout the entire 90-min session, the participants were reminded that they could obtain a refill).

**Results—**Overall, 341 participants (61.2%) bought a drink; the number who bought a drink did not significantly differ between conditions, $\chi^2(2, N = 557) = 2.69$, $p = .26$. The tendency to order a large drink was also similar across conditions: Among those who bought a drink, 41.3% bought a large drink, and the number who bought a large drink did not significantly differ between conditions, $\chi^2(2, N = 341) = 0.46$, $p = .79$. Thus, as in Experiment 2, a 16-oz drink with free refills was as appealing as a 20-oz drink with no refills, which is consistent with the findings of Experiment 2.

Most participants (62.1%) who ordered a large drink in the refill conditions obtained at least one refill. To assess the impact of the portion-limit manipulation (typical portion vs. waiter service vs. self-service) and drink size (medium vs. large) on consumption, we ran a 3 × 2 ANOVA considering all the participants who bought a drink. There were significant main effects of portion limit, $F(2, 335) = 10.37$, $p < .001$, and drink size, $F(1, 335) = 126.59$, $p < .001$. These were qualified by a significant interaction between portion limit and drink size, $F(2, 335) = 15.42$, $p < .001$ (Fig. 3).

Follow-up tests revealed that for the medium drink, consumption was similar across service styles, $F(2, 197) = 1.07$, $p = .34$. For the large drink (the only size that the refill manipulation applied to), consumption differed by service style, $F(2, 138) = 11.69$, $p < .001$. Specifically, the participants consumed 51.9% more calories in the waiter-service condition than in the typical-portion condition (waiter-service: $M = 210.75$ kcal, $SD = 83.92$; typical portion: $M = 138.72$ kcal, $SD = 37.97$), $t(93) = 5.33$, $p < .001$, $d = 1.09$. This difference was reduced in the self-service condition: Although the participants in that condition consumed more calories ($M = 176.91$ kcal, $SD = 84.85$) than those in the typical-portion condition, $t(90) = 2.79$, $p = .006$, $d = 0.58$, they consumed 19.1% fewer calories than those in the waiter-service condition, $t(93) = 1.95$, $p = .054$, $d = 0.40$.

As in Experiment 2, the experimental manipulation affected neither purchasing propensity nor drink size, but we nonetheless ran an intent-to-treat analysis as a robustness check. This analysis counted the participants declining to buy a drink as having consumed zero calories (and was necessarily collapsed across drink size). The basic pattern held: The consumption difference was marginally significant, $F(2, 556) = 2.39$, $p = .09$. Specifically, the participants consumed 22.6% more calories in the waiter-service condition than in the typical-portion condition (waiter service: $M = 94.52$ kcal, $SD = 95.93$; typical portion: $M = 77.07$ kcal, $SD = 66.28$), $t(369) = 2.04$, $p = .04$. However, requiring the participants to get their own refills reduced this perverse effect: Consumption in the self-service condition ($M = 79.17$ kcal, $SD = 86.86$) was just as low as consumption in the typical-portion condition, $t(369) = 0.26$, $p = .79$, and was lower, albeit not significantly so, than consumption in the waiter-service condition, $t(370) = 1.62$, $p = .11$. The intent-to-treat analysis was statistically weaker than the analysis of just those participants who bought a drink because it was conservative, especially considering that (a) the manipulation pertained only to large-drink orders, which were placed by only 25.3% of the sample, and (b) it excluded drink size as an explanatory variable—and drink size, not surprisingly, explained considerable variance.

Taken together, these results suggest that this method of complying with a sugary-drink portion limit could have the perverse effect of increasing consumption. However, requiring the participants to stand up and walk a tiny distance to obtain their refills helped to curb it. The fact that the participants were as likely to buy a drink in the refill conditions as in the typical-portion condition suggests that this implementation has the benefit of allowing firms to maintain sales levels (and probably profits, too, because the additional cost of the increased consumption in the refill conditions is likely to be trivial for fountain soda). However, at least in this instance, it did not achieve the intended purpose of reducing consumption.

Experiment 3a suggests that requiring participants to get their own refills alleviates the perverse effect of the free-refill response to a portion cap. In Experiment 3b, we tested whether this effect could be replicated.

### Experiment 3b

Of 285 participants, 48.4% were male and 50.5% were female; 1.1% did not report their gender. Their mean age was 30.05 years (*SD* = 12.30), and the sample was 38.9% White, 23.5% Black, 23.2% Asian, 5.6% Hispanic, 4.9% Pacific Islander, 2.5% mixed race, and 0.3% American Indian; 1.1% did not report their race.

**Method—**The participants were randomized to one of three experimental conditions that differed in portion limits and service styles (typical portion, waiter-served refills, self-served refills), as in Experiment 3a.

In this experiment, drinks were given (as opposed to being sold) to all the participants, and serving sizes were downsized (but the sizing ratios were consistent with those used by fast-food restaurants). This was done because we were primarily interested in refill behavior as a function of service style, and allowing the participants to buy drinks substantially increases the required sample size (because only 60% of participants typically buy drinks). For ease of implementation, instead of letting the participants choose their beverage type (iced tea or lemonade), a drink was placed at each cubicle before the participants arrived, alternating beverage types. However, a Post-it note stuck to each cubicle instructed the participants to raise their hand if they wanted to switch to the other beverage type. In the typical-portion condition, the participants were given a 10-oz drink with no opportunity for refills. In the refill conditions, the participants were given a smaller, 8-oz drink but could obtain refills. Refills were otherwise implemented as in Experiment 3a.

**Results—**There were significant differences in consumption between conditions, $F(2, 283) = 21.66$, $p < .001$ (Fig. 4). Specifically, the participants in the waiter-service condition consumed 83.0% more calories than those in the typical-portion condition (waiter service: $M = 93.82$ kcal, $SD = 59.24$; typical portion: $M = 51.26$ kcal, $SD = 29.30$), $t(187) = 6.27$, $p < .001$, $d = .091$. Although the participants in the self-service condition consumed 30.7% more calories ($M = 67.03$ kcal, $SD = 41.26$) than those in the typical-portion condition, $t(188) = 3.04$, $p = .003$, $d = 0.44$, they consumed 40.0% fewer calories than the participants in the waiter-service condition, $t(187) = 3.61$, $p < .001$, $d = 0.52$.

In sum, Experiment 3b replicated the results of Experiments 2 and 3a: Paradoxically, implementing a policy of free refills of sugary drinks with a portion cap may increase consumption; however, this effect is reduced when people are required to walk a distance to get a refill—even if that distance is trivial.

## Discussion

In light of the potential for a sugary-drink portion-limit policy to curb consumption but also incite restaurant and consumer backlash, we tested whether two possible implementations would achieve the former while potentially mitigating the latter by leveraging contextual, social-image, and convenience influences that drive purchasing and consumption decisions. In contrast to a prior hypothetical study (Wilson et al., 2013), the results of Experiment 1 suggest that bundling will not backfire and may curb purchases of sugary drinks. The findings of Experiments 2, 3a, and 3b, however, suggest that such a policy could be undermined if restaurants offered free refills with a 16-oz beverage. The participants found this smaller drink with free refills appealing, but it ultimately led them to consume more calories from sugary drinks, particularly when waiters served refills. Making the refill process trivially inconvenient by requiring people to get their own refills reduced this increased consumption relative to waiter-served drinks.

Our refill experiments reflect the conservative design choice to compare a large drink that is capped at 16 oz but has free refills with the next largest drink size commonly sold in restaurants: 24 oz in Experiment 2 and 20 oz in Experiment 3a. However, it is possible that if we compared a 16-oz drink with free refills with an even larger drink without free refills, consumption would not be greater in the free-refill condition. To explore this possibility, we pooled the data from all the participants who ordered a large drink—in both the typical-portion conditions and the refill conditions—in Experiments 2, 3a, and 3b. Because people tend to consume a fixed proportion of the food in a given serving container as opposed to an absolute number of calories (Geier et al., 2006), we calculated the average amount of drink consumed as a proportion of the cup's size in each condition across Experiments 2, 3a, and 3b: For the typical-portion condition, the proportion was 0.84; for the waiter-service condition, the proportion was 1.63; and for the self-service condition, the proportion was 1.34.

In the absence of a portion limit, vendors are free to use any cup size, so we applied these average proportions to various sizes of cups in excess of 16 oz. We then calculated, for a given cup size, the number of calories of Coca-Cola[2] (11.67 kcal per ounce) to which each proportion corresponded (i.e., 0.84 × 11.67 kcal × 16 oz = 156.84 kcal; 0.84 × 11.67 kcal × 20 oz = 196.06 kcal, etc.). However, with a portion limit, cup size would be fixed at 16 oz; therefore, we calculated the number of calories of Coca-Cola to which each proportion corresponded given a refillable 16-oz cup (waiter-service condition: 11.67 kcal × 16 oz × 1.72 = 321.6 kcal; self-service condition: 11.67 kcal × 16 oz × 1.25 = 233.4 kcal; see Fig. 5).

This analysis suggested that a policy of portion limits with free waiter-service refills could reduce consumption compared with the current policy of unregulated portion sizes—as long as the unregulated cup size is at least 32.8 oz (Fig. 5). Currently, large sizes at U.S. fast-food restaurants range from approximately 30 to 42 oz; thus, a policy of portion limits would be predicted to curb consumption among customers ordering a large-size sugary drink at restaurants at which the large size is more than 32.8 oz. Further, this analysis suggested that a portion-limit policy with free self-service refills would be more effective than one with free waiter-service refills. Specifically, such a policy would be predicted to reduce consumption as long as the unregulated cup size is at least 23.8 oz. Currently, medium sizes at U.S. fast-food restaurants range from approximately 20 to 32 oz; thus, a policy of portion limits with free self-service refills would be predicted to curb consumption among customers

[2]We chose Coca-Cola because it is the best-selling soda in the United States.

ordering a medium-size or larger sugary drink at restaurants at which the medium size is more than 23.8 oz. Moreover, this analysis was based on an assumption that with a policy of unregulated cup sizes, customers do not obtain refills on drinks of any size. If refills are allowed, as is often the case, the relative effectiveness of a portion-limit policy with free refills, regardless of whether they are waiter- or self-served, would probably be even greater. Of course, because of its many assumptions, this analysis is speculative.

More broadly, these interventions are an example of libertarian, or asymmetric, paternalism (Camerer, Issacharoff, Loewenstein, O'Donoghue, & Rabin, 2003; Thaler & Sunstein, 2003), an increasingly popular approach to behavior change, including health behavior, that does not limit individual free choice. Although these interventions may have the capacity to change behavior for the better without requiring self-control, it is important to evaluate their potential unintended consequences.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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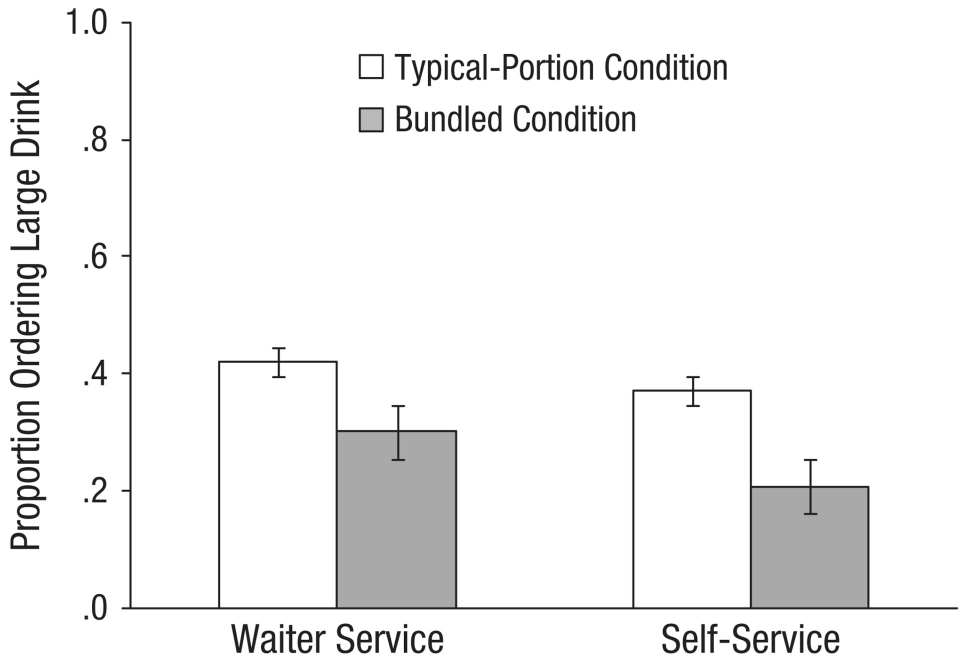


**Fig. 1.**

Results from Experiment 1: the proportion of participants who bought a large drink as a function of service style, separately for the typical-portion and bundled conditions. The error bars indicate ±1 *SEM*.

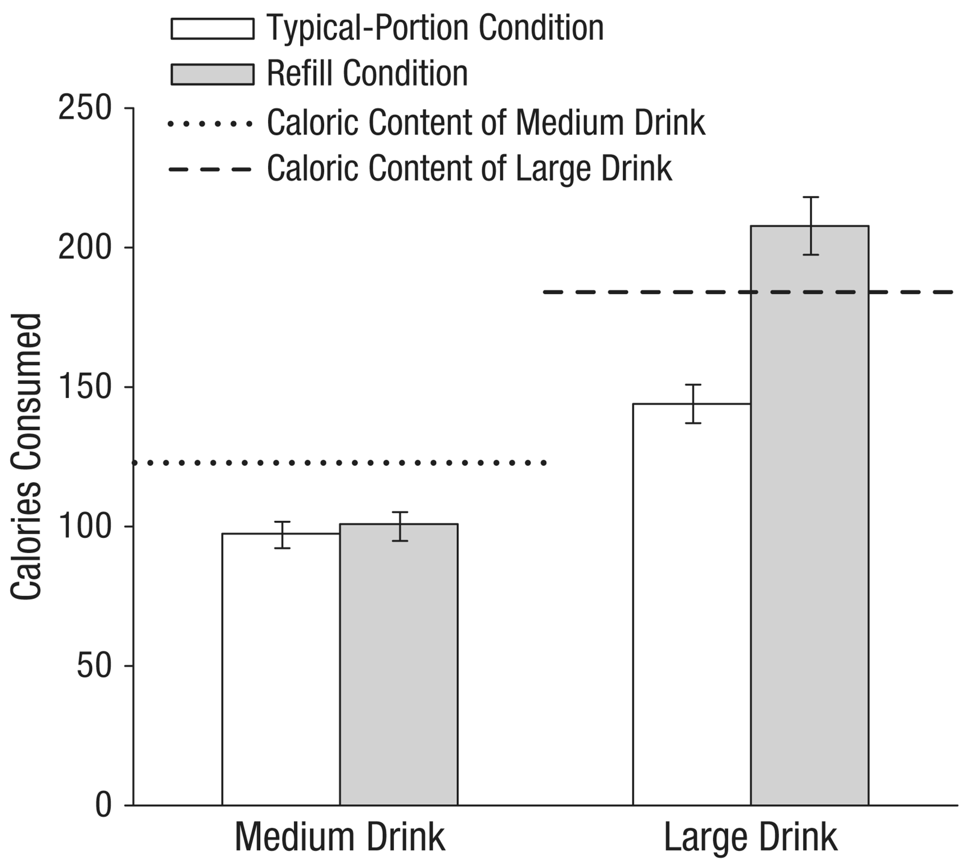


**Fig. 2.**

Results from Experiment 2: calories consumed as a function of the size of the drink bought, separately for the typical-portion condition and the refill condition. The error bars indicate ±1 *SEM*. The caloric-content lines reflect the average number of calories contained in the portion served (i.e., a 16-oz cup or a 24-oz cup), calculated from the calorie content of the two flavors—lemonade: 6.00 kcal per ounce; iced tea: 9.375 kcal per ounce.

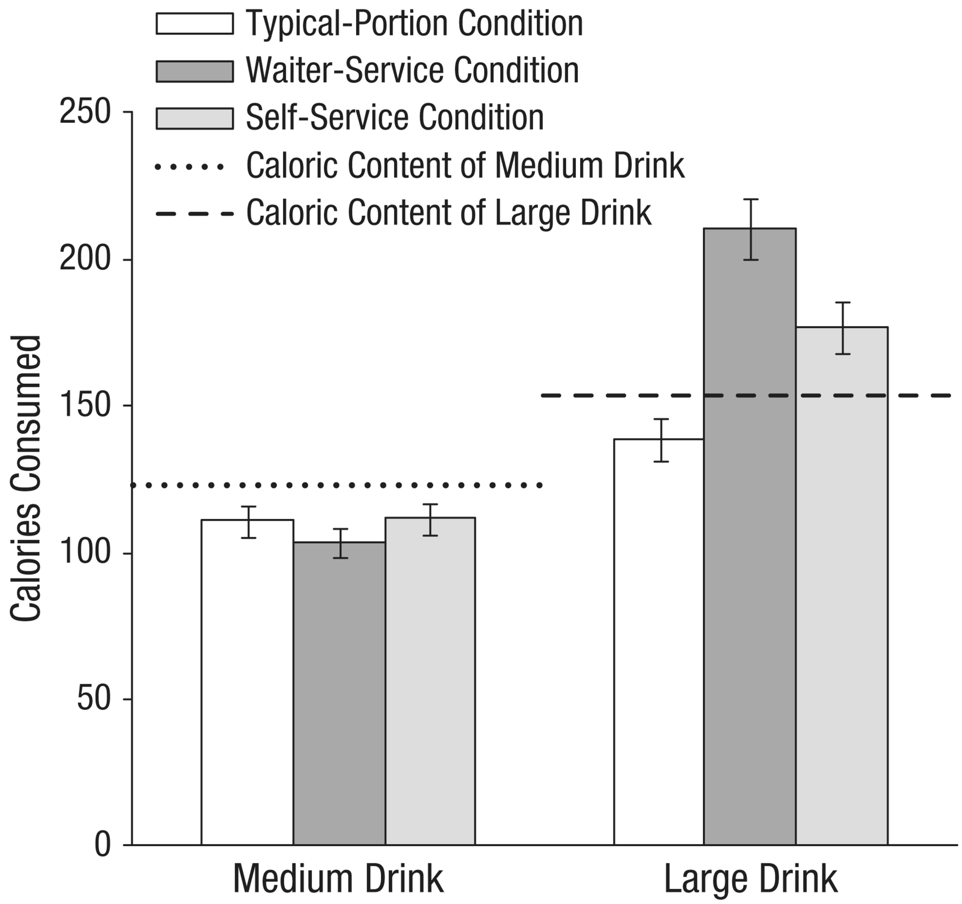


**Fig. 3.**

Results from Experiment 3a: calories consumed as a function of the size of the drink bought, separately for the typical-portion, waiter-service, and self-service conditions. The error bars indicate ±1 *SEM*. The caloric-content lines reflect the average number of calories contained in the portion served (i.e., a 16-oz cup or a 20-oz cup), calculated from the calorie content of the two flavors—lemonade: 6.00 kcal per ounce; iced tea: 9.375 kcal per ounce.

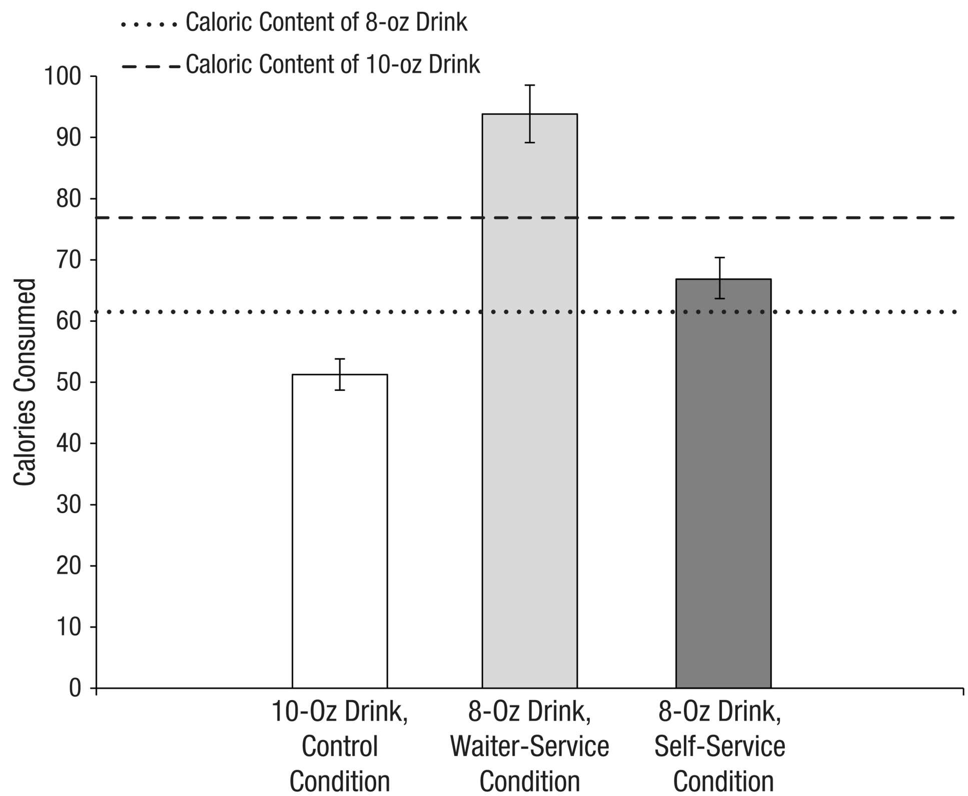


**Fig. 4.**

Results from Experiment 3b: calories consumed as a function of condition. The error bars indicate ±1 *SEM*. The caloric-content lines reflect the average number of calories contained in the portion served (i.e., an 8-oz cup or a 10-oz cup), calculated from the calorie content of the two flavors—lemonade: 6.00 kcal per ounce; iced tea: 9.375 kcal per ounce.

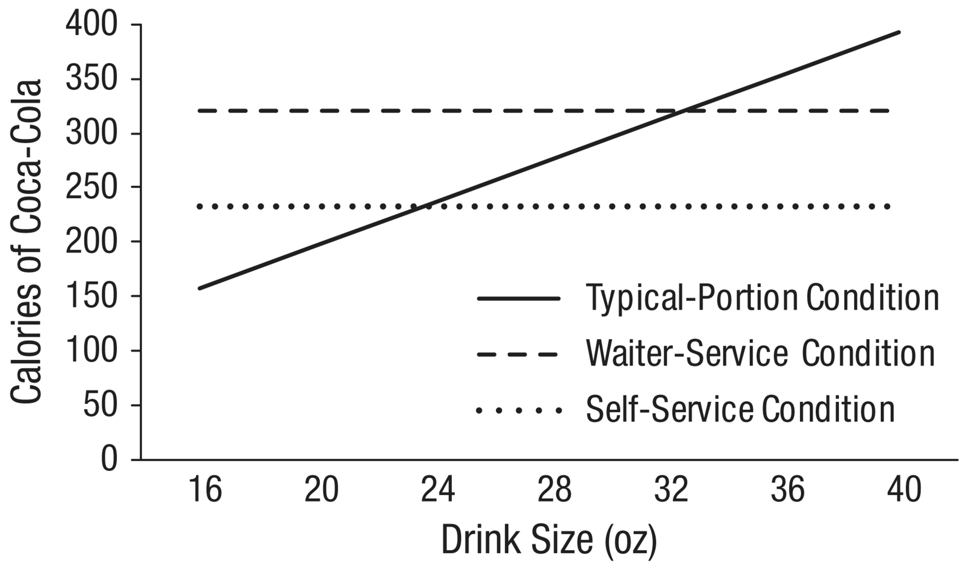


**Fig. 5.**

Number of calories of Coca-Cola consumed as a function of cup size. In the waiter-service and self-service conditions, which had free refills, cup size was limited to 16 oz; the results shown here are based on actual consumption in Experiments 2, 3a, and 3b. In the typical-portion condition, which had no refill opportunity, cup size could vary, and the number of calories consumed was estimated for a range of cup sizes according to the proportion of a cup's contents that was consumed in Experiments 2, 3a, and 3b.