

The Effect of Graphic Warnings on Sugary-Drink Purchasing



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Abstract

Governments have proposed text warning labels to decrease consumption of sugary drinks—a contributor to chronic diseases such as diabetes. However, they may be less effective than more evocative, graphic warning labels. We field-tested the effectiveness of graphic warning labels (vs. text warning labels, calorie labels, and no labels), provided insight into psychological mechanisms driving effectiveness, and assessed consumer sentiment. Study 1 indicated that graphic warning labels reduced the share of sugary drinks purchased in a cafeteria from 21.4% at baseline to 18.2%—an effect driven by substitution of water for sugary drinks. Study 2 showed that graphic warning labels heighten negative affect and prompt consideration of health consequences. Study 3 indicated that public support for graphic warning labels can be increased by conveying effectiveness information. These findings could spur more effective labeling policies that facilitate healthier choices, do not decrease overall beverage purchases, and are publicly accepted.

Keywords

decision making, food, health, policy making, preferences, open data, open materials, preregistered

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Consumption of sugary drinks, such as soda, is a leading contributor to major health problems, including obesity (Ludwig, Peterson, & Gortmaker, 2001), diabetes (Schulze et al., 2004), and heart disease (Fung et al., 2009). To reduce purchasing and consumption of sugary drinks, several local and state governments have proposed warning labels highlighting health risks; for example, San Francisco passed a policy requiring text warning labels on sugary-drink advertisements, but it has not been implemented because of legal challenges from industry (Wiener, Mar, Cohen, & Avalos, 2015). Despite these initiatives, there are no published field tests evaluating whether sugary-drink warning labels achieve their intended purpose in the real world, although two recent scenario-based lab studies point to their promise (Roberto, Wong, Musicus, & Hammond, 2016; VanEpps & Roberto, 2016). Beyond the question of effectiveness, there have been no published nationally representative polls evaluating whether the public would accept them.

Like calorie labels, warning labels aim to provide health-relevant information to induce healthy behavior change. However, past research underscores the limits of this approach; for example, the evidence on whether calorie labels reduce calorie purchasing is mixed (Bleich et al., 2017; Downs, Wisdom, Wansink, & Loewenstein, 2013). Unlike calorie labels, warning labels convey direct information about potential health harms, which might increase their potency. This information is used to overcome factors that often lead to suboptimal health decisions, including visceral factors such as hunger and self-control limits (Loewenstein, Read, & Baumeister, 2003; Stroebe, van Koningsbruggen, Papies, & Aarts, 2013; U.S. Food & Drug Administration, 2014).

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In addition to identifying the limitations of health information, research also suggests that this information can be effective when provided in a salient and intuitively comprehensible way (Downs, Loewenstein, & Wisdom, 2009; Fagerlin, Zikmund-Fisher, & Ubel, 2011; Korfage et al., 2013). For example, people choose healthier beverages when calories are expressed in physical activity equivalents (Bleich, Barry, Gary-Webb, & Herring, 2014; Bleich, Herring, Flagg, & Gary-Webb, 2012). Such translation is likely even more compelling when it triggers an affective response (Loewenstein, 1996).

Indeed, smoking cessation research has shown that graphic warning labels—which trigger an affective response—can be more effective than text warnings across a variety of outcomes (Noar et al., 2017; Noar, Francis, et al., 2016; Noar, Hall, et al., 2016; Purmehdi, Legoux, Carrillat, & Senecal, 2017). Sometimes a “diminishing cascade of effects” (Purmehdi et al., 2017, p. 36) is observed whereby effects are strongest and most consistent for proximal measures of affective arousal and attention, less so for behavioral intentions, and weakest for behaviors such as calls to quit lines and cigarette consumption. Nonetheless, even modest effects are noteworthy for such an intractable behavior, given that labeling is a relatively weak intervention compared with approaches such as taxation and choice architecture.

Why might evocative, graphic warning labels be effective? Previous research and theorizing suggest that affect serves as a cue that heightens and channels attention, increasing consideration of the risks and consequences of a decision (Emery, Romer, Sheerin, Jamieson, & Peters, 2014; Evans et al., 2015; Noar, Hall, et al., 2016). This hypothesized two-step process can serve the adaptive function of helping people make wiser decisions (Loewenstein, Weber, Hsee, & Welch, 2001; Peters, 2006; Peters, Lipkus, & Diefenbach, 2006; Slovic, Finucane, Peters, & MacGregor, 2002).

Applied to sugary-drink warnings, this reasoning suggests that warning labels might be particularly effective when depicted pictorially (as opposed to merely textually). We predicted that graphic warning labels would decrease sugary-drink selection and that this effect would be driven by a two-stage process invoking negative affect, followed by increased consideration of health over taste.

Given the significant influence of public opinion on policy (Burstein, 2003), we also assessed consumer sentiment for placing graphic warning labels on sugary drinks. A recent study found that Americans generally prefer interventions that invoke primarily cognitive processes (e.g., facts about smoking risks) over those that invoke affect (e.g., pictures of cancer patients); however, support for the latter increased when people were informed of their effectiveness (Sunstein, 2016). We hypothesized that support for graphic warnings could be improved by conveying effectiveness information.

In sum, we field-tested the effectiveness of graphic warning labels versus text, calorie, and no labels (Study 1); elucidated psychological mechanisms (Study 2); and assessed consumer sentiment (Study 3).

Study 1: Field Study

Method

The field study occurred in a hospital cafeteria in Massachusetts over 14 weeks (April–July 2016), beginning with a 2-week baseline to collect beverage-sales data. Next, each sugary-drink-labeling intervention ran for 2 weeks, each followed by a 2-week washout period when no labels were displayed (cf. Bleich et al., 2014). We prespecified that each intervention would run for 2 weeks on the basis of a power analysis with the following parameters: 95% power ($\beta = 0.05$), Type I error rate of 5% ($\alpha = .05$), a small effect size (Cohen's $d = 0.20$), prebaseline sales of 378 sugary drinks and 1,721 nonsugary drinks sold per week (based on 1 month of sales data of bottled drinks from February 2016, 2 months prior to our baseline period), and assuming a Fisher exact statistical testing procedure. This power analysis suggested that we would need to test each label for only 1 week. However, to be conservative we decided a priori to use 2-week intervals. Table 1 depicts the study timeline. The study was preregistered at ClinicalTrials.gov (<https://clinicaltrials.gov/ct2/show/NCT02744859>). Stimuli and data for this and both subsequent studies are available at the Open Science Framework (OSF; <https://osf.io/rh8pv/>).

The hospital defined sugary drinks as any beverage with more than 12 g of sugar per container (excluding milk and 100% juice). Drinks not meeting these criteria were not labeled. The calorie label followed a U.S. Food

Table 1. Timeline of Study 1

Baseline		Intervention				Postintervention
2 weeks: no label	2 weeks: calorie label	2 weeks: washout: no label	2 weeks: text warning	2 weeks: washout: no label	2 weeks: graphic warning	2 weeks: no label

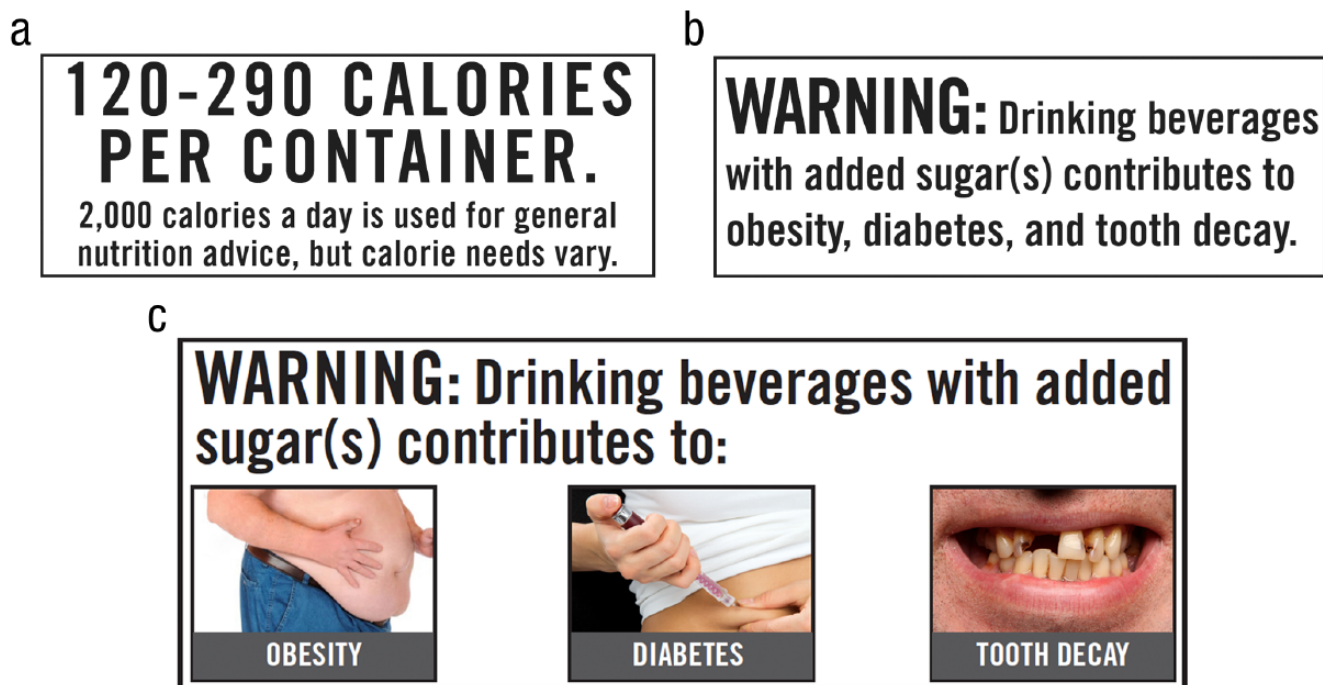


Fig. 1. Labels used in Studies 1, 2, and 3: (a) calorie label, (b) text warning label, and (c) graphic warning label. Studies 1 and 3 used all three labels, whereas Study 2 used only the graphic warning label.

& Drug Administration regulation and read, “120-290 calories per container. 2,000 calories a day is used for general nutrition advice, but calorie needs vary” (U.S. Food & Drug Administration, 2016). The text warning label used the language proposed in San Francisco: “WARNING: Drinking beverages with added sugar(s) contributes to obesity, diabetes, and tooth decay.” The graphic warning label included the same text as in the text warning label but also included images portraying obesity, diabetes, and tooth decay (see Fig. 1). We chose images that were similarly evocative to those found to be effective on tobacco products.

All bottled sugary drinks were grouped. We placed 12 salient 8 × 3 in. labels with large font (see Figs. S1 and S2 in the Supplemental Material available online) on the cooler shelves immediately below the sugary drinks. For fountain drinks, a 2.5-in. × 1.25-in. label was displayed on each sugary-drink dispenser (see Fig. S3 in the Supplemental Material), for a total of four labels on the fountain machine. To minimize concerns that the labels could shift people toward buying sugary drinks elsewhere, as opposed to truly decreasing sugary-drink purchasing, we also displayed labels in front of sugary drinks in the building’s alternate retail outlet (five labels) and vending machines (five labels); however, we did not collect their sales data.

Our primary interest was whether the labels shifted consumers away from purchasing sugary drinks.

Therefore, and consistent with recent soda-labeling research (e.g., Bleich et al., 2012; VanEpps & Roberto, 2016), our primary outcome measure was the percentage of drinks purchased that were sugary drinks.¹ This measure was superior to absolute units of sugary drinks purchased because it was less susceptible to sales fluctuations irrelevant to our treatment, such as differences in purchasing due to the day of the week (i.e., weekday vs. weekend) or seasonality; as a result, we deemed the percentage measure to be both more valid and less noisy than the unit measure. For example, if the number of customers in the cafeteria doubled during 1 week, but the customers were drawn from the same population in terms of drink preferences, then the absolute units of sugary drinks purchased would double; however, one should not infer from this that the treatment that happened to be in place that week led individual customers to double their sugary-drink purchasing. The change in absolute purchasing could therefore mask the variable of most interest: customers’ drink choices.

This logic was supported by the bottled-drink sales data from February 2016 that we analyzed prior to the start of our study to inform its design. This analysis indicated that the number of drinks purchased varied across days (namely, decreasing on weekend days and holidays), whereas the percentage of sugary drinks purchased remained relatively constant, such that absolute units purchased mainly reflected changes in the number

of customers rather than changes in drink choices. Nonetheless for completeness, we also provide the results using the units of sugary drinks purchased.

For secondary outcomes, we assessed beverage calories purchased, overall beverage purchases, share of drink types purchased, and the weight of fountain syrup dispensed.

Two data sources were used to measure outcomes because of differences in how the cafeteria's point-of-sale system recorded beverage purchases. For bottled drinks, each specific type (i.e., unique size and flavor) of bottled drink had its own product code; however, for fountain drinks, the system recorded only beverage size (not type or flavor). Thus, for bottled drinks, the data source was the cafeteria's point-of-sale system, which provided a daily summary of the number of each beverage type that had been purchased. For fountain drinks, a researcher weighed the boxes of syrup that were mixed with carbonated water to produce fountain drinks; the weights were recorded once per week. Each type (e.g., Diet Coke) used a unique ratio of carbonated water to syrup when dispensing a drink, so the weight of syrup was converted to a proxy for the number of fountain drinks sold by type.

Results

During the study period, an average of 2,548 ($SD = 290.0$) bottled drinks was purchased weekly (nonsignificant between weeks), approximately 20.5% ($SD = 1.6\%$) of which were sugary drinks. Below, we report the results of analyses for our primary outcome of the percentage of sugary drinks purchased, followed by the same analyses using the units of sugary drinks purchased as the outcome. We then report the results for the number of calories purchased.

Next, we ran a substitution analysis in which we assessed whether the label caused people to buy other types of drinks or to forgo purchasing a drink altogether. Lastly, we examined whether the effect of the label was constant throughout the 2-week period in which it was present.

Percentage of sugary drinks purchased. Our primary analysis was a Fisher exact test of the percentage of bottled sugary drinks purchased by treatment. This was the simplest and most powerful statistical test of our interventions on sugary-drink purchasing and was the test on which our power analysis was based. During baseline, 21.4% of bottled drinks purchased were sugary drinks. This percentage was statistically indistinguishable from the share of sugary drinks purchased during the calorie-label intervention (21.5%, Fisher exact $p = .84$) and text-warning-label intervention (21.0%, Fisher exact $p = .66$). However, during the graphic-warning-label

intervention, the share of sugary drinks purchased decreased to 18.2% (Fisher exact $p < .001$), for an overall drop of 3.2 percentage points (which is a 14.8% reduction compared with baseline consumption). Graphic warning labels also reduced purchasing relative to both calorie labels (Fisher exact $p < .001$) and text warning labels (Fisher exact $p = .001$).

Next, because we tested our labels consecutively as opposed to concurrently, we considered possible effects of seasonality in two ways. This was important because seasonal changes in drinking habits over the course of our study could potentially confound the relationship between the labels and beverage sales. We first calculated descriptive statistics for the percentage of bottled sugary drinks purchased during each of our intervention periods as well as each 2-week calendar period from 2014 and 2015 that matched our intervention periods (see Table 2).

During 2016, when the graphic warning labels were displayed, there was a drop in the percentage of sugary drinks purchased—a drop that did not occur during the same calendar period in either of the prior 2 years. Thus, the descriptive statistics provided preliminary evidence that the decreased purchasing during the graphic warning label treatment was not a by-product of cyclical sales.

Second, we conducted a series of regression analyses to test whether the results held when we controlled for seasonality. We started with an unadjusted multivariable regression to predict the percentage of bottled drinks purchased that were sugary drinks on each day of our study, with dichotomous independent variables for each of the three labeling interventions (see Table S1A in the Supplemental Material). We used a robust variance estimator to account for heteroskedasticity. The reference category was the baseline period, so coefficients on each of the dichotomous independent variables indicated differences relative to baseline. We then sequentially added seasonality covariates. To test whether two labeling interventions differed from each other, we ran the unadjusted regression but changed the reference category to the intervention period of interest (e.g., the calorie-label period would be the reference period when comparing the graphic-warning-label period with the calorie-label period).

In the unadjusted model (see Table S1A, Model 1), the daily percentage of sugary drinks purchased was 3.4 percentage points lower during the graphic-warning-label period compared with baseline, $\beta = -0.034$, $SE = 0.01$, $p = .001$, but it was constant during the calorie- and text-warning-label periods.

When we controlled for historical sales by adding fixed calendar-week effects (i.e., the average percentage of sugary drinks sold in the same calendar week

Table 2. Bottled-Drink Purchases During Study 1 Intervention Periods (2016) and Matched Historical Control Periods (2014, 2015)

Calendar dates	Total bottles bought	Number of sugary drinks bought
2016		
April 25–May 8 (baseline)	5,085	1,087 (21.4%)
May 9–May 22 (calorie labels)	5,414	1,166 (21.5%)
June 6–June 19 (text warning labels)	4,863	1,021 (21.0%)
July 4–July 17 (graphic warning labels)	5,021	914 (18.2%)
2015		
April 27–May 10	5,359	1,018 (19.0%)
May 11–May 24	6,816	1,377 (20.2%)
June 8–June 21	5,865	1,126 (19.2%)
July 6–July 19	5,362	1,206 (22.5%)
2014		
April 28–May 11	4,420	977 (22.1%)
May 12–May 25	4,721	958 (20.3%)
June 9–June 22	4,954	991 (20.0%)
July 7–July 20	4,491	1,010 (22.5%)

in 2014 and 2015), the percentage of sugary drinks purchased was constant during the calorie- and text-warning-label periods but declined by 5.9 percentage points during the graphic-warning-label treatment, $\beta = -0.059$, $SE = 0.023$, $p = .01$ (see Table S1A, Model 2). In other words, the effect of the graphic warning labels became stronger when we controlled for historical sales. The effect was also robust to the addition of a control for heat index (calculated using the mean daily temperature and mean daily humidity). In this model, the daily percentage of sugary drinks purchased declined by 6.3 percentage points, $\beta = -0.063$, $SE = 0.022$, $p < .001$; the coefficient for heat index was not statistically significant (see Table S1A, Model 3).

Although our analyses are focused on bottled drinks, results of a parallel analysis for fountain drinks also revealed a statistically significant effect of graphic warning labels on sugary-drink purchasing (see the Supplemental Material). We focused on bottled drinks for several reasons. First, the vast majority (about 90%) of drink purchases were bottled drinks. Second, focusing on bottled drinks enabled us to control for seasonality, which was not possible for fountain drinks because (a) we did not have historical data on changes in fountain syrup weight, so we were unable to control for fixed calendar week effects, and (b) fountain-drink data were measured at the weekly level, which would limit the number of observations per treatment in the regressions to two and prevent us from controlling for daily heat index. Therefore, the fountain-drink analysis was restricted to the Fisher exact test. Third, sales data for the two drink formats (fountain

vs. bottled) were obtained from different data sources: change in syrup weight versus number of units sold.

Units of sugary drinks purchased. The results of analyses using the units of bottled sugary drinks purchased as the outcome were generally consistent with, although weaker than, the results reported above, which used the percentage of sugary drinks purchased. The results of the primary analysis using the Fisher exact test were equivalent when units of bottled sugary drinks purchased was used as the outcome measure. During the graphic-warning-label period, consumers purchased fewer bottled sugary drinks compared with baseline (Fisher exact $p = .005$; see Table 2). There was no significant difference between the baseline period and the calorie-label period (Fisher exact $p = .25$) or between the baseline period and the text-warning-label period (Fisher exact $p = .31$).

The analyses to examine potential effects of seasonality on the units of bottled sugary drinks are presented in Table 2 and Table S1B in the Supplemental Material. Consistent with the percentage measure, the units of sugary drinks purchased declined when the graphic warning labels were displayed in 2016 but not during the same calendar period in 2014 or 2015 (see Table 2). In all regression models, the number of bottled sugary drinks purchased dropped during the graphic warning treatment by 10 to 20 bottles per day; however, this effect was not always statistically significant. We suspect that this is because the unit sales outcome was much noisier than the percentage measure: The standard

deviation for the absolute units of sugary drinks purchased during our study (38.7 bottles) was roughly half of the mean, whereas the standard deviation for the percentage measure (0.037) was 16% of the mean. Empirically, this noise occurred in large part because fewer customers frequented the cafeteria on weekend days and holidays; the number of sugary drinks purchased declined from nearly 100 bottles per day during weekdays to 25 bottles per day on weekends. Hence, the estimated drop in units of sugary drinks purchased had a much wider confidence interval when holidays and weekend days were not controlled for in the regression. This phenomenon was not an issue for our primary results using the percentage measure because the percentage of sugary drinks sold was similar on holidays or weekend days and weekdays.

In the unadjusted regression model, there was not a statistically significant decline in the units of sugary drinks sold during the graphic warning label intervention, $\beta = -12.36$, $SE = 13.77$, $p = .37$ (see Table S1B, Model 1). Controlling for holiday and weekend effects substantially reduced error variance, although the graphic-warning-label treatment did not reach statistical significance under this specification, $\beta = -12.36$, $SE = 7.01$, $p = .08$ (see Table S1B, Model 2); the coefficient for the holiday and weekend effects was statistically significant, $\beta = -69.70$, $SE = 3.45$, $p < .001$. When we controlled for historical sales, further reducing error variance, the graphic-warning-label treatment was significantly different from baseline, $\beta = -19.45$, $SE = 9.39$, $p = .044$ (see Table S1B, Model 3). When the heat index control was added, the effect was in the predicted direction, but the difference was not statistically significant, $\beta = -19.77$, $SE = 10.96$, $p = .078$ (see Table S1B, Model 4); the heat index covariate was not significant. For fountain drinks, the effect of graphic warning labels on units of sugary drinks purchased did not reach statistical significance (Fisher exact $p = .52$), as it did for the percentage measure.

Beverage calories purchased. To assess the impact of the labels on beverage calories purchased, we conducted a multivariable regression analysis in which the dependent variable was the average calories per bottled drink purchased in a given day during our treatment, with dichotomous independent variables for each of the three label interventions. We used a robust variance estimator to account for heteroskedasticity.

At baseline, the average calories per bottled drink purchased was 88 calories, 95% confidence interval (CI) = [83, 93]; during the graphic-warning-label treatment, this average declined to 75 calories, 95% CI = [71, 78], $p < .001$ (see Table S2 in the Supplemental Material). There was no statistically significant decline in calories

per drink purchased during the calorie-label treatment or text-warning-label treatment; the average calories per drink purchased was 86 calories, 95% CI = [81, 90], $p = .58$, and 85 calories, 95% CI = [81, 89], $p = .47$, respectively.

Substitution. To assess substitution effects, we ran two analyses. First, to determine whether the labels caused people to refrain from buying drinks, we ran a multivariable linear regression in which the dependent variable was total bottled drinks purchased, with dichotomous independent variables for each of the three label interventions. We used a robust variance estimator to account for heteroskedasticity. The unit of observation was 1 day. There were no significant differences in overall bottled drink sales by treatment.

Next, for any labels that reduced sugary-drink purchases, we assessed whether, within bottled drink purchases, participants switched from sugary drinks to other types of drinks. We divided bottled drinks into four categories: water (including zero calorie sparkling and zero calorie flavored), nonsugary drinks with fewer than 20 calories (diet drinks), nonsugary drinks with at least 20 calories (e.g., unflavored milk), and sugary drinks. We ran a regression similar to the one above, but the dependent variable was the share of bottled drinks purchased corresponding to a given category. The daily percentage of water drinks purchased increased during the graphic-warning-label intervention, from 24.9% at baseline to 28.1%, $\beta = 0.032$, $SE = 0.001$, $p < .001$, whereas purchasing of other drink types was unchanged. Therefore, it seems that graphic warning labels led some consumers to buy water in lieu of sugary drinks.

Duration of treatment effect. Lastly, we considered how the effectiveness of a label might change over time, both while in effect and when removed. We conducted an exploratory analysis that plotted the daily percentage of sugary drinks purchased and examined it for discernible patterns (see Fig. S4 in the Supplemental Material). There was no discernible pattern, suggesting that label impact did not change throughout the 2-week intervention periods. Notably, during the graphic-warning-label intervention—the only intervention that was effective—the decrease in sugary-drink purchasing was observed consistently throughout the 2-week period. In other words, it was not the case that a large immediate effect dissipated over the 2-week period. After these graphic labels were removed, sugary-drink purchases rebounded to baseline levels. Specifically, the average daily percentage of drinks purchased that were sugary drinks was 21.9% during baseline, 18.5% in the graphic-warning-label intervention, and 21.6% in the 2-week period

following this intervention—a significant rebound ($p = .01$).

Study 2: Graphic-Warning-Label-Mechanism Study

Method

Study 2 investigated a psychological mechanism underlying the effect identified in Study 1, namely, that graphic warning labels led some consumers to buy water instead of sugary drinks. Informed by previous research and theorizing (Evans et al., 2015; Peters, 2006), we tested a two-stage process model. Specifically, we tested whether graphic warning labels heightened negative affect, in turn prompting consideration of the information conveyed by the label (which, as described below, we operationalized as a person's consideration of health over taste when making a drink decision).

Sample. Study 2 was an online survey in which we recruited participants who indicated that they consumed at least one full-calorie soda per month. Informed by current guidelines for behavioral research (e.g., Simmons, 2014; Simmons, Nelson, & Simonsohn, 2011), we pre-specified a sample size of 200 participants ($N = 202$; 48.8% female, 51.2% male; mean age = 33.86 years, $SD = 9.74$; 80.6% Caucasian; median annual income = \$50,000–\$74,999; 82.6% attended at least some college; all nonsignificant between conditions), recruited through Amazon's Mechanical Turk.

Procedure. Participants imagined that they were at a cafeteria and had decided to buy a drink with lunch. Participants reported the brand of soda they typically choose (e.g., Coca-Cola, Pepsi, Mountain Dew, Sprite) and were directed to a screen displaying a label. Half of participants were randomly assigned to the control condition, and half were randomly assigned to the experimental condition. In the control condition, this was simply the logo for their reported drink. In the experimental condition, a graphic warning label (the same one as in Study 1) appeared below the logo (see Fig. S5 in the Supplemental Material).

Participants were then asked a series of questions. First, we assessed affective response by asking participants, "How does this label make you feel about drinking [participant's preferred brand]?" they responded on a scale from -4 , *extremely negative*, to 4 , *extremely positive* (cf. Peters et al., 2007).

Next, we measured consideration of health information conveyed by the label by asking participants to rate two statements: "I am considering how my drink

selection will impact my health" on a scale from 1 (*not at all*) to 7 (*a great deal*) and "I am thinking of choosing a drink that will maximize my..." on a scale from 1 (*taste preferences*) to 7 (*health*). We created a composite measure averaging these two items ($r = .65$, $p < .001$).

Finally, we assessed whether participants would buy water instead of their preferred sugary drink by asking them to indicate "which of these two drinks you would be inclined to buy" on a scale from 1 (*definitely [participant's preferred brand]*) to 7 (*definitely water*). The study was preregistered on the OSF (<https://osf.io/wqk65/register/5771ca429ad5a1020de2872e>).

Results

Participants who were shown the graphic warning label reported significantly greater negative affect (graphic warning: $M = -2.13$, $SD = 1.63$; no warning: $M = 2.29$, $SD = 1.47$), $t(200) = 20.18$, $p < .001$, $d = 2.84$; health consideration (graphic warning: $M = 3.84$, $SD = 1.66$; no warning: $M = 2.89$, $SD = 1.62$), $t(200) = 4.15$, $p < .001$, $d = 0.58$; and intention to purchase water (graphic warning: $M = 4.24$, $SD = 2.04$; no warning: $M = 2.72$, $SD = 1.72$), $t(200) = 5.71$, $p < .001$, $d = 0.80$, relative to those not exposed to this label.

We used the SPSS PROCESS Macro, Model 6 (Hayes & Preacher, 2014), to test for sequential mediation. We found support for the hypothesized two-stage mediation process: Graphic warning labels increased negative affect, leading to greater health consideration, in turn increasing intention to purchase water instead of a sugary drink (see Fig. 2), $\beta = 0.55$, $SE = 0.27$, 95% CI = [0.07, 1.11].

Study 3: Nationally Representative Survey

Method

Study 3 assessed public sentiment toward graphic warning labels, comparing it with two relevant benchmarks: calorie labels, a policy that had been implemented in several U.S. cities and states at the time of the study, and text warnings, a policy currently being appealed in San Francisco. We expected support for graphic warning labels to be lower, relative to these benchmarks; however, we hypothesized that support for graphic warnings would increase when effectiveness information was conveyed (i.e., the results of Study 1).

Sample. We conducted a nationally representative online survey with 402 participants (49.8% female, 50.2% male; median age = 45–54 years; 74.6% Caucasian; median annual income = \$25,000–\$49,999; 55.5% attended

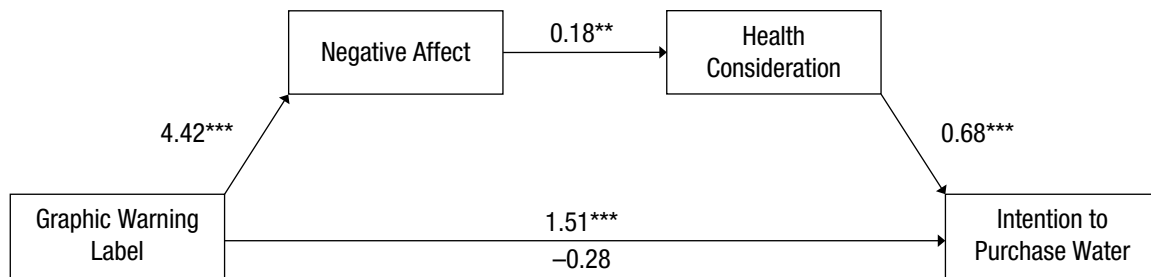


Fig. 2. Sequential mediation of the effect of graphic warning labels on the increased intention to purchase water instead of a sugary drink via negative affect and health consideration (Study 2). Path coefficients are standardized regression weights. On the path from graphic warning label to intention to purchase water, the coefficient above the line represents the direct effect without the mediators in the model, and the coefficient below the line represents the direct effect with the mediators in the model. Asterisks indicate significant paths (** $p < .01$, *** $p < .001$).

at least some college; 28.3% consumed at least one sugary drink per day; mean body mass index = 28.51, $SD = 7.57$ [excluding missing or implausible values]; all nonsignificant between conditions; full demographic information is displayed in Table S2). Participants were recruited through a survey company. The company obtains nationally representative samples by taking the prespecified sample size and determining the required quotas for demographic variables (i.e., age, gender, ethnicity, income, education) and then recruits on the basis of these quotas. We prespecified a sample size of 400 on the basis of both current suggested guidelines for sample size in behavioral research (Simmons, 2014; Simmons et al., 2011) and a power analysis using the following parameters: power set to 90% ($\beta = 0.10$), Type I error rate of 5% ($\alpha = .05$), and a small effect size (Cohen's $d = 0.10$).

Procedure. Participants viewed the three labels from Study 1 in a counterbalanced order. For each, they answered, “Do you support putting this label on sugar-sweetened beverages?” on a scale from 1, *strongly oppose*, to 7, *strongly support* (VanEpps & Roberto, 2016). Half of participants were randomly assigned to see effectiveness information accompanying the label. Specifically, for the calorie and text warning labels, participants were told that a recent study found that the label did not affect sugary-drink purchasing. For the graphic warning label, participants were told that a recent study found that the label reduced sugary-drink purchasing and were informed of the magnitude of this effect.

Prior to running this study with a nationally representative sample, we conducted a pilot version using a large convenience sample and obtained the same result as that reported below (see the Supplemental Material). In addition, in the pilot study, we manipulated whether participants rated only one label versus all three. The results did not depend on this factor; therefore, to reduce costs for the main, nationally representative survey, each participant rated the three labels, with the

order counterbalanced between participants. In the main study reported here, there were no order effects; hence, the reported results were collapsed across order. The study was preregistered at ClinicalTrials.gov (<https://clinicaltrials.gov/ct2/show/NCT02947802>).

Results

A repeated measures analysis of variance using label type as a within-subjects factor and effectiveness information as a between-subjects factor revealed a significant main effect of label type, $F(1.67, 669.26) = 12.06$, $p < .001$, which was qualified by a significant interaction, $F(1.67, 669.26) = 8.45$, $p = .001$ (see Fig. 3). (Mauchly's test indicated that the sphericity assumption was violated; therefore, we used Greenhouse-Geisser estimates.) Follow-up tests indicated that in the absence of effectiveness information, support for graphic warnings was significantly lower than both calorie labels, $t(201) = -3.80$, $p < .001$, $d = 0.53$, and text warnings, $t(201) = -6.31$, $p < .001$, $d = 0.89$. However, this effect was buffered by the provision of effectiveness information. Specifically, when effectiveness information was given, support of graphic warnings was equivalent to both calorie labels, $t(199) = -0.07$, $p = .95$, $d = 0.01$, and text warnings, $t(199) = -0.62$, $p = .54$, $d = 0.09$.

Perhaps a more intuitive way of characterizing the results is to compare the percentage of participants indicating support for the given label (i.e., responded above the neutral midpoint of the 7-point scale) across conditions. Consistent with the means reported above, in the absence of effectiveness information, a significantly smaller percentage of participants supported the graphic warnings (50.8%) relative to both calorie labels (61.9%), $z = 2.11$, $p = .03$, and text warnings (66.8%), $z = 3.14$, $p = .002$. However, when effectiveness information was given, the percentage of participants who supported the graphic warnings (55.6%) was statistically equivalent to those who supported both calorie

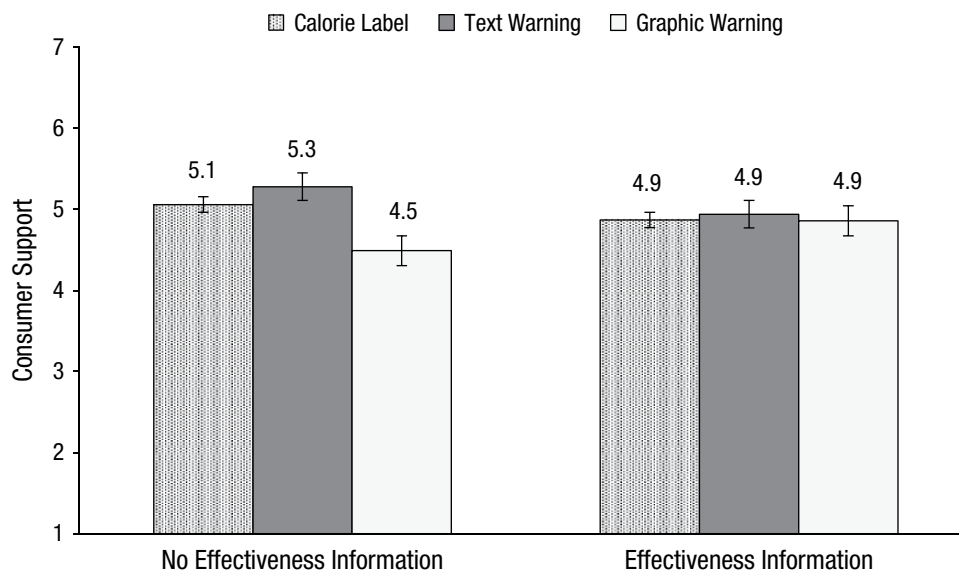


Fig. 3. Mean rating of consumer support of labels by effectiveness information and label type in Study 3 ($N = 402$). Error bars indicate ± 1 SEM.

labels (51.5%), $z = 0.80$, $p = .42$, and text warnings (56.5%), $z = 0.20$, $p = .84$.

Finally, an additional, exploratory analysis indicated that the effect of effectiveness information on label support did not depend on whether the given participant indicated that he or she consumes ($n = 335$) or does not consume ($n = 67$) sugary drinks. Specifically, the three-way interaction between label type (calorie vs. text warning vs. graphic warning), effectiveness information (provided vs. not provided), and sugary-drinker status was not significant, $F(1.67, 662.8) = 0.72$, $p = .46$, nor was the two-way interaction between effectiveness information and sugary-drinker status, $F(1, 398) = 0.31$, $p = .58$.

Discussion

Our field study suggests that point-of-sale graphic warning labels reduced the percentage of sugary drinks purchased, driving people to buy water instead of sugary drinks, whereas calorie and text warning labels did not. Consistent with this pattern, when the graphic warning labels were removed, sugary-drink purchasing rebounded to baseline levels. Study 2 sheds insight into a psychological process underlying Study 1: Graphic warning labels elicit negative affect, which increases health consideration, reducing sugary-drink selection. Study 3 suggests that graphic warning labels are supported more if their effectiveness is conveyed. Although the observed increase in support for graphic warnings was small, support then matched that of the benchmark labels—notably, calorie labels, which have since been implemented nationwide in chain restaurants. Interestingly,

but generally consistent with the study by Sunstein (2016), graphic label support did not surpass support for the other labels.

These findings offer guidance on providing information in a way that prompts healthier drink purchasing. Although the text and graphic warning labels conveyed the same facts about health risks, only the more evocative graphic labels were associated with behavior change. Consistent with this finding, a recent lab study in New Zealand found that graphic warning labels decreased intentions to purchase sugary drinks (Bollard, Maubach, Walker, & Ni Mhurchu, 2016).

This study was the first field test of the effectiveness of graphic warning labels versus text warnings or calorie labels, and our findings have legal implications. A federal attempt to mandate graphic warning labels for cigarettes failed in part because of a lack of field evidence proving that graphic warnings were not “more extensive than necessary” (*R.J. Reynolds Tobacco Co. v. U.S. Food & Drug Administration*, 2012). Our findings may provide necessary evidence to implement graphic sugary-drink warning labels.

Labeling, a form of information provision, is one of several strategies in policymakers’ toolbox to reduce sugary-drink purchasing and intake; other strategies include pricing (e.g., taxes and subsidies) and choice architecture (e.g., structuring the environment to encourage better choices). How have these other approaches fared? Evaluations of sugary-drink taxes are promising. A tax of one peso per liter in Mexico led to a 5.5% decrease in the per capita volume of sugary drinks purchased in Year 1 and 9.7% in Year 2 (Colchero, Rivera-Dommarco, Popkin, & Ng, 2017). A tax of one

cent per ounce in Berkeley led to a 9.6% decrease in the volume of sugary drinks per transaction (Silver et al., 2017). As for choice architecture, reducing portion sizes can decrease consumption (Hollands et al., 2015; Rolls, Morris, & Roe, 2002), but implementation matters. For example, a portion cap such as the one proposed in New York City could increase sugary-drink purchasing when free refills are served (John, Donnelly, & Roberto, 2017). Future research might explore potential synergies in combining labeling, pricing, and choice architecture interventions.

This research was subject to several limitations. First, because of practical constraints, the field intervention ran consecutively in a single site. It is difficult to randomly assign individuals to different (but concurrent) interventions in a real-world cafeteria setting; this would introduce contamination issues and artificiality, threatening validity. We controlled for possible seasonality effects. Moreover, our design choice paralleled past field research that found that the order in which labels were tested did not matter (Bleich et al., 2014; Bleich et al., 2012). Nonetheless, it is possible that the effect of the graphic warning label was a product of the cumulative effect of previous labels. However, our 2-week washout periods, along with Study 2's conceptual replication of the effect, minimized this possibility.

Second, we could not assess how sugary-drink purchasing might have changed outside the cafeteria. Customers might have forgone a sugary drink in the cafeteria only to buy one elsewhere. We minimized this possibility by posting the labels at the other locations where sugary drinks were sold in the building. Relatedly, we did not measure consumption. The calorie and text warning labels may not have been strong enough to reduce sugary-drink purchasing, but they might have caused consumers to drink less of each container.

Future research could test the effect of label placement and design on purchasing and consumption. For example, warnings might be more effective when placed directly on beverage containers, where consumers would have repeated exposure as they drink; by contrast, point-of-sale warnings may be forgotten after purchasing. Interestingly, in contrast to the present investigation, which found point-of-sale graphic warnings to be effective, two studies found that such warnings for tobacco did not affect purchasing (Coady et al., 2013; Kim et al., 2014); their warnings may have been less salient because they used only one large sign at the product display or one small sign at each register. We tested only one design for each label type, but many variations could be developed and tested.

Third, future research might also assess habituation in longer intervention periods. Although the effect of the graphic warning label was consistent throughout the

2-week period, tobacco warnings are more effective when their wording and design change over time (Borland et al., 2009; Wilson & Gilbert, 2008).

Future research might also investigate additional psychological processes underlying responses to warning labels. For example, do labels incite specific affective responses, such as disgust or stigma? Graphic labels may introduce concerns over negative consequences such as "fat shaming."

Fourth, future research could explore potential synergistic effects of calorie and warning labels and whether effectiveness is influenced by how calorie information is presented. Understanding the effects of different types of calorie labels across settings is an ongoing area of inquiry; although this was not our primary focus, Study 1 also offers one data point for this discussion (Bleich et al., 2017; Block & Roberto, 2014).

Finally, studies could explore heterogeneity of effects (e.g., by weight or socioeconomic status). Relatedly, although the labels in our field study were very salient, research could explore whether the labels are differentially noticed or persuasive by demographic characteristics. For example, individuals who are female, have a higher income, or are health conscious are particularly attentive to calorie information (Bleich et al., 2017). This intervention could be used in other retail settings with a large sample of diverse consumers to test the generalizability of our findings. Our setting was a northeastern hospital where sugary-drink purchasing was relatively low at baseline, and information about calories or health risks may not have been novel for some consumers, which may have limited our ability to detect changes, particularly for calorie and text warning labels.

In conclusion, this research is the first test of the real-world effectiveness and acceptability of graphic sugary-drink warning labels. Graphic warning labels decreased the percentage of sugary drinks purchased; significant changes were not observed for calorie labels or text warning labels. Consumer support for graphic warning labels can be increased by communicating the labels' effectiveness. Taken together, these studies contribute to the psychology of healthy behavior change and provide evidence to inform policymakers.

Action Editor

Bill von Hippel served as action editor for this article.

Author Contributions

G. E. Donnelly and L. Y. Zatz contributed equally to this study. All authors developed the study concept and contributed to the design of Studies 1 and 3. G. E. Donnelly and L. K. John developed and conducted Study 2. L. K. John and L. Y. Zatz led the drafting of the manuscript, with contributions from G. E. Donnelly and D. Svirsky. L. Y. Zatz, L. K.

John, and G. E. Donnelly conducted the literature review. G. E. Donnelly collected the data. D. Svirsky analyzed and interpreted the data for Study 1, with input from L. K. John and L. Y. Zatz. G. E. Donnelly analyzed and interpreted the data for Studies 2 and 3, with input from L. K. John, D. Svirsky, and L. Y. Zatz. All the authors approved the final version of the manuscript for submission.

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The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

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Supplemental Material

Additional supporting information can be found at <http://journals.sagepub.com/doi/suppl/10.1177/0956797618766361>

Open Practices



All data and materials have been made publicly available via the Open Science Framework (OSF) and can be accessed at <https://osf.io/rh8pv/>. The design and analysis plans for Studies 1 and 3 were preregistered at ClinicalTrials.gov (Study 1: <https://clinicaltrials.gov/ct2/show/NCT02744859>; Study 3: <https://clinicaltrials.gov/ct2/show/NCT02947802>). The design and analysis plan for Study 2 were preregistered at the OSF (<https://osf.io/wqk65/register/5771ca429ad5a1020de2872e>). The complete Open Practices Disclosure for this article can be found at <http://journals.sagepub.com/doi/suppl/10.1177/0956797618766361>. This article has received badges for Open Data, Open Materials, and Preregistration. More information about the Open Practices badges can be found at <http://www.psychologicalscience.org/publications/badges>.

Note

1. When we first attempted to preregister the percentage measure on ClinicalTrials.gov, the administrator rejected the measure, providing feedback that we interpreted as mandating that the outcome be a raw measure (i.e., absolute unit sales) as opposed to a transformation (e.g., percentage of sales). After we changed the outcome to a raw measure (i.e., number of

beverages), the preregistration was accepted. For transparency and to allow readers to assess the robustness of our findings, we report results using both the percentage and the unit measures.

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