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Increasing Vegetable Intake by Emphasizing Tasty and Enjoyable Attributes: A Randomized Controlled Multisite Intervention for Taste-Focused Labeling

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Abstract

Healthy food labels tout health benefits, yet most people prioritize tastiness in the moment of food choice. In a preregistered intervention, we tested whether taste-focused labels compared with health-focused labels increased vegetable intake at five university dining halls throughout the United States. Across 137,842 diner decisions, 185 days, and 24 vegetable types, taste-focused labels increased vegetable selection by 29% compared with health-focused labels and by 14% compared with basic labels. Vegetable consumption also increased. Supplementary studies further probed the mediators, moderators, and boundaries of these effects. Increased expectations of a positive taste experience mediated the effect of taste-focused labels on vegetable selection. Moderation tests revealed greater effects in settings that served tastier vegetable recipes. Taste-focused labels outperformed labels that merely contained positive words, fancy words, or lists of ingredients. Together, these studies show that emphasizing tasty and enjoyable attributes increases vegetable intake in real-world settings in which vegetables compete with less healthy options.

Keywords

label, health, vegetable, nutrition, obesity, intervention, open data, preregistered

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Public health efforts to improve dietary intake have long relied on providing nutrition information. Unfortunately, these strategies have had limited impact (Hawkes et al., 2015; Roberto et al., 2015). One shortcoming of health-focused messages is that they are at odds with taste goals in the moment of food choice. Most people prioritize tastiness over healthiness when choosing what to eat (Aggarwal, Rehm, Monsivais, & Drewnowski, 2016; Glanz, Basil, Maibach, Goldberg, & Snyder, 1998), and many people believe that healthy foods are not tasty, enjoyable, or satisfying (Finkelstein & Fishbach, 2010; Raghunathan, Naylor, & Hoyer, 2006; Suher, Raghunathan, & Hoyer, 2016). Is it possible to motivate healthy eating by highlighting tasty and enjoyable attributes of healthy foods?

Experiences with food are not objective. The exact same foods can be experienced as more or less tasty

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(Maimaran & Fishbach, 2014; Raghunathan et al., 2006), filling (Finkelstein & Fishbach, 2010; Suher et al., 2016), physiologically satiating (Crum, Corbin, Brownell, & Salovey, 2011), and neurologically rewarding (Veldhuizen, Nachtigal, Flammer, de Araujo, & Small, 2013), depending on how they are described. Early work in this area demonstrated negative impacts on taste, satiety, and preference when unhealthy or ambiguously healthy foods (e.g., crackers, cookies) were labeled as healthy as opposed to unhealthy, tasty, or neutral (Crum et al., 2011; Finkelstein & Fishbach, 2010; Lähteenmäki et al., 2010; Raghunathan et al., 2006; Suher et al., 2016; Wansink & Chandon, 2006; Wardle & Huon, 2000).[1] More recently, a handful of lab studies have investigated whether emphasizing tastiness makes *healthy* foods more enticing. In one study, for example, participants who were prompted to "choose the carrots you think are the tastiest and that you will enjoy eating the most" consumed more carrots than those prompted to "choose the carrots you think are the healthiest and that you will benefit most from eating" (Woolley & Fishbach, 2016, p. 958). Similarly, young children consumed more carrots when told a story about a character who experienced taste benefits instead of instrumental benefits from eating carrots (Maimaran & Fishbach, 2014).

This body of research provides evidence that, in theory, shifting focus to the tasty aspects of healthy foods may lead to healthier eating. However, many of the methods used to date are impractical for improving healthy eating at scale. First, many studies used some form of deceptive labeling, providing false information about fat (Raghunathan et al., 2006; Wansink & Chandon, 2006), nutrition (Suher et al., 2016), caloric (Crum et al., 2011), organic (Woolley & Fishbach, 2016), or branded (Robinson, Borzekowski, Matheson, & Kraemer, 2007) content. This approach has helped isolate psychological processes related to perceived nutritional content while controlling for actual nutritional content, but deceptive labeling is neither ethical nor sustainable in real-world settings. A second limitation is that many studies used one- to three-sentence descriptions, stories, or guided prompts to prime tastiness rather than food labels (e.g., Finkelstein & Fishbach, 2010; Maimaran & Fishbach, 2014; Provencher, Polivy, & Herman, 2009; Raghunathan et al., 2006; Suher et al., 2016; Woolley & Fishbach, 2016). These studies effectively shift lab participants' focus to the enjoyable qualities of healthy eating, but such strategies are impractical in real-world dining settings. Third, most studies were lab studies constrained to a single food type (usually unhealthy or ambiguously healthy foods) with no alternative food choices present. In real-world contexts, healthy foods must compete with highly marketed, less healthy options.

The *taste-focused-labeling* approach we report here was inspired by this seminal research but also designed to overcome these practical and methodological limitations. Taste-focused labels (e.g., "Twisted Citrus Glazed Carrots," "Ultimate Chargrilled Asparagus") are designed to elevate diners' expectations of a positive taste experience with healthy foods. They do so by using words that elicit expectations of (a) specific flavors (e.g., ingredients or preparation methods) and (b) positive experiences (e.g., that the dish is exciting, indulgent, or comforting). Several features distinguish this approach from those used in previous literature and make it particularly amenable to scaling in real-world settings. First, taste-focused labels leverage only true information about flavorful and experiential qualities of healthy foods. Second, taste-focused labels are short descriptions (~6 words) that are easily displayed in front of or on healthy foods. Third, this approach uses customized descriptions based on the flavors and preparation methods of each healthy dish, as opposed to vaguely positive language, such as "yummy," "tasty," or "enjoyable," used in previous studies (Finkelstein & Fishbach, 2010; Maimaran & Fishbach, 2014; Woolley & Fishbach, 2016). Our theory is that this targeted, nuanced approach allows healthy foods to compete with less healthy options in real-world settings because it emphasizes features that most people prioritize when making food decisions (flavor and a positive experience).

Initial evidence suggests that taste-focused labeling leads more people to choose vegetables than health-focused and basic (nondescriptive) labels do (Turnwald, Boles, & Crum, 2017; Turnwald & Crum, 2019), but critical questions remain. Do the effects of taste-focused labeling on food choice replicate across multiple real-world settings? Does actual consumption increase? What are the mechanisms and moderators of this intervention? What are the core elements of effective taste-focused labels?

The Delicious Impressions Support Healthy Eating (DISH) Study, created in partnership with the Menus of Change University Research Collaborative (MCURC; www.moccollaborative.org), was a preregistered randomized controlled multisite intervention designed to test whether taste-focused labels, compared with health-focused labels, would increase vegetable intake across five university dining halls throughout the United States. In the DISH Study, we measured behavior for 3 months in real-world settings in which healthy options competed with less healthy options, testing whether effects generalized across 71 vegetable dishes composed of 24 types of vegetables. Through multiple preregistered follow-up studies, we further tested mechanisms, moderators, and boundaries of these effects.

Table 1. Characteristics of Schools Participating in the Delicious Impressions Support Healthy Eating Study

Characteristic	School A	School B	School C	School D	School E
Undergraduate population (*n*)	7,062	19,922	19,000	37,175	50,146
Female (%)	50.0	51.5	51.5	51.8	50.0
Race/ethnicity (%)					
Asian	22.0	11.4	16.6	5.6	24.4
Black	7.0	4.5	5.7	13.7	7.6
Hispanic	15.0	7.9	14.1	20.9	12.3
White	36.0	46.1	31.6	50.2	39.4
International	9.0	18.6	24.9	6.0	11.4
Other	11.0	11.5	7.1	3.7	5.0
Geographic location (in United States)	West	Northeast	West	South	Northeast
Private/public	Private	Private	Private	Public	Public
Population density	Suburban	Urban	Urban	Rural	Suburban
Number of vegetable dishes	8	15	14	15	19
Days observed	16	42	35	39	53
Days missed	0	3	9	6	5
Mean number of diners per hour	138 (11)	239 (35)	264 (28)	431 (55)	453 (62)
Total number of diners in dining hall	3,324	15,069	13,873	33,626	71,950
Diners who chose vegetable (%)	37.5 (12.7)	11.8 (5.5)	24.0 (6.2)	10.4 (4.5)	16.6 (7.7)
School-level vegetable tastiness[a]	4.55 (0.50)	4.37 (0.57)	4.17 (0.53)	4.33 (0.54)	3.99 (0.73)

Note: Values in parentheses are standard deviations.
[a]This variable is the mean tastiness rating (1 = *not at all delicious*, 7 = *very delicious*) of all recipes served at a given school.

Method

Study design

The DISH Study was a preregistered randomized controlled intervention at five MCURC member schools, referred to as Schools A through E. A sixth school was recruited but did not collect data. Demographic characteristics of schools and their undergraduate populations are displayed in Table 1. Inclusion criteria for each school included one large dining hall with a main serving station that changed daily and that served a cooked vegetable next to at least one protein and one starch.

To test whether taste-focused and health-focused labels impacted students' vegetable selection, we randomized labeling conditions at the level of day. On each day at each school, the vegetable was randomly assigned to receive a taste-focused, a health-focused, or for some schools, a basic, nondescriptive label in a 1:1:1 ratio, so that each vegetable dish received each label once. In an effort to control for extraneous variables, we asked dining halls to operate on a repeating menu cycle (i.e., the daily menu was repeated every 3–5 weeks) so that each time a given vegetable dish was served, it was served on the same day of the week and was adjacent to the same food choices as the last time that it was served. At each school, the study began in the second or third week of the academic year, and it concluded after three menu cycles were complete. This sample size was chosen because it allowed each vegetable dish to be served under each labeling condition once at each school. At School A, however, the study lasted for two menu cycles, and only taste-focused and health-focused labels were tested. This was because this site measured consumption outcomes in addition to vegetable selection, requiring significantly greater resources and necessitating that the labor be allocated to measuring the primary comparison of interest (taste-focused vs. health-focused labeling). Each school's institutional review board approved the study procedures.

Intervention

Taste-focused labels (e.g., "Herb n' Honey Balsamic Glazed Turnips," "Sizzlin' Szechuan Green Beans with Toasted Garlic") were designed to elevate diners' expectations of a positive taste experience with vegetable dishes. To do so, we tailored each taste-focused label to each vegetable dish to provide expectations of specific flavors (e.g., words suggesting taste, ingredients, or preparation method) and convey at least one other theme intended to elevate expectations of a positive experience (e.g., words suggesting excitement, indulgence, tradition, or geographic locations). The positive-experience component was intentionally flexible to allow labels to draw on a variety of themes that might better fit some specific

dishes or contexts than others. For example, labels might elevate expectations of a positive experience by using (a) exciting words (e.g., "twisted," "sizzlin'," "splashed," "boldly," "inspired") if a unique ingredient or preparation method is used; (b) indulgent words (e.g., "glazed," "creamy," "mouthwatering," "caramelized," "juicy") if a sauce is used or the dish is particularly satisfying; (c) traditional words (e.g., "old-fashioned," "classic," "countryside," "Abuelita's," "home style," "Mama's") if the dish is hearty, comforting, nostalgic, or rooted in tradition; or (d) location-based words (e.g., "New Orleans," "Shanghai," "tavern style," "Thai," "Provence") if the dish draws from ingredients or preparation methods that are positively associated with a particular culture, location, or setting.

Although some of the above themes may better fit certain settings or dishes, all of these themes elevate expectations of a positive taste experience. Detailed instructions for how food-service providers can construct taste-focused labels and tailor them to their particular setting are freely available in an online tool kit called "Edgy Veggies" (http://sparqtools.org/edgyveggies/). The 65 taste-focused labels for which data were collected contained an average of 6.0 ($SD = 1.6$) words per description. All labels used in this study are presented in Table S1 in the Supplemental Material available online.

Health-focused labels (e.g., "Healthy Choice Turnips," "Nutritious Green Beans") were constructed using words that communicated nutritional qualities and health benefits of vegetables and were drawn from words identified in a linguistic analysis of how restaurants and promotional programs describe their healthiest foods (Turnwald, Jurafsky, Conner, & Crum, 2017). Health-focused labels contained an average of 4.0 ($SD = 0.9$) words per description.

Basic labels (e.g., "Turnips," "Green Beans") were nondescriptive. Basic labels were composed of 1.6 ($SD = 0.7$) words per description on average. Neither basic nor health-focused labels contained any of the taste-focused themes, except in a few rare cases in which a texture or ingredient word was added because diners might not otherwise have known what the food or ingredient was (e.g., "Creamed Corn" instead of "Corn," "Mashed Cauliflower" instead of "Cauliflower").

Labels were printed on an 8.5-in. × 11-in. sign posted above the vegetable. Labels for all other foods were presented according to standard practice at each school. Schools were asked not to alter their recipes but to serve the vegetable dishes they normally serve (all recipes are presented in Table S2 in the Supplemental Material). Labels were monitored daily by staff to ensure that the correct label was displayed for the intended vegetable. All labels were reviewed by a registered dietitian to ensure that each label in each condition accurately reflected the nutrients and ingredients being served. For example, dishes whose labels included the words "Reduced Sodium" met official dietary standards for a reduced-sodium dish.

Outcomes

The two primary outcomes were selection of vegetables and consumption of vegetables (Hypotheses 1 and 2 in the preregistration). Selection represented the proportion of diners who chose vegetables. Selection was measured at Schools A through D by having research assistants count every diner who selected the vegetable each day. School E lacked the resources to count individual diners and instead measured the total number of pans of vegetables served each day. The time period was always the same at a given school and encompassed the busiest lunch hours, ranging from 1.5 to 3 hr of observation each day at each school. As per our preregistered design, selection outcomes were combined across all schools for analysis by converting the selection outcome to z scores within each school. A summary of the data collected at each school is presented in Table 1.

Consumption represented the amount of vegetables that diners actually ate. Measuring consumption is laborious and requires collecting each diner's plate waste, and only School A had the staff resources to measure it. We measured consumption more robustly than the common practice of measuring on only a few random days of an intervention; instead, we measured consumption on each day of the intervention at School A (16 days total). First, the mass of vegetables selected was measured by weighing full serving dishes each time they were placed onto the serving line and then again when they were empty and removed from the serving line. The mass of vegetables selected represented the total mass of all filled serving dishes minus the total mass of all empty serving dishes removed from the serving line throughout the lunch period. To measure the mass of vegetables wasted, we collected plate waste from every diner at the entrance to the waste rooms. Two waste rooms were the only places to dispose of uneaten foods (all other trash receptacles were removed from the dining hall), and research assistants dressed as dining hall staff took plates from every diner at the entrance to the waste rooms. All waste was scraped by research assistants into waste bins, except for the vegetable of the day, which was scraped into a separate preweighed bin. This represented the total mass of vegetables wasted. Finally, to calculate consumption, we subtracted the mass of vegetables wasted from the total mass of vegetables selected. Values were adjusted to account for differences in the number of diners in the dining hall each day.

Our secondary outcome tested whether (a) individual vegetable-dish tastiness and (b) the average school-level vegetable tastiness moderated the effects of taste-focused versus health-focused labeling on vegetable selection (Hypothesis 3 in the preregistration). A prior lab study (Woolley & Fishbach, 2016) showed that priming taste goals versus health goals increased consumption when the healthy food was tastier (apple or raw carrot) but not when the healthy food was less tasty (raw spinach). These findings suggest that the tastiness of individual vegetable dishes may moderate the effect of consumption for foods with taste-focused labels. We made a similar hypothesis about tastiness as a moderator. However, for this study, in which the primary outcome was choice and patrons were repeat diners with prior taste experiences with the given dining hall context, we hypothesized that average school-level vegetable tastiness would moderate the effects. Diners at each school likely have a general belief about how tasty the vegetables in their dining hall tend to be, which could lend more credibility to taste-focused labels. Taste-focused labels may be perceived as less credible in settings with less tasty foods.

As detailed in the preregistration, it was not feasible to collect actual taste ratings for all 71 vegetable dishes across all five geographic locations. Therefore, in order to isolate the actual taste of vegetable dishes, we ascertained (without the accompaniment of the label) vegetable-dish taste ratings by first having 301 online participants rate the expected tastiness of vegetable recipes (1 = *not at all delicious*, 7 = *very delicious*) and then validating those online ratings with actual taste ratings of 12 recipes (17% of the full sample of vegetable dishes) from 139 actual student diners. The Pearson correlation coefficient between online ratings and actual taste ratings was high (r = .80). Therefore, as detailed in the preregistration, the standardized online ratings were used to evaluate whether tastiness was a moderator at the individual vegetable level as well as of the average taste rating by school (i.e., mean tastiness rating of all vegetable dishes served at each school). See Supplemental Methods in the Supplemental Material for details.

Statistical analysis

Data were analyzed using multilevel models (mixed models) with the *lmerTest* package (Kuznetsova, Brockhoff, & Christensen, 2017) in RStudio (Version 1.1.463; RStudio Team, 2015). Selection outcomes were analyzed using a mixed-model linear regression that predicted vegetable selection (with schools weighted equally) as a function of labeling condition, with random effects of vegetable dishes nested within schools. Consumption outcomes at School A were analyzed using a mixed-model linear regression that predicted the mass of vegetables consumed as a function of labeling condition, with a random effect of vegetable dish. To examine whether the effects of labeling condition on vegetable selection were moderated by (a) the tastiness of individual vegetable dishes or (b) the average school-level vegetable tastiness, we added an interaction term for Labeling Condition × Vegetable Tastiness to the mixed-model linear regression for selection described above, separately for individual vegetable tastiness and for school-level vegetable tastiness.

As planned, observation days were excluded from analysis if the wrong vegetable was served, if the recipe of the vegetable had been altered, or if the outcome on a single day at a given site was ±3 standard deviations from the mean. Effect sizes are reported as standardized regression coefficients for vegetable-selection outcomes and as Cohen's d for all other outcomes. In the results, we report all measures that were analyzed for this research's target research questions, as well as all data exclusions. The study period was defined a priori, and no analyses were conducted until the conclusion of data collection. Data and preregistration information are publicly available on the Open Science Framework at https://osf.io/39vsg/.

Results

Intervention implementation

Data were collected on 89% of all planned days; 23 target days across all five schools were missed because of limited availability or substitution of the scheduled vegetable (12 days), limited staff for counting (7 days), missing card-swipe data (2 days), incorrect labeling (1 day), and values ±3 standard deviations from the mean at a given school (1 day). Overall, 185 days of data were collected (M = 37 days observed per school, SD = 14), with the results representing 71 vegetable dishes (using 24 different types of vegetables) and 137,842 individual diner decisions.

Vegetable selection

Vegetable-selection outcomes are presented in Figure 1. Across all five schools, taste-focused labels increased vegetable selection compared with health-focused labels by 0.46 standard deviations (β = 0.46, 95% confidence interval, or CI = [0.27, 0.66], $p < .001$). This represented a 29% increase in vegetable selection when taste-focused, rather than health-focused, labeling was used. Taste-focused labeling also significantly increased vegetable selection by 14% compared with basic labeling (β = 0.25, 95% CI = [0.03, 0.48], p = .030), replicating

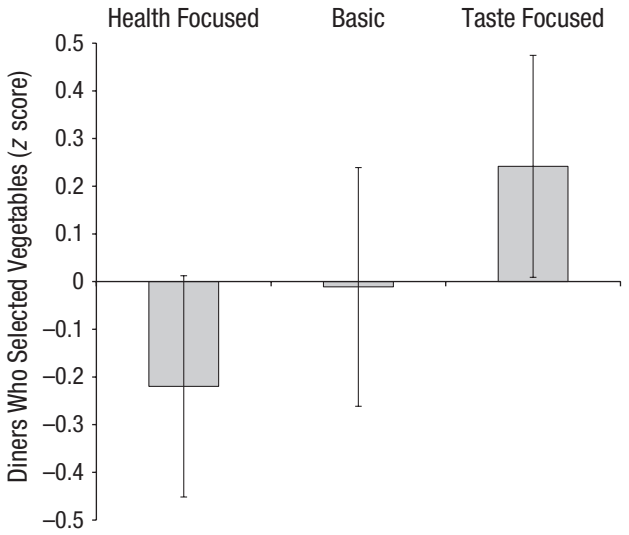

Fig. 1. Proportion of diners across all five schools in the multisite study who selected vegetables, separately for each labeling condition. Error bars represent 95% confidence intervals of the model estimate for each labeling condition.

results from prior field research at a single site (Turnwald, Boles, & Crum, 2017). Basic labeling trended toward being more effective than health-focused labeling, but the effect was not significant at the .05 level (β = 0.21, 95% CI = [–0.02, 0.43], p = .072).

Vegetable consumption

Vegetable consumption across all days of the intervention at School A is presented in Figure 2. A greater mass of vegetables was selected (self-served) by diners per day when vegetables were presented with taste-focused labels versus health-focused labels (mean difference = 1.88 kg/day, 95% CI = [0.50, 3.30], p = .029, d = 1.10, 95% CI = [0.29, 1.93]), and there was no difference by condition in the mass of vegetables that diners threw away (mean difference = 0.10 kg/day, 95% CI = [–0.19, 0.44], p = .56, d = 0.23, 95% CI = [–0.44, 0.99]). This resulted in the same vegetables being consumed in greater quantities per day (a 39% increase) when they were given taste-focused labels than when they were given health-focused labels (mean difference = 1.78 kg/day, 95% CI = [0.70, 2.99], p = .018, d = 1.16, 95% CI = [0.46, 1.95]).

Moderating role of vegetable tastiness on selection

The effects of taste-focused labeling on selection varied by school (see Table S3 in the Supplemental Material) and were larger among schools A through D (β = 0.59, 95% CI = [0.39, 0.79]) than at School E (β = –0.10, 95% CI = [–0.58, 0.38]); School E's vegetable recipes were rated as least tasty among the five schools (Table 1). Therefore, on the basis of prior research (Woolley & Fishbach, 2016), and following the plan in our preregistration, we tested whether vegetable-recipe tastiness (at both the individual and school level) moderated the effects of taste-focused labeling on vegetable selection. Across all five schools, the tastiness of individual vegetable dishes did not significantly affect the degree to which taste-focused labeling increased selection (Labeling Condition × Individual Vegetable-Dish Tastiness interaction: β = 0.18, 95% CI = [–0.04, 0.39], p = .111). However, there was a significant Labeling Condition × School-Level Tastiness interaction (β = 0.32, 95% CI = [0.12, 0.52], p = .002; Fig. 3). This indicated that there was a greater increase in vegetable selection in response to taste-focused labeling in schools that served tastier vegetable recipes on average (e.g., Brussels sprouts roasted with olive oil and finished with crispy shallots and sun-dried tomatoes) than in schools that, on average, served less tasty vegetable recipes (e.g., boiled Brussels sprouts). Stronger school-level moderation than individual-dish moderation (β = 0.32 vs. β = 0.18, respectively) suggests that general experiences with vegetable tastiness in a given dining hall are more influential than more subtle, day-to-day fluctuations in the tastiness of any single vegetable dish.

Addressing Theorized Mechanisms: Supplementary Study A

Taste-focused labeling is theorized to work by elevating expectations of a positive taste experience. Because we were unable to collect individual diners' expected taste

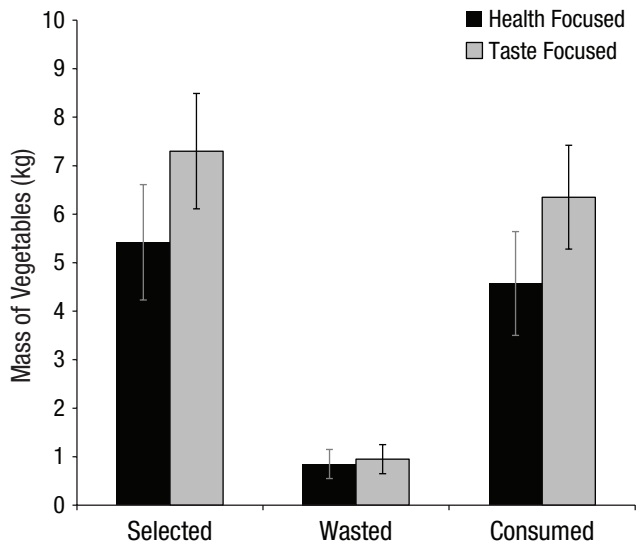

Fig. 2. Mean vegetable mass selected, wasted, and consumed per day at School A in the multisite study, separately for each labeling condition. Error bars represent 95% confidence intervals of the model estimate for each condition.

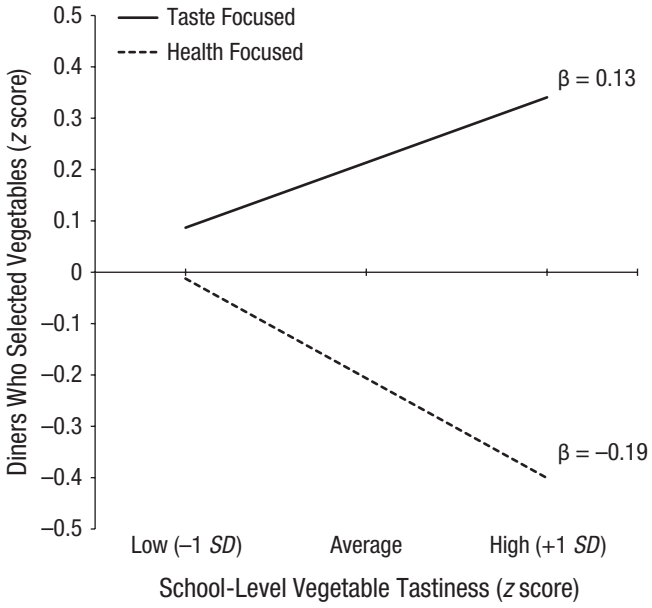

Fig. 3. Proportion of diners across all five schools in the multisite study who selected vegetables as a function of school-level vegetable tastiness and labeling condition.

ratings during the intervention, we designed Supplementary Study A (a preregistered experiment) to test this hypothesized mechanism. Because most people eat vegetables for health reasons instead of taste reasons (Woolley & Fishbach, 2016), we also tested the hypothesis that taste-focused labels shift people's reason for choosing vegetables from the default of health benefits to the desire for a tasty experience. Finally, collecting expected taste ratings across all labels used in the multisite intervention enabled us to test a potential alternative explanation of why the intervention was less effective at School E: that the taste-focused labels used at School E were perceived as less appealing than the taste-focused labels used at other schools, absent the particular context of the schools.

Method

An online sample of 151 participants, which yielded 80% power to detect a small to moderate effect size ($d = 0.3$) using a mixed effects model (Judd, Westfall, & Kenny, 2017), was recruited from Amazon Mechanical Turk. Four participants were excluded because they did not pass attention checks, resulting in a final sample of 147. Each participant viewed a random sample of 30 labels (the taste-focused, basic, and health-focused label for each of 10 vegetable dishes) selected from the full sample of labels used in the multisite study. The labels were presented one at a time in random order. For each dish, participants indicated their expectations of a positive taste experience ("How delicious would this taste?"; 1 = *not at all delicious*, 5 = *very delicious*), their likelihood of choosing that dish ("How likely would you be to choose this?"; 1 = *not at all likely*, 5 = *very likely*), and whether they "would primarily choose this for health benefits or for a tasty experience" (1 = *for health benefits*, 5 = *for a tasty experience*). Mixed-effects linear regression models predicted each outcome as a function of the fixed effect of labeling condition and random intercepts of participant and of vegetable dish. To test for mediation, we used the PROCESS macro (Hayes, 2013) with 5,000-sample bootstrapped 95% confidence intervals to test whether expectations of a positive taste experience mediated the effect of label condition on vegetable selection (conditions were coded as follows: health focused = –1, basic = 0, taste focused = 1).

Results

First, choice results mirrored the vegetable-selection results in the multisite study: Participants indicated that they were significantly more likely to choose the same vegetable dishes if they had taste-focused labels than if they had basic labels ($b = 0.32$, 95% CI = [0.23, 0.40], $p < .001$, $d = 0.22$, 95% CI = [0.16, 0.28]), and this was true to a greater extent than if dishes had health-focused labels ($b = 0.51$, 95% CI = [0.43, 0.59], $p < .001$, $d = 0.36$, 95% CI = [0.30, 0.42]). As hypothesized, results showed that taste-focused labels also increased expectations of a positive taste experience compared with basic labels ($b = 0.46$, 95% CI = [0.38, 0.53], $p < .001$, $d = 0.35$, 95% CI = [0.29, 0.41]), and this was again true to a greater extent compared with health-focused labels ($b = 0.64$, 95% CI = [0.56, 0.71], $p < .001$, $d = 0.50$, 95% CI = [0.44, 0.56]). Health-focused labels were less likely to be chosen ($b = 0.19$, 95% CI = [0.11, 0.28], $p < .001$, $d = 0.14$, 95% CI = [0.08, 0.19]) and were perceived as less tasty ($b = 0.18$, 95% CI = [0.11, 0.26], $p < .001$, $d = 0.14$, 95% CI = [0.08, 0.19]) than basic, nondescriptive labels. (See Table S4 in the Supplemental Material for descriptive statistics by condition and outcome.)

We next tested whether expectations of a positive taste experience mediated the effect of label condition on vegetable selection among online participants' hypothetical selection decisions. Confirming our preregistered hypothesis, results showed that expectations of a positive taste experience fully mediated the effect of label condition on vegetable selection (indirect effect = 0.29, 95% CI = [0.25, 0.33]). The remaining direct effect of taste-focused descriptions was reduced to such an extent that it was negative (direct effect = –0.03, 95% CI = [–0.06, –0.00], $p = .036$; Fig. 4).

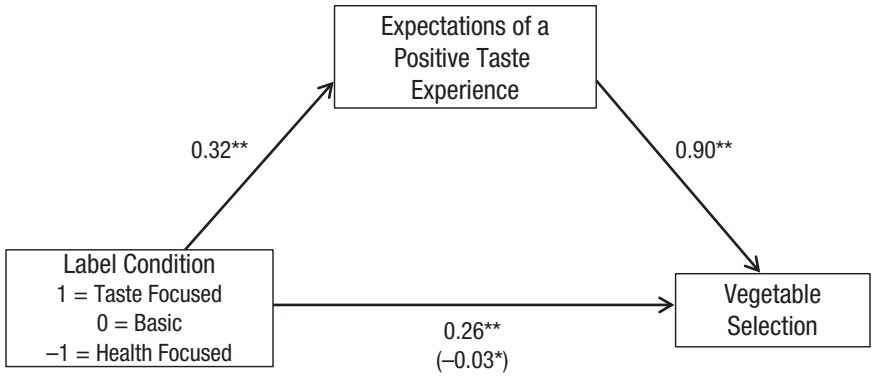

Fig. 4. Mediation model from Supplementary Study A showing the effect of label condition on vegetable selection as mediated by expectations of a positive taste experience. Unstandardized regression coefficients are given. The value in parentheses represents the coefficient when label condition and expectations of a positive taste experience were entered simultaneously into a regression predicting vegetable selection. Vegetable selection represents online participants' self-reported likelihood of choosing vegetable dishes in Supplementary Study A. Asterisks indicate significant paths (*$p < .05$, **$p < .001$).

Similarly, taste-focused labels changed the reason why participants chose vegetable dishes (see Fig. S1 in the Supplemental Material). As hypothesized, taste-focused labels shifted people's reason for choosing vegetables from being primarily for health benefits to being more for a tasty experience compared with basic labels (b = 0.81, 95% CI = [0.73, 0.89], $p < .001$, d = 0.58, 95% CI = [0.53, 0.64]) and to a greater extent compared with health-focused labels (b = 1.08, 95% CI = [1.00, 1.16], $p < .001$, d = 0.80, 95% CI = [0.74, 0.86]). Health-focused labeling shifted people's reason for choosing vegetables to be more toward health benefits compared with basic labeling (b = –0.27, 95% CI = [–0.35, –0.19], $p < .001$, d = –0.20, 95% CI = [–0.26, –0.14]).

Results showed no differences between the taste-focused labels from any two schools on participants' expectations of a positive taste experience (bs for differences between schools = 0.02–0.22, all ps > .134, ds = 0.01–0.17). Absent the school context, the taste-focused labels used at School E (where the intervention was least effective) did not elicit decreased expectations of a positive taste experience compared with the taste-focused labels used at School A (where the intervention was most effective), b = –0.02, 95% CI = [–0.34, 0.30], p = .92, d = –0.01, 95% CI = [–0.27, 0.24]. Because the taste-focused labels used at schools did not instill different expectations about the taste experience when isolated from the context of a given school, these results support the idea that heterogeneity in the efficacy of taste-focused labeling across schools is better explained by differences in school contexts—specifically, variation in the average tastiness of a school's vegetable recipes.

Testing Alternative Explanations: Supplementary Study B

Taste-focused labels were designed to emphasize both expectations of specific flavors and expectations of a positive experience. As a result, some of the taste-focused labels unintentionally contained more words than health-focused labels in the multisite experiment. To rule out the potential explanation that length of description was driving the effects, we compared descriptions of equal word length in Supplementary Study B. Furthermore, because taste-focused labels are rarely seen accompanying healthy foods, another possible mechanism through which they increase choice is via invoking surprise or curiosity among diners. Therefore, Supplementary Study B tested the preregistered hypothesis that the mechanism driving the effects was increased expectations of a positive taste experience, controlling for any mediating effect of surprise or curiosity. Finally, Supplementary Study B tested our theoretical assertion that taste-focused labels are most effective when they provide both specific flavor expectations and expectations of a positive experience. We compared taste-focused labels with three alternative types of labels that could be mistakenly assumed to be taste-focused but, because they did not meet both criteria (i.e., providing both a flavor expectation and a positive-experience expectation), were hypothesized to be less effective.

Method

In this preregistered study, an online sample of 69 participants was recruited from Amazon Mechanical Turk.

A power analysis indicated that a sample of this size would yield 80% power with the present design to detect a small effect size ($d = 0.2$) using a mixed effects model (Judd et al., 2017). Two participants were excluded for failing attention checks, resulting in a final sample of 67 participants. Each participant viewed 42 labels created from seven different vegetable dishes each receiving six separate labels: taste focused, health focused, basic, fancy, vaguely positive, and ingredients lists (see Table S5 in the Supplemental Material). The taste-focused, health-focused, and basic labeling conditions were used in the multisite study; fancy, vaguely positive, and ingredients-list labels represented three alternative label conditions that may seem similar to taste-focused labeling but were hypothesized to be less effective because they lacked one of the two components of taste-focused labels. Fancy labels (e.g., "Ambrosial Zucchini a l'Italienne," "Venerable Full-bodied Butternut Squash") and vaguely positive labels (e.g., "Absolutely Awesome Zucchini," "Extraordinary Butternut Squash") represented descriptions that increase expectations of a positive experience but do not provide specific flavor expectations. Ingredients-list labels ("Zucchini, Bread Crumbs, Parmesan," "Butternut Squash, Oil, Pepper, Salt") represented labels that provide specific flavor expectations but do not increase expectations of a positive experience because they merely list ingredients.

All labels were matched for description length, except for basic labels and vaguely positive labels, which are inherently shorter because they are specifically intended to be nondescriptive (basic labels) or to be positive but vague (vaguely positive labels). After viewing each label one at a time in random order, participants rated expectations of a positive taste experience ("How delicious would this taste?"; 1 = *not at all delicious*, 5 = *very delicious*), surprise or curiosity ("To what extent are you surprised or curious about this dish?"; 1 = *not at all curious*, 5 = *very curious*), and the likelihood that they would choose the vegetable dish ("How likely would you be to choose this?"; 1 = *not at all likely*, 5 = *very likely*).

To test for multiple mediation, we used the PROCESS macro (Hayes, 2013) with 5,000-sample bootstrapped 95% confidence intervals to simultaneously compare the potential mediating effects of expectations of a positive taste experience and of surprise or curiosity. The preregistered model used online participants' ratings of expectations of a positive taste experience and of surprise or curiosity as mediators and their likelihood-of-choosing measure as the dependent variable (label conditions were coded as follows: health focused = 0, taste focused = 1).

Results

First, as hypothesized in the preregistration, results showed that even when matched for description length, dishes with taste-focused labels were perceived as significantly tastier ($b = 0.86$, 95% CI = [0.73, 0.99], $p < .001$, $d = 0.66$, 95% CI = [0.56, 0.76]) and were significantly more likely to be chosen ($b = 0.81$, 95% CI = [0.67, 0.95], $p < .001$, $d = 0.60$, 95% CI = [0.49, 0.70]) than dishes with health-focused labels (see Fig. S2 in the Supplemental Material). Exploratory comparisons revealed that dishes with health-focused labels led to lower expectations of tastiness and a lower likelihood of selection compared with vaguely positive labels, fancy labels, and merely listing ingredients (see Fig. S2). See Supplemental Results in the Supplemental Material for a description of all exploratory comparisons, and see Table S6 in the Supplemental Material for descriptive statistics by label condition and outcome.

Second, taste-focused labels did increase surprise or curiosity compared with health-focused labels ($b = 0.97$, 95% CI = [0.84, 1.11], $p < .001$, $d = 0.76$, 95% CI = [0.66, 0.86]; see Fig. S2). Yet as hypothesized, results of multiple-mediation analysis confirmed that the mediating role of expectations of a positive taste experience (indirect effect = 0.68, 95% CI = [0.54, 0.81]) was much stronger than, and remained significant after controlling for, the mediating effect of surprise-curiosity (indirect effect = 0.15, 95% CI = [0.11, 0.21]; see Fig. 5).

Finally, compared separately with dishes with basic, vaguely positive, fancy, and ingredients-list labels, dishes with taste-focused labels were perceived as tastier (bs = 0.36–0.72, all ps < .001, ds = 0.27–0.56) and were more likely to be chosen (bs = 0.42–0.80, all ps < .001, ds = 0.31–0.58; Fig. S2). This suggests that, as hypothesized, taste-focused labels are distinct from and more effective than labels that only elevate expectations of a positive experience without providing specific flavor expectations (i.e., vaguely positive and fancy labels) and compared with labels that provide only specific flavor expectations but do not elevate expectations of a positive experience (i.e., ingredients lists).

Discussion

Across five sites, 185 days of data collection, 71 vegetable dishes made from 24 different vegetables, and 137,842 individual diner decisions, taste-focused labels increased vegetable selection by 29% compared with health-focused labels and by 14% compared with basic labels. Vegetable consumption also increased by 39%. These results conceptually replicate previous findings from lab studies that primed taste goals with prompts

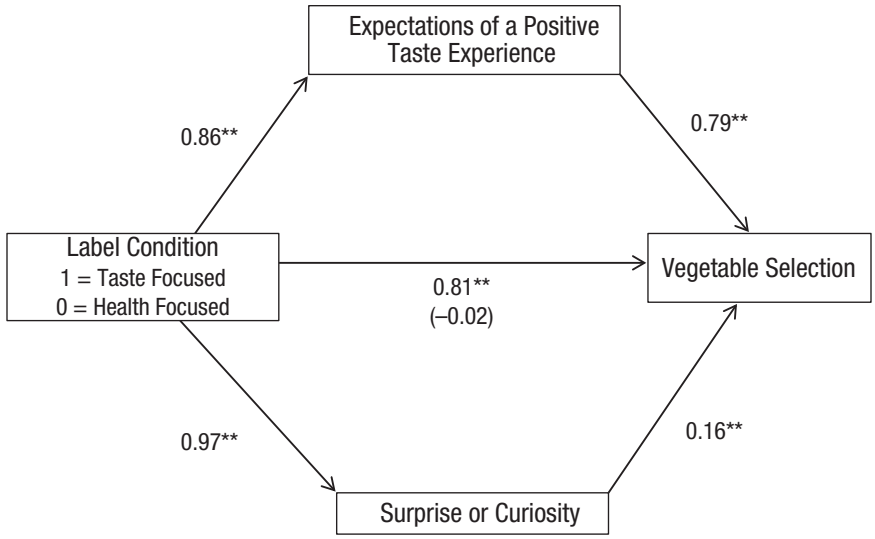

Fig. 5. Multiple mediation model from Supplementary Study B showing the effect of label condition on vegetable selection as mediated by expectations of a positive taste experience and surprise or curiosity. Unstandardized regression coefficients are given. The value in parentheses represents the coefficient of label condition after controlling for the mediators. Asterisks indicate significant paths ($p < .001$).

or stories (Maimaran & Fishbach, 2014; Woolley & Fishbach, 2016) and extend them by demonstrating that taste-focused labels are a nondeceptive, time- and resource- effective intervention for increasing vegetable consumption at scale in real-world settings. This article also extends initial research (Turnwald, Boles, & Crum, 2017; Turnwald & Crum, 2019) by demonstrating that the taste-focused labeling intervention is replicable in a preregistered multisite study, influences consumption as well as selection, and, as theorized, works by increasing expectations of a positive taste experience.

Preregistered follow-up studies identified mediators, moderators, and boundaries of the effects found in our multisite intervention. Taste-focused labeling was more effective at some sites than others, in part because of how tastily, on average, the vegetable dishes were prepared within each dining hall. This moderation, by the credibility of the context in which it is claimed, converges with other evidence suggesting that psychological interventions are most effective in contexts that reinforce the intervention message (Walton & Wilson, 2018; Yeager et al., 2019). It also suggests that taste-focused labeling may be more effective in establishments in which people expect to be served better-tasting healthy foods (e.g., farm-to-table restaurants vs. fast food restaurants) and highlights the importance of coupling taste-focused labeling with culinary strategies to ensure that taste-focused labels are credible.

This research also helps clarify what taste-focused labeling is not. Although taste-focused labels pique curiosity because of their novelty, invoking surprise is not the primary mechanism. Moreover, taste-focused labeling is not simply a matter of adding more words, listing ingredients, or using vague or fancy words. Taste-focused labels are most effective when they provide expectations of both specific flavors and a positive experience. This finding represents a theoretical advance over prior work, in which words like "tasty" or "enjoyable" were used to motivate consumption (Finkelstein & Fishbach, 2010; Maimaran & Fishbach, 2014; Woolley & Fishbach, 2016).

Several limitations are worth noting. Because collecting behavioral data was laborious and required research assistants to count the number of diners choosing vegetables, School E used a less precise method of measurement than other schools. For similar reasons, consumption data were measured only at School A. The self-serve structure of dining halls prevented us from measuring how the intervention impacted individual diners' vegetable choices or whether other food choices changed. We were unable to measure individual differences that might have moderated our results, such as dieting or restrained-eating status, and we acknowledge that health-focused labels may be preferred by dieters and restrained eaters to help them avoid unhealthy foods (e.g., Irmak, Vallen, & Robinson, 2011; Papies & Veling, 2013). Additionally, mechanism and boundary questions were tested in supplementary studies rather than as part of the multisite intervention. Although we cannot be completely certain, we expect that similar psychological processes were operating for participants in the multisite study. Finally, though some of the vegetable recipes used in this study incorporated small amounts of fat (e.g., butter, cheese, bacon), most were

prepared with plant oils, herbs, and spices, which enhance both flavor and health benefits. Although adding fats or other ingredients to dishes may slightly increase caloric content, the most up-to-date nutritional science suggests that this is a healthier approach than reducing calories or restricting fat (Afshin et al., 2019).

The effect sizes found in this multisite replication are noteworthy. Still, to tackle the major issue of unhealthy eating, more research is needed to build environments that invoke sizable changes in choice and enjoyment of healthier foods. Labeling is one of myriad possibilities that could harness a taste-focused approach. Nutrition education and cognitive training strategies could focus on tasty and enjoyable aspects of healthy eating instead of exclusively (Van Dessel, Hughes, & De Houwer, 2018) or primarily (Boswell, Sun, Suzuki, & Kober, 2018) on health benefits. Culinary strategies to prepare healthy foods more flavorfully (e.g., Cohen et al., 2015; Spencer, Kurzer, Cienfuegos, & Guinard, 2018) could further increase the likelihood of positive taste experiences. Societal institutions (e.g., restaurants, food companies, schools, government) and individuals could incorporate taste-focused language surrounding healthy foods into daily messaging that the public is exposed to (e.g., food labels, advertisements) and that individuals perpetuate in social networks (e.g., social media, dialogue). Finally, taste-focused labels could be combined with other established strategies (e.g., choice architecture, making healthy foods more affordable and accessible) to improve food environments.

In conclusion, these findings demonstrate that taste-focused labeling is a scalable, low-cost, wise intervention (Turnwald & Crum, in press; Walton & Wilson, 2018) for increasing vegetable intake. While research and policy have justifiably called for limiting the public's exposure to appealing advertising of unhealthy foods (Kelly et al., 2010), and for using calorie labels (e.g., Block & Roberto, 2014), red "traffic-light" labels (e.g., Thorndike, Gelsomin, McCurley, & Levy, 2019), and graphic warning labels (e.g., Donnelly, Zatz, Svirsky, & John, 2018) to discourage unhealthy choices, few approaches leverage tasty and enjoyable components of healthier foods. The present research demonstrates the possibility and critical importance of intervening in the problem from the other direction—increasing the lure of healthy foods.

Action Editor

Ayelet Fishbach served as action editor for this article.

Author Contributions

B. P. Turnwald and A. J. Crum conceived and designed the study. All authors contributed to protocol details. B. P. Turnwald, J. D. Bertoldo, M. A. Perry, P. Policastro, L. Pine, P. Connors, and G. Challamel were responsible for data acquisition, and B. P. Turnwald was responsible for data analysis. B. P. Turnwald wrote the first draft of the manuscript, and all authors contributed critical revisions of the manuscript. All authors approved the final version of the manuscript for submission.

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Ghislaine Challamel represents the Menus of Change University Research Collaborative collaborators, a complete list of whom is provided in the Supplemental Material available online. Detailed instructions for constructing taste-focused labels and tailoring them to different settings are freely available in an online tool kit called "Edgy Veggies" (http://sparqtools.org/edgyveggies/).

Declaration of Conflicting Interests

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/10.1177/0956797619872191

Open Practices

All data have been made publicly available via the Open Science Framework and can be accessed at https://osf.io/39vsg/. The design and analysis plans for the multisite study, Supplemental Study A, and Supplemental Study B were preregistered at https://osf.io/39vsg/. For the multisite study, analyses for Hypothesis 4 in the preregistered plan were not conducted because after registering the study, we realized that Hypothesis 4 was confounded and not testable with our experimental design. It was not possible to isolate the appeal of a description from the recipe

used for a given dish. All other preregistered hypotheses are reported in this article. The complete Open Practices Disclosure for this article can be found at http://journals.sagepub.com/doi/suppl/10.1177/0956797619872191. This article has received badges for Open Data and Preregistration. More information about the Open Practices badges can be found at http://www.psychologicalscience.org/publications/badges.

Note

1. Although some studies report that emphasizing health qualities can increase consumption (Finkelstein & Fishbach, 2010; Irmak et al., 2011; Provencher et al., 2009; Suher et al., 2016; Wansink & Chandon, 2006), these findings seem to be isolated to contexts in which the food is unhealthy (e.g., cookies, candy, crackers) and there are no alternative foods to choose from. In these contexts, participants consumed more of the unhealthy snack because they perceived it as less satiating (Finkelstein & Fishbach, 2010; Suher et al., 2016) or because they felt less guilt (Wansink & Chandon, 2006), particularly in the case of dieters (Irmak et al., 2011).

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