



Emphasizing appeal over health promotes preference for nutritious foods in people of low socioeconomic status

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ABSTRACT

People of low socioeconomic status (SES) have disproportionately poorer dietary health despite efforts to improve access and highlight the health benefits of nutritious foods. While health-focused labels and advertisements make healthier options easier to recognize, they can prime a number of negative associations about healthy foods (e.g., taste, satiety, cost), which may be particularly aversive for low SES groups. This within-subjects study recruited people of low and high SES (those without and with a college degree) and compared their product expectations, experiences, satiety, and choice when consuming a bottled fruit and vegetable smoothie promoted as pleasurable (“Crave”) or as healthy (“Nutralean”). Relative to Nutralean, Crave improved product expectations and behavioral measures of satiety across all participants. However, Crave enhanced expectations, experiences, and product choice more for low SES than high SES participants. Importantly, improvements were achieved without deception of nutritional facts and without decreasing perceived healthiness or increasing perceived cost. These findings identify SES as an important moderator in health-focused promotion and suggest how the rapidly growing healthy food industry can more effectively appeal to low SES groups, contexts which the majority of Americans navigate.

Unhealthy foods are so readily accessible and aggressively marketed that some scholars have suggested we live in a “toxic environment” for health (Horgen, Choate, & Brownell, 2001). Unhealthy environments are even more evident for Americans of lower socioeconomic status (SES) who, in addition to having worse access to healthy foods (e.g., fruits and vegetables) (Meyer, Yoon, & Kaufmann, 2013), are also exposed to more unhealthy food advertising than high SES groups (Powell, Wada, & Kumanyika, 2014). These conditions contribute to poorer diets and greater risk of preventable disease in low SES communities (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010; Wang et al., 2014) and have prompted public health and policy initiatives to prioritize making healthy foods and beverages more accessible and easier to identify amongst less healthy options (Mozaffarian, Angell, Lang, & Rivera, 2018).

Expanding access to healthy foods is undoubtedly important. Yet even when healthy foods are more accessible, healthy purchasing does not dramatically improve (Cummins, Flint, & Matthews, 2014; Peng & Kaza, 2019). This evidence suggests that ameliorating inequities in food access, alone, is not enough. We propose that this is because in American contexts, healthy foods are marketed in ways that are less appealing and

especially misaligned with many cultural values and preferences of low SES groups.

Healthy foods are predominantly marketed by touting their nutritive benefits, such as through nutrition facts panels or front-of-package health claims (Kessler, 2014; Williams, 2005). Conversely, foods that are less healthy leverage a broader suite of positive associations with appealing qualities such as taste, satisfaction, fun, indulgence, and social connection (Emond, Smith, Mathur, Sargent, & Gilbert-Diamond, 2015; Folta, Goldberg, Economos, Bell, & Meltzer, 2006; Harris, Bargh, & Brownell, 2009; Manganello, Smith, Sudakow, & Summers, 2013). Advertisements for Coca-Cola, Doritos, or McDonald’s, for example, seldom mention nutrition and instead show a range of people or fictional characters finding comfort, joy, and satisfaction of cravings in their foods.

The presentation of foods affects more than the willingness to buy a product. It shapes expectations and the ultimate experience of that product. Emphasizing health qualities may make healthy options easier to identify. However, experimental evidence shows that when foods are portrayed as healthy, people are less likely to choose them and expect them to be less tasty (Raghunathan, Naylor, & Hoyer, 2006), filling

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(Suher, Raghunathan, & Hoyer, 2016), and enjoyable (Raghunathan et al., 2006). Foods portrayed as healthy are associated with a maladaptive physiological satiety response (Crum, Corbin, Brownell, & Salovey, 2011) and can leave people needing to consume more to feel equally satiated (Provencher, Polivy, & Herman, 2009).

Together, this research suggests that even if a food possesses health-promoting qualities, it may be beneficial to focus on more broadly appealing attributes such as pleasure, indulgence, and social connection. However, limited research has tested how different portrayals of healthy foods resonate with low SES populations for whom health-focused marketing may be especially ineffective. Appeal-focused marketing is likely more enticing to most consumers, but may especially appeal to low SES groups compared with health-focused promotion for several reasons. First, in the U.S., health behaviors like eating healthily are overwhelmingly portrayed as an individual pursuit marked by effortful self-control and personal responsibility (Hook & Markus, 2020; Mozafarian et al., 2018). This independent view of health more strongly aligns with higher SES (Wardle & Steptoe, 2003) than lower SES groups, who find value in interdependence and for whom good health is associated with fostering close, supportive relationships (Chen & Miller, 2012; Levine, 2017; Markus & Kitayama, 1991). This suggests the particular importance of social relationships, as both a source of pleasure and an under-utilized cornerstone of health among people of low SES. Second, healthy foods are seen as more expensive (Haws, Reczek, & Sample, 2017) and sometimes exclusive, often associated with being middle class and White (Oyserman, Fryberg, & Yoder, 2007). Thus, emphasizing health may not resonate with low SES people's experiences and identities as would other qualities of food, like taste and satisfaction. Third, the experience of resource scarcity or deprivation, which is more likely among working class contexts marked by lower socioeconomic resources, is associated with greater preference for more energy-dense foods (Cheon & Hong, 2017; Sim, Lim, Forde, & Cheon, 2018). Because people implicitly associate healthier foods with being less filling (Suher et al., 2016), highlighting health qualities likely deters choice among low SES groups even when these foods are readily available.

These reasons help explain the shortcomings of healthy eating promotion (and the success of unhealthy food advertising) in reaching low SES communities. More importantly, they underscore the potential of acknowledging healthy foods as pleasurable and inherent to social relationships. Rising SES-based disparities in health call for tailoring marketing approaches to align with the views and preferences of groups wherein the disadvantage lies. Therefore, we developed novel promotional materials for enhancing the appeal of healthy foods, particularly for people of low SES.

To understand how individuals from different socioeconomic backgrounds perceive and experience health-versus appeal-focused promotional approaches, the current study recruited a diverse community sample consisting of equal proportions of people of high and low SES, as measured by educational attainment. By affording greater financial, cognitive, and occupational resources for health maintenance behaviors, one's level of education is often considered the most reliable and meaningful indicator of SES for health (Cutler & Lleras-Muney, 2010; Lawrence, 2017). Therefore, people of high and low SES are defined here as those with and without a college degree. In a within-subjects experiment, participants sampled a bottled fruit and vegetable smoothie for which we designed two product labels and commercial advertisements. One product label and commercial advertisement ("Crave") emphasized pleasure and social connection, and the other product label and commercial advertisement ("Nutralean") emphasized health and nutrition. We hypothesized that Crave, by harnessing an appeal-focused marketing approach, would lead to more positive product expectations, better experiences with the product, increased satiety (subjective, physiological, and behavioral satiety), and greater likelihood of choosing and endorsing the product. Relative to Nutralean's health-focused approach, we predicted that Crave's appeal-focused approach would be particularly effective among low SES

individuals. Our hypotheses and analytic plan were pre-registered on the Open Science Framework (<https://osf.io/k3p8u/>); Also see Supplementary Note).

1. Materials and methods

Participants. N = 62 participants were recruited via community postings and flyers under the guise of an independent study comparing taste and metabolic response to foods and beverages from competing brands in exchange for \$100. One participant failed multiple attention checks and was removed from all analyses, resulting in a final sample of 61 participants that varied by socioeconomic status (47.5% no Bachelor's degree/low SES, 52.5% Bachelor's degree/high SES), race (16.4% Black/African American, 27.9% Asian American, 39.3% White/European American, and 16.4% Latinx American; 39.3% ethnic majority, 60.7% ethnic minority), and gender (59.0% men, 41.0% women). Participants ranged in age from 21 to 66, with an average of 43.0 years. This sample also varied in weight status (44.3% healthy weight, 19.7% overweight, 36.1% obese), with 31.0% of high SES participants and 41.4% of low SES participants considered obese (Body Mass Index ≥ 30). In this sample, low SES individuals did not have significantly higher BMIs than those of high SES ($b = 2.40$, 95% CI[-0.77, 5.56], $p = .135$). The sample size for this study was determined based on sample sizes of related studies examining psychological and physiological responses to different presentations of a standardized meal (Cassady, Considine, & Mattes, 2012; Crum et al., 2011) and sample size calculations ensuring adequate power to detect medium-sized effects in analyses of within-between interaction effects on behavior and physiology (see Supplementary Methods for sample size determination).

Procedure. Participants were scheduled for two 2.5 h lab visits each randomly assigned to one of two conditions (appeal-focused or health-focused). In these visits, they consumed a standardized healthy product, a bottled fruit and vegetable smoothie available in stores nationwide. Given the product was consistent across conditions, participants sampled the smoothies in separate visits, scheduled 1 week apart on average, to prevent participants from realizing they were the exact same beverage. Conditions were counterbalanced such that half of participants viewed the appeal-focused condition followed by the health-focused condition and half of participants viewed the health-focused condition followed by the appeal-focused condition.

Prior to their visits, participants were required to undergo an overnight fast and report the time of their last meal to ensure a fast of at least 10 h. At the beginning of each visit, participants rated their expectations of the product (e.g., expected tastiness, indulgence, fullness, healthiness) after seeing only the nutrition facts, which were consistent with the actual product. Participants then rated the same product expectations measures again after viewing the product label and commercial advertisement (modified according to condition). Next, participants were presented with the smoothie and had 10 min to consume the entire contents (15.2 fl. oz./450 mL) before rating their experience of consuming the product in terms of appearance, taste, smell, and texture. Immediately after consumption, participants indicated the additional amount of smoothie required for satiation and rated their product choice and endorsement (i.e., likelihood of buying, recommending to others, price willing to pay). At the end of the visit, we measured participants' subsequent snack consumption and at the end of the final visit, had them choose between the appeal-focused or health-focused product after being exposed to both conditions. At several timepoints throughout the visit, participants rated their subjective satiety (i.e., self-reported hunger and fullness) while trained nursing staff collected blood samples for analysis of physiological satiety (i.e., ghrelin, GLP-1, gastric emptying rate). All visits followed the same protocol and collected data on the same measures with the following exceptions: (1) Visit 1 included additional time at the start of the session for the participant to review the protocol, complete the consent form, and obtain height and weight; (2) Visit 2 included an additional measure towards the end of the session

asking participants to choose between the two products they sampled; (3) Visit 2 included a debrief at the end of the session. See Fig. 1 for study design and Supplementary Methods for additional details on experimental protocol.

All participants provided consent at the initial visit and could opt out of participation at any point during the study. Study protocols were approved by the Stanford University Institutional Review Board. This experiment was conducted with clinical and laboratory assistance from the Clinical and Translational Research Unit (CTRU) and Human Immune Monitoring Center (HIMC) at Stanford University.

Conditions. In all visits, regardless of condition, the test beverage is presented with nutrition facts consistent with the actual product, a commercially available bottled fruit and vegetable smoothie. This product contained a wide variety of fruits and vegetables (cherries, purple carrots, red beets, sweet potato, strawberries, plums, yellow corn, apples, chickpeas, lemon, and chicory root) and was made with no added sugar.

The *appeal-focused* condition referred to the smoothie as “Crave” and was designed to emphasize its appealing qualities via a product label and 1-min commercial advertisement (Fig. 2). The label described Crave as a rich and creamy berry smoothie that represents pleasure and indulgence (“Life without limits... Indulgence you deserve”), with a colorful geometric design. The 1-min commercial advertisement for Crave played stimulating background music while displaying a series of images alluding to the product satisfying cravings for fun, indulgence, and social connection.

In the *health-focused* condition, the smoothie was referred to as “Nutralean” and was presented with a label and commercial highlighting its nutritive, health-promoting (“helps prevent obesity”), and restrictive qualities (“Light and healthy”; “Reduced sugar, gluten-free, fat-free”). The 1-min commercial advertisement for Nutralean also included stimulating music, but instead highlighted its suitability for a

variety of diets (e.g., vegetarian, gluten-free, and paleo) and touted Nutralean as a smarter, healthier way to achieve daily recommended servings of fruits and vegetables.

Measures. *Product expectations* were measured at two time points in each visit before participants consumed the smoothie. First, participants rated their initial expectations of the smoothie after viewing the nutrition facts alone (“Based on the nutritional information, to what extent do you think this product is: Tasty, Filling, Indulgent, Fun/Exciting”; 1 = *Not at all...* 4 = *Very*; Cronbach’s alpha range: 0.66-0.84). Participants rated expectations of appeal along the same 4 items for a second time after having seen the product label (including nutrition facts) and 1-min commercial advertisement (“Based on the product label and commercial ...”; Cronbach’s alpha range: 0.80-0.82).

Expectations of the product’s healthiness and expensiveness were also measured before consumption of the smoothie to determine whether focusing on appeal, an approach reminiscent of unhealthy food promotion, leads participants to expect they are consuming a less nutritious product, which may contribute to its appeal. In light of our interests in SES disparities, we also wanted to explore whether appeal-focused labels and advertisements would signal that a product was particularly expensive, a perception that may inadvertently discourage low SES participants. Therefore, participants rated how “expensive” and how “healthy” (1 = *Not at all...* 4 = *Very*) they expected the smoothie to be after viewing the nutrition facts alone and after viewing the product label and commercial. Participants also indicated how much they “think one bottle of this product costs” (in U.S. dollars).

Product experience was measured immediately after consumption of the smoothie, which asked participants “On a scale from 1 to 5 where 1 represents ‘Displeasing’ and 5 represents ‘Pleasing’, please rate the product on the following qualities: Appearance, Taste, Smell, Texture” (Cronbach’s alpha range: 0.65-0.86).

Behavioral satiety was measured in two ways. The first involved a self-

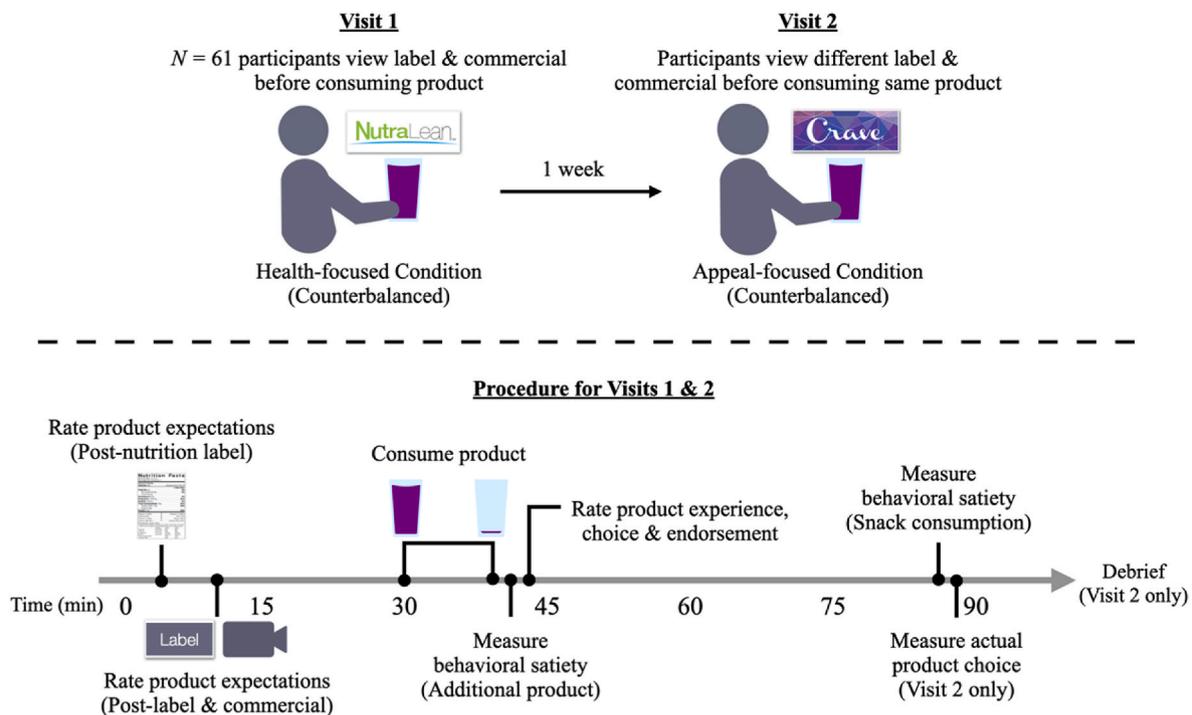


Fig. 1. *Experiment Design.* Note. Procedure for within-subjects experiment with counterbalancing. Visits 1 and 2 were identical in procedure and measures with the exception of actual product choice and debrief (at the end of visit 2 only). In each visit, participants rated product expectations (how tasty, indulgent, filling, and fun/exciting the product would be) after viewing the nutrition label alone (T6) and again after viewing the product label and commercial advertisement (T10). Participants consumed the product (T30 to T40) and rated product experience (appearance, taste, smell, and texture) before indicating product choice (likelihood of buying), endorsement (recommending to a friend, price willing to pay for the product at T42), and behavioral satiety (additional product required for satiety at T41 and subsequent snack consumption at T88). Subjective satiety (self-reported hunger and fullness at T0, T23, T42, T53, T68, T83) and physiological satiety (ghrelin, GLP-1, and gastric emptying via blood samples collected at T0, T25, T55, T70, T85) were measured at several timepoints throughout each visit.



Fig. 2a. Product Label (a) and Commercial Advertisement Clips (b) for Crave and Nutralean. Note. For each condition, we designed a product label and a commercial advertisement, which can be viewed on: <https://osf.io/k3p8u/>. (a) Product labels for appeal-focused/Crave condition and health-focused/Nutralean condition with identical nutrition facts panels

report measure taken immediately after consumption of the smoothie in which participants could pour into a glass the additional amount of smoothie needed to feel fully satiated. Participants were told “We need to get a measure of how much of the smoothie you feel that you would need to feel full so that we can get a sense of how hungry or full you are. Please pour into this glass the amount that you would need to feel full in addition to what you already drank. If you feel completely full, you do not need to pour any more. If you need more space than this glass provides, there are extra glasses. Note that you won’t actually be drinking any more of the smoothie today.” Afterwards, the experimenter measured the amount poured (in mL).

The second measure of subsequent eating behavior occurred at the end of each visit, after the last blood draw was completed but before the participant was discharged. The experimenter told participants “As a thank you for participating and for fasting to prepare for this study, please help yourself to these snacks,” then provided an assortment of snacks, two healthier options (almonds and dried cranberries) and two less healthy options (potato chips and chocolate chip cookies). Snacks were weighed before and after consumption to measure the quantity of grams consumed.

Subjective satiety was measured via self-reports of hunger and fullness at 6 different time points throughout each visit (T0, T23, T42, T53, T68,



Fig. 2b. (b) Clips from 1-min commercial advertisements for appeal-focused/Crave condition and health-focused/Nutralean condition.

T83). Self-reported hunger (fullness) was measured by asking participants to rate “On a scale from 1 to 7, where 1 means you are not hungry (full) at all and 7 means you are extremely hungry (full), how hungry (full) do you feel?”.

Physiological satiety was measured via changes in ghrelin, GLP-1, and in rates of gastric emptying. Blood samples were taken at T0, T25, T55, T70, and T85 to measure ghrelin (indicative of physiological hunger) and GLP-1 (indicative of physiological fullness). Plasma ghrelin and GLP-1 concentrations were measured via electrochemiluminescence immunoassays. Units of measurement are in mean fluorescence intensity (MFI) and were log-transformed to reduce high skewness and kurtosis.

Changes in acetaminophen concentration in the bloodstream indicated gastric emptying, the rate at which food leaves the stomach and enters the small intestine. Slower rates of gastric emptying typically indicate better absorption of nutrients from food and greater attenuation of glycemic response (i.e., slower rises in glucose and insulin) after consumption. To measure gastric emptying, 1000 mg acetaminophen was administered to participants at T29, immediately before product consumption. Serum acetaminophen concentration was assessed in

blood draws taken at T25 (baseline), T55, T70, and T85 of each visit and measured via enzymatic colorimetry. See Supplemental Information for additional details regarding sample processing and analysis of physiological satiety.

Product choice was measured in two ways, a choice between Crave and Nutralean and ratings of likelihood of buying each of the products. At the end of the second visit, after having sampled products in both conditions, participants had to ultimately choose between Crave or Nutralean. Participants responded to the question “As a thank you for participating, we’d like to offer you a free bottle of the product of your choice” (0 = *Nutralean*, 1 = *Crave*). Additionally, participants were asked “How likely is it that you would buy this product?” (1 = *Extremely unlikely*, 7 = *Extremely likely*) immediately after sampling the product in each visit.

Product endorsement was also measured after sampling the product in each visit by asking participants “How likely is it you would recommend this product to a friend?” (1 = *Not at all likely*, 7 = *Extremely likely*) and “How much would you be willing to pay for a bottle of this product?” (in U.S. dollars).

Analytic Plan. All analyses were run in R (Version 3.5.2). Mixed effects models were run via the *lme4* package and significance values were obtained using the *lmerTest* package. Mixed effects models were used for most outcomes with exception to outcomes measured at a single timepoint. For each outcome, we tested for moderations by SES (0 = High SES, Bachelor's degree, 1 = Low SES/No Bachelor's degree) and report on both main effects of label condition and interactions with SES. Linear mixed effects models included the random intercept effect of participant and where there were multiple timepoints of the same measure within a single visit, linear mixed effects models also include the interaction effect of time and the random effect of visit nested within participants.

Specifically, changes in product expectations were analyzed using a linear mixed effects model predicting expectation ratings as a function of the interaction of the fixed effects of time (1 = post-nutrition facts, 2 = post-label/commercial) and condition (0 = *Nutralean*, 1 = *Crave*) with the random effects of participant and of item (i.e., tasty, filling, indulgent, fun/exciting). The model also nested visits within individual participants, reflecting a within-subjects design.

Changes in expected healthiness, expected expensiveness, subjective (self-reported) and objective (ghrelin, GLP-1, acetaminophen concentration) satiety were analyzed using separate linear mixed effects models predicting ratings/values as a function of time (0 = Time 1, 1 = Time 2) and condition with the random nested effect of visit within participants. Separate models were run to analyze changes between each timepoint. Ghrelin, GLP-1, and acetaminophen concentrations were log-transformed to reduce skew.

Differences in product experience ratings between conditions was analyzed using a linear mixed effects model predicting ratings as a function of condition with the random effect of participant and of item (i.e., appearance, taste, smell, texture). To analyze effects on subsequent consumption, choice, and endorsement we ran separate models predicting total, healthy (almonds, dried cranberries), and unhealthy snack (chips, cookies) consumption, as well as likelihood of buying, price willing to pay, and likelihood of recommending to a friend. Each of these outcomes were predicted as a function of condition with the random effect of participant. Data from participants' reports of the additional amount of smoothie they would need to feel full yielded significant zero-inflation (0 mL in 34.4% of visits). Therefore, we used a Poisson generalized linear mixed effects model to predict the amount of smoothie poured (in mL) as a function of condition with the random effect of participant.

Actual product choice, which was measured at a single timepoint at the end of the last visit, was analyzed via a chi-square goodness-of-fit test that determined whether the observed difference between conditions were greater than 50/50. Lastly, effect sizes for all outcomes are reported in Cohen's *d* (see Supplementary Methods for details on effect size calculation).

2. Results

Confirming our first hypothesis, *Crave* led to more positive expectations than *Nutralean* after seeing the product label and commercial advertisement ($b = 0.47$, 95% CI[0.31, 0.64], $t(849.0) = 5.60$, $p < .001$, $d = 0.55$). Simple effects revealed that *Nutralean* reduced product expectations ($b = -0.18$, 95% CI[-0.30, -0.07], $t(423.0) = -3.17$, $p = .002$, $d = -0.22$) and *Crave* strongly enhanced expectations prior to consumption ($b = 0.29$, 95% CI[0.17, 0.41], $t(423.0) = 4.76$, $p < .001$, $d = 0.33$). Exploratory analyses of each item within the aggregate measure of appeal showed that the *Crave* label and advertisement enhanced expectations of taste ($b = 0.51$, 95% CI[0.23, 0.79], $t(120.0) = 3.55$, $p < .001$, $d = 0.59$), indulgence ($b = 0.84$, 95% CI[0.56, 1.11], $t(120.0) = 5.89$, $p < .001$, $d = 0.98$), and fun/excitement ($b = 0.54$, 95% CI[0.22, 0.86], $t(120.0) = 3.27$, $p = .001$, $d = 0.63$), but had no effect on how filling participants expected it to be compared to *Nutralean* ($b = -0.00$, 95% CI[-0.30, 0.30], $t(180) = -0.00$, $p = 1.00$, $d = 0.00$).

Also as predicted, there was a significant moderation by SES according to educational attainment ($b = 0.47$, 95% CI[0.14, 0.79], $t(847.0) = 2.77$, $p = .006$, $d = 0.40$) (Fig. 3). *Crave* enhanced product expectations compared to *Nutralean* among high SES participants ($b = 0.25$, 95% CI[0.02, 0.48], $t(443.0) = 2.16$, $p = .032$, $d = 0.22$), but the effect was nearly 3 times stronger among low SES participants ($b = 0.72$, 95% CI[0.48, 0.95], $t(401.0) = 5.91$, $p < .001$, $d = 0.62$). Additionally, there were no main effects or interactions with SES on perceptions of healthiness (main effect: $b = 0.15$, 95% CI[-0.09, 0.39], $t(120) = 1.21$, $p = .228$, $d = 0.22$; SES interaction: $b = 0.02$, 95% CI[-0.46, 0.50], $t(118.0) = 0.08$, $p = .941$, $d = 0.02$) or cost (main effect: $b = 0.10$, 95% CI[-0.14, 0.34], $t(120.0) = 0.80$, $p = .425$, $d = 0.15$; SES interaction: $b = 0.01$, 95% CI[-0.47, 0.49], $t(118.0) = 0.04$, $p = .969$, $d = 0.01$). For participants from low SES backgrounds, *Crave* was perceived as more appealing than *Nutralean*, without decreasing perceived healthiness ($b = -0.14$, 95% CI[-0.56, 0.28], $t(56.0) = -0.64$, $p = .523$, $d = -0.14$) or increasing perceived cost (expensiveness rating: $b = 0.10$, 95% CI[-0.28, 0.48], $t(56.0) = 0.53$, $p = .598$, $d = 0.12$; expected price: $b = 0.05$, 95% CI[-0.36, 0.45], $t(60) = 0.22$, $p = .824$, $d = 0.10$).

With respect to product experience (ratings of appearance, taste, smell, and texture after sampling), the main effect of label condition was not significant (aggregate: $b = 0.01$, 95% CI[-0.13, 0.14], $t(423) = 0.12$, $p = .905$, $d = 0.01$). However, there was a significant interaction with SES ($b = 0.43$, 95% CI[0.16, 0.70], $t(422) = 3.14$, $p = .002$, $d = 0.44$). As predicted, low SES participants had a more pleasant experience while drinking *Crave* than they did while drinking *Nutralean* ($b = 0.23$, 95% CI[0.05, 0.41], $t(199.0) = 2.51$, $p = .013$, $d = 0.20$). However, high SES participants exhibited the opposite pattern, and tended to report more positive experiences with *Nutralean* compared with *Crave* ($b = 0.20$, 95% CI[0.00, 0.39], $t(220.0) = -1.96$, $p = .051$, $d = -0.17$) (Fig. 4). Exploratory examination of individual items of product experience showed that compared to high SES participants, low SES participants rated *Crave* as significantly more pleasant in taste ($b = 0.75$, 95% CI[0.21, 1.29], $t(59.0) = 2.72$, $p = .008$, $d = 0.77$) and appearance ($b = 0.65$, 95% CI[0.23, 1.07], $t(59.0) = 3.03$, $p = .004$, $d = 0.67$), but not in texture ($b = 0.23$, 95% CI[-0.30, 0.76], $t(59.0) = 0.85$, $p = .397$, $d = 0.24$) or smell ($b = 0.08$, 95% CI[-0.37, 0.53], $t(59.0) = 0.34$, $p = .732$, $d = 0.08$) compared to *Nutralean*.

Satiety was measured via self-report (ratings of hunger and fullness), physiological measures (blood biomarkers of hunger and satiety), and behavioral measures (pouring additional product, subsequent snack consumption). In terms of subjective satiety (i.e., self-reported hunger and fullness), we found no differences by condition over time or moderations by SES (fully reported in Supplementary Results). Similarly for physiological indicators of hunger (ghrelin), fullness (GLP-1), and gastric emptying rates (acetaminophen concentration), we did not observe significant differences by condition over time or moderations by SES (see Supplementary Results).

While we observed no differences in self-report or physiological measures of satiety, differences did emerge in behavioral measures of satiety. We asked participants to pour into a glass the additional amount of smoothie (in mL) that they required in order to feel fully satiated. Mixed-effects Poisson regression analyses revealed a significant main effect of condition ($b = -0.20$, 95% CI[-0.23, -0.17], $p < .001$, $d = -0.15$) such that participants needed to consume less of the smoothie to feel full when it was labeled *Crave* compared to when the same beverage was labeled *Nutralean*. There was also a significant SES interaction ($b = -0.18$, 95% CI[-0.23, -0.13], $p < .001$, $d = -0.21$), such that relative to high SES participants, those of low SES needed to consume significantly less *Crave* than *Nutralean* in order to be fully satiated. The difference between *Crave* and *Nutralean* was 2.5–3 times as large among low SES participants ($b = -0.30$, 95% CI[-0.33, -0.26], $p < .001$, $d = -0.36$) than among high SES participants ($b = -0.11$, 95% CI[-0.15, -0.08], $p < .001$, $d = -0.15$). Absent of subjective and physiological changes in hunger, results showed that appeal-focused promotional approaches reduced the need to consume more of the product, especially among low

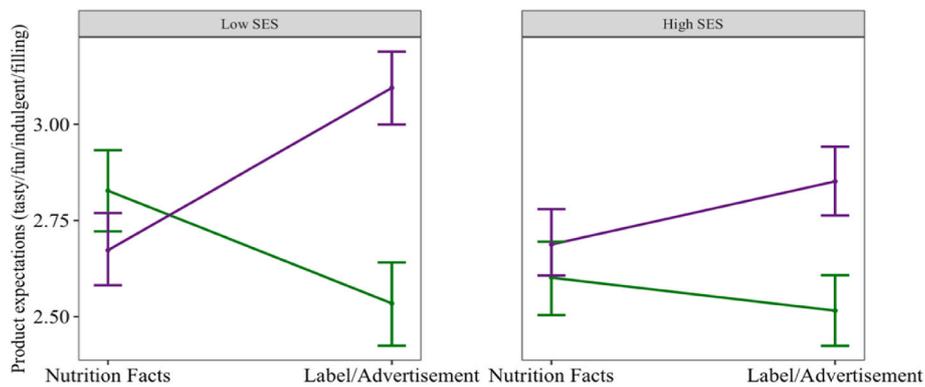


Fig. 3. Expectations of Crave versus Nutralean Post-Nutrition Facts and Post-Label and Advertisement in High and Low SES Participants. Note. Model-predicted means and 95% confidence intervals from linear mixed effects model. Purple lines/bars represent appeal-focused/Crave condition, green lines/bars represent health-focused/Nutralean condition.

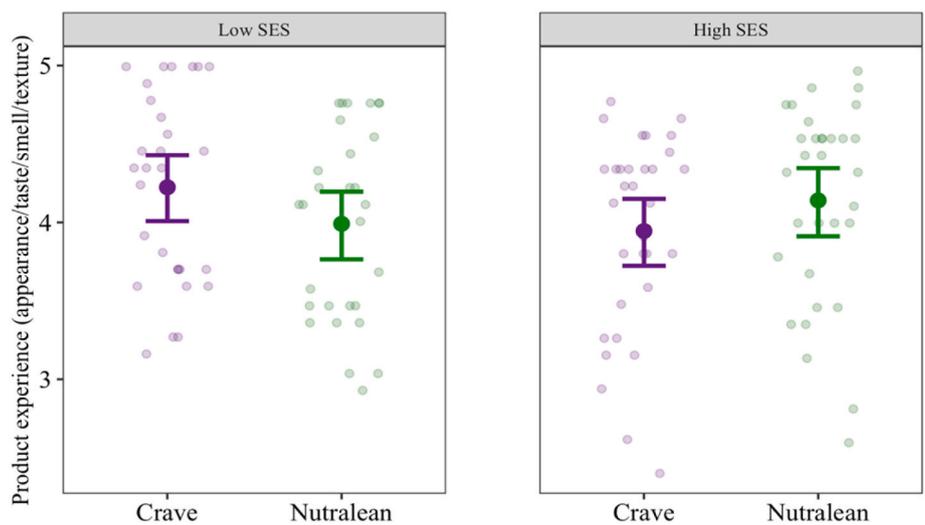


Fig. 4. Product Experience of Crave versus Nutralean in High and Low SES Participants. Note. Model-predicted means and 95% confidence intervals from linear mixed effects model. Purple lines/bars represent appeal-focused/Crave condition, green lines/bars represent health-focused/Nutralean condition.

SES participants.

Although participants indicated needing less Crave in order to feel full via the pouring measure, it is possible that participants would prefer to satisfy any residual hunger with other foods. To test whether the influence of Crave and Nutralean’s promotional approach extends to subsequent consumption of other foods outside of the product testing paradigm, we offered a variety of complimentary snacks at the end of each visit as a behavioral measure of satiety. Four snacks ranged in nutrition quality to include foods that were more healthy (almonds and dried cranberries) or less healthy (potato chips and chocolate chip

cookies). Consistent with the behavioral pouring measure, participants ate fewer total snacks after consuming Crave than they did after consuming Nutralean ($b = -23.38$ g, 95% CI[-39.27, -7.49], $t(60.0) = -2.91$, $p = .005$, $d = -0.36$). There were no differences by type of snack (healthy vs. unhealthy; $b = 0.53$ g, 95% CI[-17.15, 18.21], $t(180.0) = 0.06$, $p = .954$, $d = 0.01$), as simple effects tests revealed that Crave reduced consumption of both unhealthy snacks ($b = -11.42$ g, 95% CI [-18.38, -4.47], $t(60.0) = -3.25$, $p = .002$, $d = -0.31$) and healthy snacks ($b = -11.95$ g, 95% CI[-22.99, -0.91], $t(60.0) = -2.14$, $p = .037$, $d = -0.33$) relative to Nutralean (Fig. 5). There were no

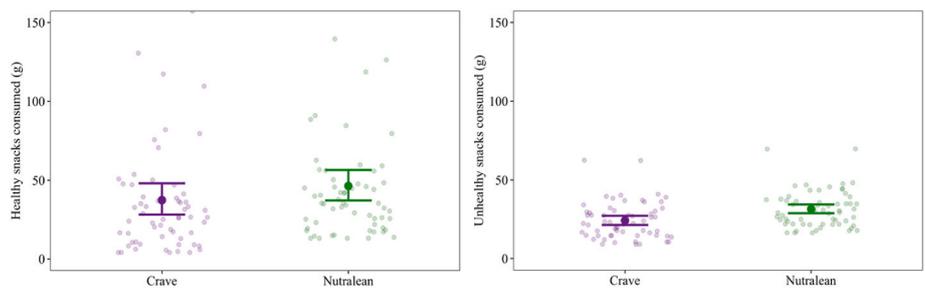


Fig. 5. Healthy and Unhealthy Snack Intake After Consumption of Crave versus Nutralean. Note. Model-predicted means and 95% confidence interval from linear mixed effects model. Healthy snacks included almonds and dried cranberries. Unhealthy snacks included potato chips and chocolate chip cookies. Purple lines/bars represent appeal-focused/Crave condition, green lines/bars represent health-focused/Nutralean condition.

interactions with SES on participants' consumption of total snacks ($b = 11.27$ g, 95% CI[-20.42, 42.96], $t(59.0) = 0.70$, $p = .489$, $d = 0.18$), healthy snacks ($b = 10.61$ g, 95% CI[-11.33, 32.56], $t(59.0) = 0.95$, $p = .347$, $d = 0.24$), or unhealthy snacks ($b = 0.66$ g, 95% CI[-13.26, 14.57], $t(59.0) = 0.09$, $p = .927$, $d = 0.02$).

Product choice was measured in two ways: actual choice between Crave and Nutralean and a self-reported measure of their likelihood of buying each product individually. We found convergent evidence from both measures of a significant SES interaction. A Chi-square goodness-of-fit test revealed that although more participants chose Crave ($n = 34$) than chose Nutralean ($n = 27$), this difference was not statistically significant ($\chi^2(1) = 0.80$, $p = .370$). However, as predicted, low SES participants chose Crave instead of Nutralean more than high SES participants ($b = 1.05$, 95% CI[0.02, 2.14], $p = .051$; Odds Ratio = 2.86, 95% CI[1.02, 8.46]) (Fig. 6a). Whereas a majority of high SES participants chose Nutralean (56.2%), 69.0% of low SES participants chose Crave.

Similarly, there was no main effect of condition ($b = 0.13$, 95% CI [-0.25, 0.51], $t(60.0) = 0.68$, $p = .497$, $d = 0.08$) in terms of participants' likelihood of buying the product. As predicted, however, there was an interaction such that low SES participants indicated that they would be more likely to buy Crave than Nutralean ($b = 0.74$, 95% CI [0.00, 1.47], $t(59.0) = 1.96$, $p = .055$, $d = 0.50$) relative to high SES participants (Fig. 6b). No significant main or interaction effects were found on product endorsement in terms of price willing to pay (main effect: $b = 0.07$, 95% CI[-0.26, 0.40], $t(60.0) = 0.42$, $p = .674$, $d = 0.05$; SES interaction: $b = 0.06$, 95% CI[-0.60, 0.73], $t(59.0) = 0.18$, $p = .856$, $d = 0.05$) or how likely participants were to recommend the product to others (main effect: $b = 0.28$, 95% CI[-0.25, 0.81], $t(60.0) = 1.04$, $p = .304$, $d = 0.10$; SES interaction: $b = 0.52$, 95% CI[-0.53, 1.57], $t(59.0) = 0.97$, $p = .338$, $d = 0.25$).

3. Discussion

This study demonstrated that marketing nutritious products with an emphasis on appeal instead of health enhanced product expectations and increased behavioral measures of satiety after consumption. When a fruit and vegetable smoothie was labeled and advertised as Crave, participants expected it to be more tasty, indulgent, and fun than when the exact same beverage was labeled and advertised as Nutralean. Importantly, these improvements were achieved without increasing perceived price or decreasing perceived healthiness of the drink. After consuming Crave, participants indicated that they required 35 mL less additional smoothie to feel full and consumed approximately 23 fewer grams of additional snacks on average, including fewer unhealthy snacks, than

when they consumed Nutralean.

Critically, we recruited participants of low and high SES to determine if SES or educational attainment would moderate effects, with Crave resonating more with low SES groups than Nutralean based on theories of identity relevance and evidence of negative associations with healthy foods. As predicted, SES moderated the effects of product marketing on expectations, experience, behavioral satiety, and choice. Low SES participants expected Crave would be even more appealing than Nutralean compared with high SES participants. Whereas high SES participants tended to prefer the experience of Nutralean during consumption, low SES participants had much more pleasant experiences drinking Crave, including increased reported tastiness. Compared to Nutralean, consumption of Crave reduced the amount of additional smoothie required for satiation to a significantly greater extent among low SES participants than high SES participants. Ultimately, low SES participants reported greater likelihood of purchasing Crave and had 2.9-times greater odds of actually choosing Crave over Nutralean compared to high SES participants (69.0% of low SES chose Crave vs. 43.8% of high SES chose Crave).

Counter to predictions, we did not find significant differences in physiological responses. Based on previous research showing physiological changes from indulgent versus depriving portrayals of a milkshake beverage product (Crum et al., 2011), we expected Crave to increase physiological satiety after consumption compared to Nutralean (i.e., changes in biomarkers for hunger, like ghrelin, or for fullness, like GLP-1). Physiological changes were theorized to occur through product expectations, particularly with respect to the expected fullness of the product. However, unlike previous research presenting foods as either low- or high-calorie via altering nutrition information (Crum et al., 2011), this study presented identical nutrition facts panels in all conditions that was consistent with the actual product. This may help explain why there were no differences by condition in expected fullness, suggesting that participants may have judged fullness more strongly on calorie or nutritional information than on label design or advertisements. Furthermore, we expected that physiological responses would be moderated by SES such that Crave would induce greater physiological satisfaction among low SES participants, based on prior evidence showing differences in physiological responses by subjective SES (Cheon, Lim, McCrickerd, Zaihan, & Forde, 2018; Sim, Lim, Leow, & Cheon, 2018). However, whereas previous research manipulated participants' subjective SES before consumption (Cheon et al., 2018; Sim, Lim, Leow, & Cheon, 2018), we recruited participants of actual high and low SES based on education levels without enhancing the salience of participants' social status. Such differences in how SES was defined may have also contributed to the non-significant effects on hunger and satiety observed in this sample.

Taken together, our findings advance scientific understanding of how promotional strategies can influence one's expectations, experience, and choice of healthy foods, including how people of high and low SES can drastically differ in their reaction to health-focused marketing. First, this study developed a comprehensive, highly controlled within-subjects experiment examining psychological, behavioral, and physiological responses to different healthy food marketing strategies. In contrast to studies that used various forms of deception that would not be ethical to implement in real-world settings (e.g., falsifying nutritional facts, inducing feelings of low subjective SES), here we demonstrated that enhancing perceptions and preferences for a healthy product is possible by changing the attributes that are emphasized in packaging and promotional material. Moreover, most studies to date have shown the detrimental effects of emphasizing health attributes of unhealthy foods (e.g., cookies, milkshakes). Although more recent studies have leveraged the appeal of healthy foods to promote healthier options (e.g., via taste-focused labeling), these studies have been limited to university dining locations (Turnwald, Boles, & Crum, 2017; Turnwald et al., 2019). Here we used a healthy convenience product and recruited diverse community members to provide novel insights on effective promotional strategies beyond high SES (and younger) populations

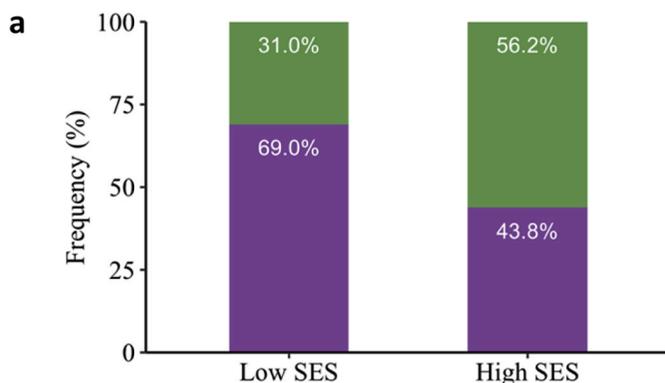


Fig. 6a. Product Choice (a) and Likelihood of buying (b) for Crave versus Nutralean between Low and High SES Participants. Note. Purple lines/bars represent ratings in appeal-focused/Crave condition, green lines/bars represent health-focused/Nutralean condition. (a) Frequency of high and low SES participants' actual choice between Crave or Nutralean.

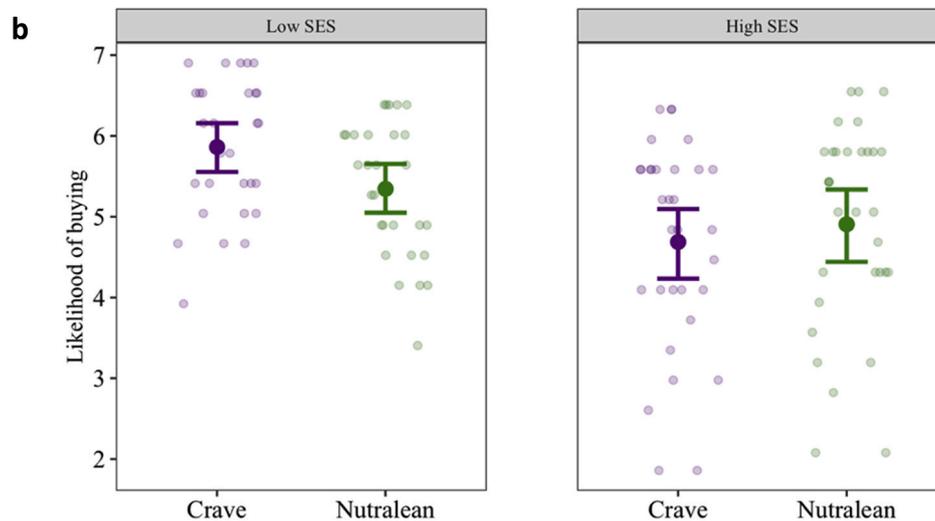


Fig. 6b. (b) High and Low SES participants' self-reported likelihood of buying Crave and of buying Nutralean. Model-predicted means and 95% confidence interval from linear mixed effects model.

typically found in university communities. Given rampant socioeconomic disparities in health, enhancing the appeal of fruit and vegetable-based products that can also be found in convenience stores is especially critical as these contexts represent where people of lower SES more readily access food. This suggests that despite intentions to make healthy options more convenient and identifiable, health-focused marketing does little to promote preference for nutritious foods or to compete with the sea of unhealthy food advertising that deliberately targets low SES groups. Presenting healthy foods as appealing thus represents an alternative but complementary approach to interventions that reduce positive associations of unhealthy foods, such as by harnessing values of autonomy and rebellion against junk food companies in adolescents (Bryan, Yeager, & Hinojosa, 2019).

Before adopting the promotional approaches in this study, healthy food companies and marketing agencies should note the following considerations regarding study sample and design that may limit the generalizability of results. First, SES was determined solely by educational attainment. Because a person's level of education, occupation, and income are all important indicators of SES, observed effects may be unique to this single dimension of SES. Thus, results should be interpreted with this definition of SES in mind. Future research is needed to compare the moderating influence of a range of socioeconomic indicators on reactions to healthy food marketing (e.g., income vs. education, objective vs. subjective SES). Our sample was also relatively small (though well-powered to detect medium effect sizes), limited to Northern California residents, and therefore may not be representative of the broader U.S. population. Second, our study design was limited in that effects of different marketing strategies were assessed with respect to a single product. Thus, future work is still needed to determine whether similar labels and commercials would yield SES differences for other types of healthy foods (e.g., grains, nuts, dairy products). Additionally, since each product was presented with both a full product label and a 1-min commercial, it remains unclear how these materials would operate in isolation or if both would be necessary to elicit changes in product evaluation.

We also cannot know from this study the effects that different promotional materials might have on eating behavior over time. Given our within-subjects design, participants were exposed to both appeal- and health-focused conditions, which precluded analysis of long-term effects of individual approaches. When deciding among approaches to scale, our results underscore the need for industry agencies to be mindful of not only the socioeconomic conditions of the populations with whom they work, but also the food perspectives and preferences that these

different cultural contexts afford. In the case that healthy food providers lack resources to support segmented marketing or advertisements, it may be helpful to know that the appeal-focused product still demonstrated significant improvements in product expectations and subsequent eating behavior. However, additional research is needed to understand long-term effects of appeal-focused marketing for a variety of healthy foods in actual retail locations and with real media advertisements. It would be particularly interesting and important to explore if and how broader media campaigns focusing more on the appeal of healthy foods could alter consumer choice at the population level.

In conclusion, we found that whereas health-focused marketing enhances product choice among high SES participants, appeal-focused marketing for the same product is more effective among low SES participants. While much remains to be explored, our results provide crucial insight into how the rapidly growing healthy food industry can effectively appeal to low SES groups—contexts which the majority of Americans navigate (two-thirds of Americans over 25 do not hold a college degree; McElrath & Martin, 2021). Increasing access is important but is likely incomplete in addressing disparities in eating behavior if nutritious foods are presented in ways that are particularly unappealing to low SES groups. As results from this study are understood, efforts to resolve SES disparities in eating behavior may also require reimagining healthy foods beyond their consequences for health, instead fostering pleasure and social connection to enhance the appeal of nutritious foods.

Ethical statement

All participants provided consent at the initial visit and could opt out of participation at any point during the study. Study protocols were approved by the Stanford University Institutional Review Board.

Our hypotheses and analytic plan were pre-registered on the Open Science Framework (<https://osf.io/k3p8u/>). Data and code used for analyses are also available on OSF.

Author contributions

D.Z.B., B.P.T., and A.J.C conceived and designed the study; M.A.P. and D.Z.B. were responsible for data acquisition; D.Z.B. analyzed the data; D.Z.B. wrote the first draft, and all authors provided critical comments on the manuscript. All authors approved the final version of the manuscript for submission.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.appet.2022.105945>.

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