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Nutrition labeling reduces valuations of food through multiple health and taste channels

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A B S T R A C T

One popularized technique to promote healthy dietary choice involves posting calorie or other nutritional information at the time individuals make a consumption decision. While the evidence on the effectiveness of such interventions is mixed, relatively little work has focused on the underlying mechanisms of how such labels alter behavior. In the research reported here, we asked 87 hungry laboratory subjects to make bids over foods with or without nutrition labels present. We found that the presence of a nutrition label reduced bids by an average of 25 cents. Furthermore, we found this reduction was driven by differences in perceptions and the importance individuals placed on health features of the foods, but also by differences in the importance individuals placed on more visceral taste features. These results help explain the various methods in which nutritional information postings or other policy tools can nudge individuals to consume healthier options.

1. Introduction

With the recent growth in obesity levels across much of the developed world, a number of public policy solutions have been suggested with the intention of aiding individuals in choosing to consume healthier meals. One such proposal has involved posting calorie information on restaurant menus as consumers make decisions over which items to order (Burton, Creyer, Kees, & Huggins, 2006; Kiszko et al., 2014). The underlying idea is that by transmitting nutritional information, which individuals may be unaware of, in an easily accessible format at the time of consumption, people will be more likely to use such information and will make more health conscious decisions (Miller & Cassady, 2015). However, the results of such interventions appear to have mixed results in practice, either by nudging decisions to healthier options with a range of effect sizes or by finding null effects (vanEpps, Roberto, Park, Economos, & Bleich, 2016; Auchincloss, Mallya, Leonberg, Glanz, & Schwarz, 2013; Bollinger, Leslie, & Sorensen, 2011; Wisdom, Downs, & Loewenstein, 2010; Elbel, Kersh, Brescoll, & Dixon, 2009, 2013; Cantor, Torres, Abrams, & Elbel, 2015; Finkelstein, Strombotne, Chan, & Krieger, 2011; Ellison, Lusk, & Davis, 2013).

Although techniques aimed at helping consumers make better decisions are important, the mechanisms through which viewing nutritional content can influence food decisions are not clear. If attending to a food's nutritional content does in fact alter its valuation, then what variables about the decision do such scenarios affect? Most of the previous literature assumes that the introduction of health information can affect valuations through reminders or information regarding its calorie content (Miller & Cassady, 2015), but the underlying mechanism in such cases remains unclear. For instance, does nutritional information increase the importance of health content in decision-making or does it lead to changes in the perception of how healthy a food is considered to be?

The current research was designed to address two open questions relevant to this literature. First, does attending to a food's nutrition label change how people value such foods? Second, what are the computational variables that are altered by the inclusion of such nutritional information?

The answers to the above questions are important for several reasons. With respect to the first question, although previous work has shown that posting nutritional content can nudge decisions towards healthier foods in certain contexts (Cioffi, Levitsky, Pacanowski, & Bertz, 2015), it has not established how the underlying valuations of such foods are altered. Studying individual food valuations provides a systematic way to investigate how these labels alter consumption utility. With respect to the second question,

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several possible mechanisms can be responsible for potential changes in valuation and exploring these in more detail allows us to improve public policy interventions to focus on the most impactful channels (Ludwig, Kling, & Mullainathan, 2011).

2. Method

Subjects. Eighty-seven students participated in the study (71% female; mean age = 21.2). We aimed to collect at least forty participants for each of the two experimental conditions, as detailed below. Participants were recruited via an online subject pool platform that informed them they were required to fast for 4 hours before the beginning of the experiment. This requirement was verified via self-report before subjects were permitted to enter the laboratory. Immediately after entering the laboratory, subjects signed an informed consent form. All subjects were paid a total of $25 for their participation over approximately 1 hour and the local institutional review board approved the experiment.

Tasks. Subjects participated in four tasks, each over a set of the same fifty snack foods displayed on a computer screen one at a time in a random order (see Table 1 for a list of high and low calorie foods). Stimuli were selected from Hare, Malmaud, and Rangel (2011). The snack foods were all previously rated as appetitive and included a mix of healthy and unhealthy snacks. Fig. 1 details the timing and design of a typical trial. The experiment was conducted using Psychophysics Toolbox (Brainard, 1997).

First, subjects performed a liking-rating task in which they rated how much they would enjoy eating each of the snacks at the end of the experiment. They entered their ratings on an integer scale with range −3 to 3 in response to the question, "How much would you enjoy that particular food at the end of today's experiment?" Similar scales to this have been used in several previous studies that use a similar set of foods (Hare, Camerer, & Rangel, 2009; Krajbich et al., 2011; Sullivan, Hutcherson, Harris, & Rangel, 2015) This task was designed to both familiarize participants with the set of foods and estimate a baseline level of hunger.

In the following three tasks, subjects were randomly sorted into two groups. The first group contained the experimental treatment where subjects saw each food with its nutrition label directly above it, which we denote as the "nutrition" condition. The second group saw each food without any nutrition information, which we denote the "no label" condition. The nutrition labels that were visible in the "nutrition" condition detailed the total calories as well as the grams of fat, saturated fat, sugar, and sodium. In addition, the guideline daily recommended amount of each nutrient was displayed to subjects at the top of each label.

In the second task, subjects made Becker-DeGroot-Marshack bids over foods to consume at the end of the experiment (Becker, DeGroot, & Marschak, 1964). Briefly, the rules of such an auction are that a subject is allowed to enter a bid, b, for a snack. At the end of the experiment, each subject randomly draws a number, x, from an envelope. If $b \geq x$ then the subject would purchase the snack and pay $\$x$; however, if $b \leq x$ then the subject gets and pays nothing. The bidding mechanism was explained in detail and various examples were given in the instructions. These instructions made clear that the mechanism was incentive compatible, meaning that each subject's optimal strategy was to enter their true valuation for the food. Bids were made from $0 to $4.50 in $0.50 increments and were entered by pressing a button. Subjects placed bids over each food twice in a random order. Furthermore, participants were informed that at the end of the experiment one bidding trial would be chosen at random and implemented. Regardless of whether or not they successfully purchased a snack, subjects would need to remain in the laboratory for an additional 20 minutes after the completion of the experiment. Those who successfully purchased a snack would be able to eat the snack in that 20 minute waiting period.

In the third and fourth tasks, subjects entered health ratings (i.e., "how healthy you believe that food to be, independent of any taste considerations") and taste ratings (i.e., "how tasty you believe that food to be, independent of any health considerations") over the individual foods. As in the liking ratings, these ratings were entered on an integer scale from −3 to 3. Critical to the design of the experiment, if the subject was placed in the nutrition condition in the bidding task, they also viewed nutrition labels for each of the snacks as they entered health and taste ratings.

Table 1
Example snacks.

Food	Calories
Low Calorie Snacks	
Celery	6
Carrots	25
Cherry Tomatoes	25
Green Grapes	34
Brussels Sprouts	38
High Calorie Snacks	
3 Musketeers Candy Bar	240
Peanut M&Ms	243
Cinnamon Toast Crunch Cereal	260
Butterfinger Candy Bar	275
Haagen-Dazs Ice Cream Bar	300

Note: Examples of the 5 lowest and highest calorie snacks depicted to subjects. Calories represent the number of calories in the quantity of food depicted in its image.

3. Results

Baseline Levels. We first investigated whether there were baseline differences in food preferences between conditions, either due to differences in hunger or differences in underlying preferences over the individual food items. To do so, we compared the average liking ratings over foods from both groups since this task always appeared first and was identical across conditions as no nutrition labels were included, although the order of the foods was randomized across subjects. We found no differences in mean liking ratings suggesting that subjects found the foods similarly appetitive between conditions ($t(85) = 0.89$, $p = 0.375$).

Bidding Behavior. We next examined how the presence of a nutrition label affected subjects' valuations of the foods. Participants in the no label condition bid $0.96 (SD = $0.54) on average while those in the nutrition condition bid $0.71 (SD = $0.55) indicating that the nutrition label significantly lowered subjects' bids ($t(85) = 2.09$, $p = 0.039$).

Furthermore, subjects in the nutrition condition took significantly longer to enter their bids (M = 2.21s, SD = 0.85s) than those in the no label condition (M = 1.88s, SD = 0.64s; $t(85) = 2.04$, $p = 0.044$), suggesting that although those who saw a nutrition label may not have taken the time to read every attribute on the label, they still spent time attending to a portion of the posted calorie information.

Our next analysis concerned whether the nutrition label differentially affected high versus low calorie foods. Here, we first split the foods into those containing either above or below the median number of calories. The above main effect of differences in bids between treatments replicated in high calorie foods (no label: M = $1.04, SD = $0.61; nutrition: M = $0.72, SD = $0.62; $t(85) = 2.47$, $p = 0.016$), but not low calorie foods (no label: M = $0.87, SD = $0.53; nutrition: M = $0.70, SD = $0.55; $t(85) = 1.43$, $p = 0.156$) although the low-calorie null result was in the same direction as the high-calorie finding. When nutritional

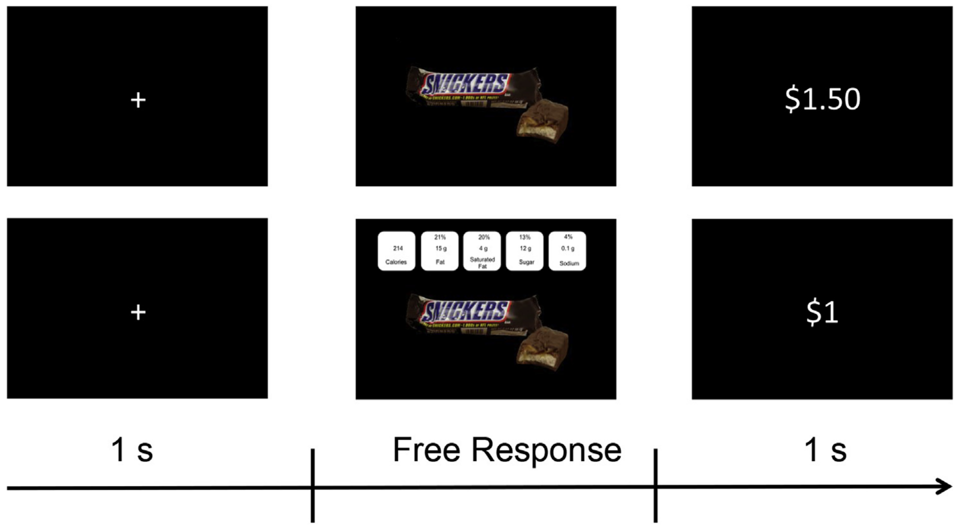

Fig. 1. Trial design. Top row depicts a typical bid trial in the no label condition and the bottom row depicts a bid trial in the nutrition condition. In both cases, subjects first saw a fixation cross for 1 s, then had as long as they liked before entering a bid, and finally saw feedback for 1 s before moving to the next trial.

information was made salient, individuals bid approximately the same for high and low calorie options ($t(42) = 0.25$; $p = 0.802$); however, when calories were unknown subjects tended to more highly value the higher calorie options ($t(43) = 3.29$, $p = 0.002$).

Attribute Perception Mechanisms. The final two sets of results examine the mechanisms through which the above valuation differences can be attributed. The health and taste attributes of each food can alter valuations of the snacks in one of two ways (Fisher & Rangel, 2014). First, the nutrition label can affect the levels of how healthy or tasty foods are perceived to be, which we call an attribute perception mechanism. For instance, it could be that regardless of the nutritional content of a food, the presence of a nutrition label results in foods being perceived as more or less healthy. Second, the label can affect the importance, or weight, that each attribute receives when estimating the value of the food. For instance, noticing a nutrition label may result in people caring more about how healthy foods are and hence, place more weight on the healthiness of a snack when deciding whether to purchase it.

We test the first mechanism by comparing the average ratings of each attribute between conditions (Fig. 2). First, we found evidence

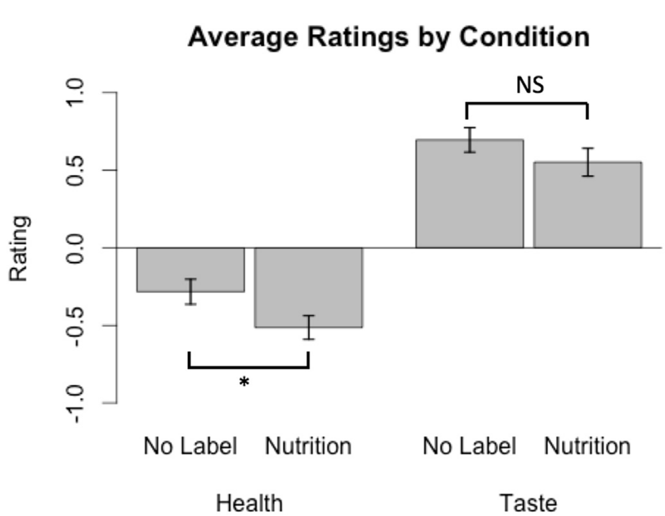

Fig. 2. Mean health and taste ratings for each treatment condition. Standard errors are clustered by subject. $^{*}p < 0.05$.

for an attribute perception mechanism in health ratings in that the nutrition condition perceived food to be less healthy on average than the no label condition (no label: $M = -0.28$, $SD = 0.54$; nutrition: $M = -0.51$, $SD = 0.50$; $t(85) = 2.07$, $p = 0.042$). This suggests that regardless of the nutritional content, being prompted with its caloric information results in a decision maker perceiving the food as less healthy on average. Intriguingly, we found little evidence that subjects paid much attention to the label itself as the response times in each condition were not statistically different (no label: $M = 2.11s$, $SD = 0.68s$; nutrition: $M = 1.90s$, $SD = 0.51s$; $t(85) = 1.60$, $p = 0.11$). However, there was no evidence for an attribute perception mechanism in the taste domain (no label: $M = 0.70$, $SD = 0.53$; nutrition: $M = 0.55$, $SD = 0.59$; $t(85) = 1.21$, $p = 0.232$).

Attribute Weighting Mechanisms. We next examined whether subjects differentially weighted health and taste attributes as they made valuation decisions over the foods. To do so, we first defined an indicator variable that took value 1 when the subject was in the nutrition condition and value 0 if in the no label condition. We then ran a linear mixed-effects regression, using the lme4 package in R (Bates, Maechler, Bolker, & Walker, 2015), where we regressed the bid on a constant, health rating, taste rating, and their interactions with the nutrition condition indicator variable. This regression had random slopes and intercepts for each subject.

The results appear in Table 2. First, the nutrition-health interaction suggests those in the nutrition condition weighed health more in their valuation decisions than those in the no label condition. Controlling for taste, a food with the same level of health in both conditions is valued at 5 cents more when its caloric information is revealed. However, since, on average, the health ratings of foods are negative, this increased weighting on health often worked to lower the valuation of foods in the nutrition condition.

Second, the nutrition-taste interaction suggests those in the nutrition condition weighed taste less compared to those in the no label condition. Specifically, after controlling for health, a food with the same level of taste in both conditions is valued at 9 cents less when its nutrition label is present. In these dual attribute weighting mechanisms, the taste channel results in a effect size of about twice that of the health channel holding the value of these attributes constant.

Finally, we found no evidence of baseline differences in bidding

Table 2
Attribute weighting mechanisms.

Constant	0.72**
	(0.07)
Health	0.01
	(0.01)
Taste	0.32**
	(0.02)
Nutrition	−0.12
	(0.10)
Nutrition x	0.05**
Health	(0.02)
Nutrition x	−0.09**
Taste	(0.03)
N	87

Note: Linear mixed-effects regression results of bid on the dependent variables listed above. Nutrition is a binary variable that takes value 1 when the subject was in the nutrition condition and value 0 when the subject was in the no label condition. Health and Taste are the subjective attribute ratings given by each participant. Standard errors appear below in parentheses.
**$p < 0.01$.

behavior independent of attributes, as the nutrition indicator was statistically indistinguishable from zero. This suggests that changes in how attributes are weighted, but not baseline differences, drive the differences in valuations across conditions.

4. Discussion

In the above experiment we examined, first, to what extent does the presence of a nutrition label alter food valuation and, second, how do such labels alter certain computational variables used the decision-making process? With respect to the first question, we found that being provided with the nutrition content of a snack significantly lowered bids for foods. With respect to the second question we found that when a nutrition label was present, foods were perceived as less healthy and individuals placed more importance on health and less importance on the tastiness of foods.

While much previous work that has presented nutrition or calorie labels to individuals has focused on analyzing how these labels affect the total number of calories ordered, the valuation elicitation here allows us to address questions concerning how underlying variables, such as healthiness and tastiness, are affected by labels. The results suggest that the presence of a label lowers a foods' valuation, which is consistent with previous work that has found other types of labels, such as "fat free," can alter valuation regardless of the attribute levels of items (Liaukonyte, Streletskaya, & Kaiser, 2015). A natural follow-up for future work concerns what additional features could be placed on a product to increase its valuation while still providing useful dietary information.

Furthermore, we found that when nutritional information was provided subjects bid approximately the same for high and low calorie foods; however, when such information was not provided subjects valued the high calorie food 15 cents more on average. In line with this, some previous findings suggest that individuals do prefer more calorically dense foods (Drewnowski, 1998) and that a familiar snack food's valuation correlates with its true caloric density when calorie information is not provided (Tang, Fellows, & Dagher, 2014). Our results complement these previous findings in the no label condition, but not when the nutrition label was provided. It is possible that the presence of nutritional information interrupts the processes that lead to a correlation between value and caloric content by cuing reminders of health, although this is best explored in future work.

The mechanism results are intriguing as although previous work suggests that the inclusion of health information may bias health computations, the results here find that the presence of health information also alters the importance individuals place on tastiness. Hence, an important self-control technique may be to deemphasize the role of taste when making dietary choices. Novel public policy interventions might aim to exploit this channel through techniques that communicate that individuals may place too much weight on taste information, or by approaching individuals in a physiological state when taste importance may have naturally fluctuated lower than a typical baseline level, such as when an individual is satiated.

Several features of the experiment are worth highlighting. First, subjects made decisions over common snack foods that did not contain as many calories as a typical meal. Although subjects had previous experience consuming many of these foods, as opposed to restaurant meals where food may differ in preparation and ingredients, the nutrition label still biased the decision-making process. A limitation of our work is the extent to which this finding generalizes to real world behavior. For instance, in this experiment the nutrition label was easily visible when subjects entered bids, taste, and health ratings; however, physical products in a grocery store often have less salient nutrition information on the back of products and these may be less commonly attended than in our experiment. Other snack foods used in our experiment, such as fresh produce, are typically sold without corresponding nutrition information.

Second, subjects made valuation decisions over foods displayed one at a time rather than choosing a single food from a menu of multiple alternatives. It is possible that the presentation of multiple foods works to bias the choice process in different ways than those observed here. Furthermore, the posting of only calorie content rather than the full nutritional label provided here could differentially alter behavior, as there is likely variance over the nutritional attributes at which an individual chooses to attend.

Finally, previous work has found that salient nutrition labels (e.g., traffic light labels) can have a larger impact on healthy eating than the standard nutrition labels utilized here (Enax, Hu, Trautner, & Weber, 2015, 2016). Future work should investigate the extent to which these more salient labels work through similar mechanisms as those identified here.

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