Truthful, Misguiding Labels: The Implications of Labeling Production Processes rather than their Outcomes

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Abstract

Using a best-worst ranking exercise we compare the inferences made by consumers regarding the nutritional value and healthiness of fluid milk and soymilk beverages under several combinations of three labeling regimes: front label, back label (including the nutritional information panel), and an index measure of nutrition value, the Ratio of Recommended to Restricted nutrients (RRR score). We find that, when only front label (process) information is available, consumers tend to overstate the relevance of certain product attributes (e.g. organic) and underestimate the effect of others (soy vs. cow milk). Indeed, product rankings significantly change when the information treatment includes the nutritional panel and/or RRR scores (outcome labels). Interestingly, nutritional panel and RRR scores are found to induce similar product rankings. A similar experiment is conducted to measure consumers' ability to assess the (relative) environmental impact of alternative milk and soymilk products. We find that rankings and judging criteria are much more heterogeneous for this task, suggesting that environmental impact information contained in existing labels is minimal or subjectively interpreted.

The main objective of food labeling is to inform consumers about product characteristics that play an important role in the purchase decision-making process, but are hard to observe and assess by consumers (Caswell et al., 2011). For example, the effect of food nutrients on human health cannot be immediately determined even after consumption. Nutritional food labels have been implemented to educate consumers about healthy eating and enable them to make healthy food choices (Higginson, 2002). In the US, there is a long history of nutrition regulation culminating with the Nutrition Labeling and Education Act (NLEA) passed by Congress in 1990 (Drichoutis et al., 2011). The NLEA went into effect in 1994 and gave the Food and Drug Administration (FDA) the authority to require specific nutritional labeling. The regulation also required a new format for the nutrition information panel and standardized serving sizes. Prior to implementation of the NLEA, food manufacturers provided nutritional information on a voluntary basis (Drichoutis et al., 2011).

However, even though nutritional labeling is assumed to allow consumers to make healthier food choices, obesity rates in USA are still rising (Berning et al., 2008, 2010). The World Health Organization (2008) reports 1.5 billion overweigh adults and at least 500 million obese adults in the world. By 2015, these figures are expected to rise to 2.3 billion overweight and 700 million obese adults (WHO, 2008). Research reveals generally low levels of use of the information on product label (Higginson, 2002). In Europe, Higginson (2002) reports that only 22-59% of British adults look particularly for nutrition information when shopping, while a study with US consumers (Roe, 1999) finds that truncated information search (looking only at front product label) decreases the level of accurate health benefit inferences made by consumers. When the back nutrition panel is also used, the amount of nutrition information is hard to compare across products and only one or two nutrition facts (generally fat or sugar) are used in decision-making (Black et al., 1992; Higginson et al., 2002).

Similar to nutrition, other credence aspects of foods such as the environmental impact of food products, present information asymmetry problems for buyers. The environmental impact of a product has been revealed to be a significant food value to consumers (Lusk et al., 2009) and studies show that demand for more environmentally friendly foods does exist (Blend et al., 1999). Yet, there is no mandated way of conveying environmental information to consumers.

This study examines how consumers read and interpret food labels to assess the nutritional and environmental outcomes associated with food consumption. In addition to assessing the nutritional and environmental information carried by front and back of package labels, we also consider the use of an index-type label summarizing nutritional information. Indices, as summarized information, are found to be easier to read and compare across products (Viswanathan et al., 2002). For example, the Ratio of Recommended to Restricted food components (RRR Score) is a scientific measure of the product's overall nutrient quality, based on the nutrients found on the back panel label

(Scheidt et al., 2004). The RRR Score is easily calculated as the ratio of food components that are beneficial for consumption (i.e., protein, dietary fiber, calcium, iron, vitamins A and C) compared with those that should be restricted (i.e., calories, sugars, cholesterol, saturated fat, and sodium) (Scheidt et al., 2004). The nutrition score takes values from 1-10, with 10 suggesting a product having the most recommended to restricted food components and 1 suggesting a product having the least recommended to restricted food components. We include the RRR index in our study to test whether it facilitates the transmission of detailed nutrition information in a concise and easy to use manner.

With these general guidelines in mind, fluid milk is chosen as the researched product. Soy milk is also included in the study as a milk substitute with varied nutrition and environmental outcomes. In terms of nutrition, milk may have a variety of effects on human health depending on its levels of fat, sugar, carbohydrates, etc. Milk production also has various potential harmful effects on the environment. These negative effects influence air quality (through production and transportation), soil quality (via appropriate grazing and waste management practices), water quality (by monitoring waste runoff), etc (Center for US Dairy, 2010; EPA, 2007). Surveying more than 500 farms and 50 processing plants across the U.S, a greenhouse gas (GHG) Life Cycle Assessment (LCA) for fluid milk found that that the carbon footprint of a gallon of milk, from farm to table, is 17.6 pounds of carbon dioxide. In conjunction with other secondary research, the study finds that U.S. dairy contributes approximately 2 percent to the total U.S. GHG emissions (Innovation Center for US Dairy, 2010).

Our study objectives are threefold. First, we assess how objective or subjective the interpretation of food labels is by measuring the cross-consumer concordance in perceptions regarding the healthiness of alternative fluid milk products under three information regimes: (1) only front label information, (2) front and back panel information, or (3) a product-specific nutrition index presented in conjunction with regular labels.

Second, we want to determine whether consumers can determine the environmental impact of a product by using product cues and test the null hypothesis that, while regulated nutritional information is consistently interpreted across consumers, interpretation of the environmental impact remains more subjective.

Third, we want to test if more concise information delivered in the form of an index (available only for nutritional value), can effectively substitute a complete list of product attributes. Previous studies suggest that alternative formats of highlighting back panel nutrition information, such as shelf edge nutrition information emphasizing health claims (e.g., reduced sodium, or fat) significantly affects consumer preferences and behavior (Berning et al., 2008, 2010). How information is presented on the label is important in conveying a clear and uniform nutrition message. These findings can generate policy implications for future environmental labeling by investigating various labeling methods to determine which of them conveys information to consumers in a more uniform fashion.

1. Background

The traditional belief in classical economic theory is that consumer choices on food products are based on consumer preferences over food attributes. A representative consumer maximizes the utility by consuming commodities having specific characteristics (McFadden, 2001). Alternatively, it has been shown that consumers may not have clear preferences over particular product attributes, but in turn consume products that are consistent with some internal values they have or some desired end-states they want to achieve through the act of consumption (Lusk et al., 2009; Gutman, 1982). Lusk et al. (2009) speculate that while consumers may not have specific preferences over Calcium or Vitamin A intake (i.e., specific product attributes), they do have internally consistent rankings of “food values” such as nutritional content, appearance or taste. Food values are a stable set of meta-preferences that drive consumers’ preferences for specific food attributes. These food values are abstract in nature (i.e., “convenience”, “tradition”, or “fairness”) and directly map into desired end-states consumers aspire towards (Lusk et al., 2009). In other words, the labeled nutrition information maps into more general values consumers have. In turn, these values translate into choices over competing products.

The connection between psychological values and consumer behavior in the marketplace has been formalized in the means-end chain literature (Gutman, 1982). This theory specifies that people engage in activities (means) that guide them towards desired states of being (ends) such as happiness, belonging, accomplishment, etc. As a result, products are not only grouped into categories, but also into the functions they have in generating desired end-states. Choosing a product with a particular set of attributes over one with a different set of attributes is linked to specific consequences of the consumption act (Gutman, 1982). Consumers choose the product-attributes combination that maximizes their desired end-state.

Nutrition or health is generally believed to be the most important end-states sought by consumers. In a series of surveys assessing consumer motives for buying organic food, “Personal health/it is better for me/my family” was listed as a motive for 53% of surveyed participants in 1999, for 49% of surveyed participants in 2002, and 66% of surveyed participants in 2004 (Soil Association surveys in Padel et al., 2005).

Nutrition is a credence attribute whose effect on human health cannot be immediately determined even after consumption. Government intervention in the form of standardized nutrition labeling is expected to alleviate the information asymmetry in the market where producers hold more information about product characteristics than consumers (Caswell, 1996). Nutrition labeling reduces moral hazard for producers to misrepresent their products. For example, tasty food (an experience attribute) is generally unhealthy since it tends to have a high content of sodium, sugar, or fat. In absence of trusted nutrition labeling, producers will manufacture tasty (yet unhealthy) food over less tasty but healthier alternatives. Government mandated labeling acts as a "warranty" preventing producers to misrepresent food products, as consumers have access to nutrition information that was previously "hidden".

Ideally, the mechanism (labeling) conveying this information to consumers is easy to read, use, and compare across products. In terms of *how* nutrition information is presented to consumers, several research contributions are worth mentioning. When a large amount of nutrition information is offered, poor performance in identifying healthier alternatives is often observed (Levy, et al., 1996), possibly because too much information may lead to "information overload" (Golan et al., 2000). Listed daily values for each nutrient are found to have positive results in helping consumers identify healthier alternatives (Levy, et al., 1996). However, Viswanathan et al. (2002) found that summary information (in the form of averages, or ranges) outperforms percent daily values in helping consumers judge the nutritional content of a brand when multiple brands are available for comparison. Alternative formats of highlighting back panel nutrition information, such as shelf edge nutrition information emphasizing some health claims (e.g., reduced sodium, or fat) significantly affects consumer preferences and behavior (Berning et al., 2008, 2010), suggesting that label format is important. Keisel et al. (2010) also find that labels that reduce search costs by summarizing the information on the nutrition panel change consumer purchase behavior. Overall, it appears that consumers do not perform well when they have to do math calculations or handle quantitative information (Eves et al., 1994; Hawkes, 2004; Levy and Fein, 1998). Therefore, formats avoiding quantitative tasks to derive information should be preferred (Drichoutis et al., 2006).

While health is indeed a top priority for consumer, other reasons underlying food choice have been lately increasing in importance for consumers. "Better for the environment/better for wildlife" was listed as a motive of buying organic food by 28% of surveyed participants in 1999 (Soil Association surveys in Padel et al., 2005). In 2002, 59% of surveyed participants list the environment as a motive for purchasing organic foods, and in 2004 this number increased to 78% of surveyed participants (Soil Association surveys in Padel et al., 2005). In five years, the percentage of people using the environment as a purchase criterion for organic foods more than doubled. Relative to other motives for buying organic foods listed in this survey (such as "taste" or "genetically-modified free"), product impact on the environment is the reason experiencing the highest rise in popularity with consumers over the years. Lusk et al (2009) also conclude that the environment (the effect of food production on the environment) is a significant value guiding consumer choice.

While nutrition is a vital contributor to human health and misinformation on this front can potentially be life-threatening, environmental impact of food production generally does not have immediate life-threatening consequences. This may be one of the reasons for its delayed certification. However, future impacts on quality of life due to environmental problems may affect human welfare in the long run. In addition, firms can misrepresent products as environmentally-friendly (by advertising “local” production, for example, as means of reducing carbon footprint). While local products may reduce food miles, they can be environmentally damaging in other aspects (through other forms of energy consumption, for example). When consumers do not have access to overall environmental impact, firms highlight positive claims while ignoring or omitting negative ones.

One way to signal environmental friendly products to consumers is through voluntary eco-labeling. Eco-labels entail an assessment of the product’s impact on the environment including production process, use, and disposal of the product (van Raveswaay et al., 1997). Since they are not directly regulated by the government, eco-labels are considered market-oriented (Loureiro et al., 2001). Voluntary use of eco-labels by producers must suggest some benefits such as increased demand, product differentiation, or obtaining a price premium. However, products that are more environmentally friendly identify as such, while products that are damaging for the environment are not identified or penalized as “bads”. In the context where only top environmental performers are labeled, consumers may purchase a particularly “bad” product for the environment believing that it is actually “average” or “good” for the environment. Eco-labeling rewards “good” performers, while it does not penalize “bad” ones.

Investigating seafood products Johnston et al. (2006) find that, at parity of taste, consumers may consider switching to less-preferred fish species that carry the eco-label. This indicates that demand for environmentally-friendly goods may increase if other characteristics, such as taste, are at par with similar, less environmentally-friendly, products. In a laboratory experiment, Cason (2002) finds evidence that certified green labeling by governments mitigates asymmetric environmental information and can elicit higher valuation from consumers. A study on eco-labeled apples also finds substantial demand for this product compared to similar, non-labeled, apples (Blend et al., 1999). At a zero price premium per pound, 72.6% of the surveyed consumers said they would buy eco-labeled apples. As the price premium increases to $0.40, the purchase probability of labeled apples decrease, but about 40% of the sample would still buy the eco-labeled good.

A study with Danish consumers finds that individuals develop personal norms (such as product packaging) when choosing environmentally friendly products, and these norms are a significant predictor of their propensity to choose environmentally friendly options in the supermarket (Thǿgersen, 1999). This suggests that when credence attributes, such as the environmental impact of a product, are hard to assess, experience or search attributes can be used as proxies for harder to assess credence attributes. For example for nutrition, food safety may be too costly to measure (e.g., the absence of pesticide residues) but management practices (e.g., organic farming) can be used as proxies for the final product characteristics (Grolleau et al., 2005). In lack of mandated environmental information, consumers can use product cues such as packaging material, location of production relative to point of sale, method of production (organic or conventional), etc., to determine which products are in their preferred environmentally-friendly product set.

The literature above outlines several concepts related to consumer behavior regarding nutrition and the environment. First, new additions to consumer choice theory suggest that individuals make purchase decisions in order to achieve desired end-states. While individual product attributes factor into this decision, consumer preferences over attributes are less meaningful than preferences over desired end-states. Second, the best means for conveying credence information are still under debate for nutrition (summaries, percent daily values, list of attributes), and are very rudimentary (product cues) for the environment. Under the current labeling regime, what is the most consistent way of transmitting nutritional credence information to consumers, and what lessons can be learned for future environmental labeling? The rest of this paper attempts to examine these questions.

2. Methodology

The first objective of this study is to evaluate the effectiveness of current nutrition labels in conveying information uniformly across consumers. To this end, we administer a best-worst scaling survey to rank 10 milk products according to their perceived nutritional impact. We use the progressive release of label information to observe how participants change their ranking when additional, perhaps more relevant, nutrition information is revealed. The resulting health rankings can be compared against the products' actual nutrition values (provided by the RRR score) to identify ranking inconsistencies across participants under each treatment. In addition, agreement regarding rankings between participants can be measured for each information treatment.

Best-worst choice experiments gained momentum in the early '90s with a publication by Finn et al. (1992). Originally proposed in 1990 by Louviere and Woodworth in a working paper, the best-worst method is rooted in Thurstone's (1927) psychological method of paired comparisons. Sometimes also called *max-diff*, the method makes consumers compare all the pairs of alternatives available in a set and choose the one which maximizes the utility difference (between the *best* and the *worst*). The underlying assumption is that consumers have an intrinsic continuum of a value or degree of interest, and this method places the alternatives in the choice set along this continuum (Finn, 1992). In our case, this continuum is the "impact on my health" of our set of products. Best-worst has several advantages over traditional measures of measurement such as Likert scales. First, it forces people to make trade-offs by choosing a best and a worst alternative. On the other hand, on a scale system, all alternatives could be viewed as "best/ important" or "worst/ least important" (Lusk, 2009). Second, people interpret ordinal scales differently. When a person chooses a 5 from a scale of 1 to 5, this can actually represent a 4 for another respondent (Lusk, 2009). However, there is no measurement bias in the best-worst scale relative to the Likert scale as there is only one best-worst pair each consumer can choose (Cohen et al., 2002). Therefore, best-worst coefficients are directly comparable between people and result in individual as well as aggregate ranking scales. Third, despite the sometimes large number of choice sets and the repetitiveness of the exercise, participants find the task easy and quick to complete (Goodman et al., 2005, Auger et al., 2004, Cohen et al., 2002). Fourth, compared to simply ranking products directly from 1-10, best-worst ranking is more accurate as it reduces the cognitive burden for participants and is able to discriminate between products that at first glance appear to be equally important.

In this study, the best-worst task follows an orthogonal design that distributes the alternatives (products) across choice sets. A balanced incomplete block design (BIBD) was created with our ten products, such that across 15 choice sets, each product appears the same number of times (6 times) and each individual set contains 4 products[1]. Some experimental designs used in the literature so far (Finn et al., 1992, Lusk et al, 2009, Goodman et al., 2005) are not uniform in the sense that the choice sets are of unequal size (for example, some have 4 alternatives, while others have 5). This can be confusing or difficult for participants to adjust to. Experimental designs such as BIBDs overcome this weakness (Lusk, 2009). BIBDs also have the advantage that each alternative (product) is shown the same number of times (in this study, 6 times) and that the pair-wise frequencies are equal (Kuhfeld, 2010). This ensures that no one product is under- or over-represented in the experiment, and consumers see each product the same number of times individually and paired with the rest of the products.

Ten actual milk products that differ in their nutritional characteristics are selected for the experiment based on several nutrition attributes. As nutrition characteristics that are important to consumers, we include: organic (yes/no), chocolate flavoring (yes/no), fat (whole milk vs. reduced fat), and soy (yes/no). Soymilk increases the variation in nutritional and environmental outcomes across products, which is a desired characteristic in our product selection process. Table 1 presents the design matrix yielding the ten milk products of various nutrition outcomes.

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[1] In SAS, the %mktbsize and %mktbibd macros were used to generate a BIBD design with 10 attributes, 4 attributes per choice set, and 6 total appearances of each product

(Insert Table 1 here)

Throughout this process, our goal is not to create a perfect experimental design, but to fit real-life products into a laboratory experiment. The main purpose of this design matrix is to ensure that the products entering the experiment cover a wide spectrum of nutritional outcomes. The RRR scores of our selected products are provided in Table 2 and a visual interpretation in Figure 1, where it evident that most of the chosen attributes cannot be used to immediately predict the RRR score: chocolate milk has scores ranging from 5.2 to 5.9; soy milk (not flavored) ranges from 9.9-10. While the RRR score does not show any nutritional improvements for "organic" products, some consumers believe organic products to be healthier (Magnusson et al., 2001 and 2003; Emma, 2005).

(Insert Table 2 and Figure 1 here)

In the literature, most conjoint and choice experiments use theoretical combinations of product attributes and attribute levels in order to distinguish the effect of each treatment individually on the choice consumers make. However, these hypothetical product choices are artificially constructed and generally do not represent real alternatives consumers encounter in everyday life. At the expense of relaxing design characteristics, this study distinguishes itself by providing respondents with real choices (products) they could encounter in a local grocery store on any given day. One advantage of this approach is that consumers are already familiar with the products in the study and the information on product label. While in real-life shopping experience consumers purchase milk according to different reasons (taste, price, craving a particular flavor); we asked our study participants to inspect the label for health outcomes, so that we can distinguish the effect of product characteristics on perceived nutrition.

The label information treatments included in the survey progress from the lowest to the highest information content: (1) Front label; (2) Front + back label; (3) Front label + RRR score; (4) Front label + back label + RRR score. In total, 148 people participated in the nutrition survey, and each participant was exposed to more than one treatment. The information delivered in each treatment is showed in Figure 2.

(Insert Figure 2 here)

In the end, 101 participants were exposed to the Front label only, 51 to the Front and Back labels, 97 to the Front, Back and RRR, and, finally, 47 to the Front and RRR. Examples of the best-worst questions with different label treatments are provided in Figures 2 and 3.

(Insert Figures 3 and 4 here)

The motivation for sequencing label treatments from the lowers to the highest information resolution is rooted in grocery store behavior. In the grocery store, consumers are presented with several options of the same product category on the store shelf. These products have the front label facing out, and generally, browsing the front label is enough for some consumers to make a purchase decision. Others prefer to pick up the product and consult the more detailed nutrition information on the back nutrition panel. When back panel information is hard to read or compare across products, summarized information such as the RRR may be easier to interpret. In the survey, the RRR Score is incorporated in the product label as a number in a black square in the right-hand side corner of the front of the milk container (see Figure 3).

The second study objective is to measure the information gap following the lack of environmental labeling. A similar best-worst ranking exercise to nutrition is performed, this time asking participants to choose the best and the worst product form several options according to their perceived environmental impact.

Research shows consumers use product cues such as product packaging to determine a product's impact on the environment (Thǿgersen, 1999). We use several popular environmental cues to identify milk products with various impacts on the environment: organic (yes/no), local (Colorado Proud label vs. none), container type (plastic vs. cardboard). Soy milk is also included in the environmental section of the survey, as soy milk production may be perceived as environmentally different from animal milk production. Scientifically, it is not clear yet which milk type (soymilk or cow milk) has a larger impact on the environment. While the production process of soymilk could be more environmentally friendly (less methane emissions), processing soybeans into milk can be more energy-intensive than processing milk (Silverman, 2010). Table 3 provides summarized information of the design matrix and the products chosen for this task.

(Insert Table 3 here)

A similar best-worst ranking exercise following a BIBD with 15 sets of 4 products each is implemented for participants to determine the environmental impact of the products. In the environmental survey, 96 consumers participated.

In the overall survey (nutrition and environment), a total of 244 people participated. In the summer of 2011 and in another recruitment session in spring 2012, survey participants were recruited amongst Colorado State University (CSU) administrative staff and general Colorado population based on a first-reply policy to our invitation e-mail. Multiple sessions of 20-25 participants each were delivered via computer in a controlled setting in a laboratory on CSU premises. A catalog with enlarged pictures of the products included in the survey was provided to each participant as an additional visual support complementing the product pictures on the computer screen. The survey completion time varied from 25-50 minutes and participants were paid a flat compensation of $25 for their time. In addition to the best-worst nutrition and environmental sections described above, socio-demographic questions identical for all versions of the survey were included. They and inquired about household composition, education, income, gender, age, and ethnicity.

Responses assessing participants' dietary habits and environmental attitudes were collected to be used in subsequent analyses as control for individual dietary preferences. The dietary questions, provided in Table 4, are a subset of the Index of Diet Quality (Leppala et al., 2010). Based on several specific dietary habit responses, a diet index is calculated to summarize each participant's diet quality and habits at the time.

(Insert Table 4 here)

The same rationale motivates questions assessing participants' environmental concern. These questions are a subset of the New Environmental Paradigm (NEP) Scale, which is considered the standard instrument in the social and behavioral sciences for measuring concern about the environment (Dunlap et al., 2000). Following Kotchen et al. (2007), five statements from the NEP scale presented in Table 5 were included in the survey as a control for respondent's environmental attitudes in subsequent analyses.

(Insert Table 5 here)

3. Sample Demographics

The study sample statistics provided in Table 6 are comparable to state of Colorado demographics provided by the US Census Bureau (US Census Quick facts, 2012). Demographics are provided separately for participants in the health and the environmental sections of the survey. In terms of racial composition the statistics show: whites (non-Hispanic) 70% in Colorado, 83% to 93% in our sample, black 4% in Colorado, 1-4% in our sample, Asian 2.8% in Colorado and 1-2% in our sample, Hispanic 11.3% in Colorado and 2-5.2% in our sample. The median household income in the state of Colorado (years 2006-2010) is $56,456. This is comparable to our sample median of $50,000-75,000.

(Insert Table 6 here)

Most households have up to two members (83-89%) or more (10-17%). This is indicative of young families with no kids (75% of the sample also has no children). However, 25% of the sample does have one or more kids. This is especially useful in the context of our survey since families with kinds usually tend to buy milk frequently and are very familiar with the product.

In terms of demographics, 71-74% of our sample is female. This is in agreement with the fact that most of our respondents are primary shoppers (80-88%), since generally it is the female in house household who also takes the lead in grocery shopping.

Regarding the socio-economic characteristics, the average education level in our sample is probably higher than the national average. Most participants have a graduate degree (39-49%). 30-37% of respondents have a college degree, while the rest have technical (9-12%), some graduate (7-10%), and high school studies (2-3%). For income, there is a wide variation with the lowest income under $20,000 and the highest one of over $150,000. Generally however, the highest percentage of respondents report a household income of about $50-74,000 (25-30%), followed by $35-49,000 (15-19%) and $75-99,000 (16-19%).

4. Empirical Methodology

The first objective of the data-analysis is to investigate consumer ranking of milk products according to their perceived environmental impact and perceived nutrition outcome under different information treatments.

To this purpose, best-worst data is analyzed using the counting method (Lusk et al, 2009). This implies that the final "rank" of a particular product, *j*, is calculated as the difference between the amount of times it has been voted "best" and the amount of times it has been voted "worst" across all study participants:

$$Rank_j = \sum_{k=1}^{15} Best_{ij} - \sum_{k=1}^{15} Worst_{ij}$$

Where *i*=individual, *j*=product, *k*= choice sets

When the resulting rankings are sorted in decreasing order, the product with the highest "score" is ranked first and interpreted as being the overall most important to consumers, the next one is the second highest in importance, and so on. This analysis will provide a complete ranking under each information treatment.

The second study objective is to test the null hypothesis that, while regulated nutritional information is consistently interpreted across consumers, interpretation of the environmental impact remains more subjective. Here, we can also investigate whether a nutrition index can substitute an entire list of nutrition attributes. In order to achieve this goal, we compare the concordance in environmental ranking to the concordance in nutrition ranking under different information treatments.

Kendall’s coefficient of concordance (W) is a measure of the agreement among *m* judges who are assessing a given set of *n* products. If product *i* is given rank $r_{i,j}$ by judge number *i*, then the total rank given to product *j* is $R_j = \sum_{i=1}^{m} R_{i,j}$.

The sum-of-squares deviation (S) from the total rank given to product *j* is defined as:

$$S = \sum_{j=1}^{n} (R_j - \bar{R})^2,$$

Where $\bar{R}$ is the mean value of all the ranks: $\bar{R} = \frac{1}{2}m(n+1)$. Kendall’s W statistic is calculated from the previous as:

$$W = \frac{12\,S}{m^2(n^2 - n)}$$

Kendall's W ranges from 0 (meaning no agreement, responses may be regarded as essentially random) to 1 (complete agreement between raters). Intermediate values of W indicate a greater or lesser degree of unanimity among respondents. In this study, the W test is calculated for each nutritional information treatment individually and separately for the environmental ranking.

The third objective of this study is to investigate how consumers assess environmental and nutrition product outcomes by using environmental product cues and nutrition attributes. To this end, a rank ordered logistic regression model is used to link nutrition and environmental outcome rankings to product characteristics. The rank ordered logistic model is an application of the conditional logit model for ranked outcomes proposed by McFadden (1974). In the economics literature, this model was developed by Beggs et al. (1981) and later by Hausman et al. (1987). In the marketing literature where it developed independently (Punj etal., 1978; Chapman et al., 1982), the term ‘‘exploded logit model’’ has been used (Drewes et al., 2006; Allison et al., 1994). However, both models are equivalent and are based on the random utility framework that also justifies the standard multinomial logit model (Luce, 1959; Allison et al., 1994).

In a typical logit model measuring utility via revealed preference, consumers are presented with *j* alternatives which must be ranked. Individual *i* associates each alternative *j* with a specific level of utility U*ij* he or she derives from it (Drewes et al., 2006).

In our study, however, we ask participants to rank products according to their perceived nutritional or environmental impact. Nutrition and environment are only some of the factors mapping into consumer utility derived from milk consumption. Other characteristics of products in set *J* affecting utility across consumers *I* are, for example, taste, value, price, texture, etc:

$$U_{ij} = (Nutrition_{ij};\ Environment_{ij};\ Taste_{ij};\ Price_{ij};\ etc.)$$

In our experiment, individual *i* associates each product *j* with a specific level of nutrition (N_{ij}) or environmental (E_{ij}) outcome, and uses this latent scale to choose the best and worst products in a choice set. We assume that nutrition and environmental outcomes, N_{ij} and E_{ij} respectively, are composed of a systematic (μ_{ij}) and a random (ε_{ij}) component (following Allison et al., 1994; Drewes et al., 2006, on the structure of utility).

$$N_{ij}, E_{ij} = \mu_{ij} + \varepsilon_{ij} \qquad (1)$$

The systematic component μ_{ij}, in turn, is generally assumed to be a linear function of the characteristics of the individual, X*i*, and of the attributes of the alternatives Z*j* (i.e., the milk products). In this case, product attributes Z*j*, such as whole or organic milk do not vary across consumers *i*, but only across products *j*:

$$\mu_{ij}\left(Z_j, X_i\right) = \beta Z_j + \delta X_j + \varepsilon_{ij} \qquad (2)$$

Parameters β and δ capture the impact on perceived nutrition and environmental outcomes of changes in product attributes or personal characteristics. Because X_j, the characteristics of individual participants do not vary across choice sets (the same individual makes a series of choices across multiple choice sets), δX_j drops out of the model. This is a feature of the conditional and rank ordered logit models. If the effect of individual characteristics on choices is a relevant result, interaction terms between these characteristics (age, income, gender, etc.) and product characteristics that vary across choice sets (whole, chocolate, soy, etc.) can be created and included in the model in order to capture this effect.

The conditional logit model where only one choice is considered allows maximum likelihood estimation of the parameters when participants make a "best choice" from a set of alternatives (Allison et al., 1994). However, in a best-worst setup, a series of choices are made and a complete ranking of alternatives (sometimes with ranking ties) can be inferred from these choices. In this case, the conditional logit model can be applied to each choice separately, creating an "exploded" logit model accounting for all choices an individual makes within a set of alternatives.

For example, within a choice set containing 4 items (A, B, C, and D), the probability for individual *i* to rank the products in this specific order can be expressed as the probability of choosing alternative A from the set A, B, C, D, multiplied by the probability of choosing alternative B from the remaining alternatives B, C, D, multiplied by the probability of choosing alternative C from the remaining alternatives C and D (Train, 2009).

$$Prob(ranking\ A, B, C, D) = \frac{e^{\mu A}}{\sum_{j=A,B,C,D} e^{\mu k}} * \frac{e^{\mu B}}{\sum_{j=B,C,D} e^{\mu k}} * \frac{e^{\mu C}}{\sum_{j=C,D} e^{\mu k}} \tag{3}$$

When ties in ranking between two alternatives occur, as is the case with the current dataset, the assumption is that the respondent has a preference ordering for the tied items, but we don't know what it (this approach is formalized in Allison et al., 1994). In our dataset, from a set of 4 products, the respondent may assign rank 1 to A, the "best" product, and rank 4 to D, the "worst" product. The remaining two products, named here 2.5B and 2.5C, are tied for rank 2.5 (the average between rank 2 and rank 3). Here, there are two possibilities: item 2.5B is preferred to item 2.5C, or item 2.5C is preferred to item 2.5B (Allison et al., 1994). Because these alternatives are mutually exclusive, Pr (2.5B or 2.5C) = Pr(2.5B) + Pr(2.5C). Following this logic, the probability for tied items accounting for the remaining item D, ranked fourth, is:

$$\left(\frac{e^{\mu 2.5B}}{e^{\mu 2.5B} + e^{\mu 2.5C} + e^{\mu D}}\right)\left(\frac{e^{\mu 2.5C}}{e^{\mu 2.5C} + e^{\mu D}}\right) + \left(\frac{e^{\mu 2.5C}}{e^{\mu 2.5B} + e^{\mu 2.5C} + e^{\mu D}}\right)\left(\frac{e^{\mu 2.5B}}{e^{\mu 2.5B} + e^{\mu D}}\right) \tag{4}$$

The final model contains the product of 15 choice sets of the form displayed in equation (3) above, with ties. To obtain a generalized expression, within a choice set of four items, let Y_{ij} be the rank given by respondent *i* to item *j*. Then let $\delta_{ijk} = 1$ if $Y_{ij} \geq Y_{ik}$, and $\delta_{ijk} = 0$ otherwise. Finally, in an abbreviated form following Allison et al. (1994), the likelihood function L_i for one individual across all choice sets (ignoring ties for simplicity) can be generalized as:

$$L_i = \prod_{j=1}^{15}\left[\frac{exp(\mu_{ij})}{\sum_{k=1}^{4} \delta_{ijk}\, exp(\mu_{ik})}\right] \tag{5}$$

For a sample of *n* respondents, the expression (5) above yields the following model which can be estimated via maximum likelihood:

$$logL_i = \sum_{i=1}^{n}\sum_{j=1}^{15}\mu_{ij} - \sum_{i=1}^{n}\sum_{j=1}^{15} log\left[\sum_{k=1}^{4}\delta_{ijk}exp(\mu_{ik})\right] \tag{6}$$

As mentioned previously, the systematic component μ_{ij} is a linear function of the characteristics of the individual, X*i*, and of the attributes of the products Z*j* (in this case, the milk products). Substituting the expression for μ_{ij} defined in (2) into expression (6) above results in the models to be estimated in this study.

Four different models of this type are estimated in this study.

Model (1) quantifies the impact of nutrition product attributes (such as whole, organic, chocolate flavored, or soy) on nutritional outcomes under different information treatments. The systematic component $\mu_{ij}(Z_j, X_i) = \beta_1 Whole_j + \beta_2 Organic_j + \beta_3 Choco_j + \beta_4 Soy_j + \varepsilon_{ij}$ is substituted in equation (7).

Model (2) quantifies the impact of environmental product attributes (such as organic, local, cardboard, or soy) on environmental outcomes. The systematic component $\mu_{ij}(Z_j, X_i) = \alpha_1 Local_j + \alpha_2 Organic_j + \alpha_3 Cardboard_j + \alpha_4 Soy_j + \varepsilon_{ij}$ is substituted in equation (6).

Model (3) quantifies the impact of nutritional information on the back panel label (such as fat content, protein content, etc) on nutritional outcomes. The systematic component $\mu_{ij}(Z_j, X_i) = \rho_1 Fat_j + \rho_2 Carbs_j + \rho_3 Protein_j + \rho_4 Iron_j + \varepsilon_{ij}$ is substituted in equation (6). The nutrition categories included in this specification are chosen while attempting to decrease the high correlations between the different attributes. For example, calories are highly correlated to cholesterol level, sodium levels, and carbohydrates. In this case, only one of these attributes (carbohydrates) was included in the model. A correlation matrix detailing these connections is provided in Table 7.

(Insert Table 7 here)

Model (4) quantifies the cumulative impact on ranking of all information available under each information treatment (nutritional information, product attributes, and the RRR score). The systematic component is specified here is an example including the maximum resolution of information (currently under the front + back panel + RRR score). The systematic component for the maximum information treatment is:
$\mu_{ij}(Z_j, X_i) = \lambda_1 Fat_j + \lambda_2 Carbohydrates_j + \lambda_3 Protein_j + \lambda_4 Iron_j + \lambda_5 Whole_j +$

$\lambda_6 Organic_j + \lambda_7 Chocolate_j + \lambda_8 Soy_j + \lambda_9 Front_j + \lambda_{10} FrontBack_j + \lambda_{11} FrontRRR_j + \lambda_{12} FrontBackRRR_j + \varepsilon_{ij}$ is substituted in equation (6).

For the rest of the information treatments, the specification above changes to include only the existing information within each individual treatment.

Within the framework defined above, product ranking is assumed to correspond to the different levels of environmental and nutrition outcomes. A product that is ranked higher (i.e., closer to rank 1 which is the "best") signals an increased nutritional or environmental outcome to the consumer. Due to the "panel" nature of the data (each participant is linked to 15 choice sets each containing four rankings), we use a robust (clustered on each participant) estimator of the variance-covariance matrix in conjunction with the ranked ordered logit models specified above.

While the individual coefficients of these models cannot be interpreted in probabilistic terms without a transformation in the form of log odds ratio or likelihood (Long et al., 2006), their sign and magnitude can be considered to be the relative impact of product attributes on nutritional or environmental outcomes. A positive coefficient is interpreted, in this case, as the increase in rank due to a marginal increase in the product attribute. However, an increase in rank implies, for example, going from 1st place to 2nd place, which is actually a decrease in perceived outcome due to the attribute. In other words, positive coefficients indicate that consumers believe the attribute to be "bad" for health or environmental outcomes and rank products containing it lower.

5. Results

(1) Results for Nutrition

Regarding nutrition outcomes, the results consist of the product rankings under different information treatments, concordance of rankings, and effect of product and nutrition attributes on the ranking structure.

Tables 8-11 illustrate how the 10 milk products were ranked according to their perceived nutritional impact under four different information treatments. The ranking for the Front label only are presented in Table 8. The first product is ranked in first place (Horizon Organic Fat Free Milk) by a sizeable agreement of 74 favorable votes more than the following product from 2nd place (Silk Organic Unsweetened Soymilk). Participants also identify the least healthy product by a high margin (119 votes). However, comparison to the true nutritional ranking offered by the RRR score reveals that most of the products (8 out of 10) are inconsistent with the RRR ranking.

(Insert Table 8 here)

When participants are exposed to the Front and Back nutritional label, the RRR score reveals that again 8 out of 10 products are inconsistent with the RRR as shown in Table 9. In Table 10, under the Front and RRR treatment only 4 out of 10 products are assigned are inconsistent with the RRR ranking, while under the Front, Back and RRR treatment (Table 11), 6 products are assigned an incorrect rank.

(Insert Tables 9, 10 and 11 here)

The least healthy product is consistently identified as "Lucerne Reduced Fat Chocolate Milk", while this product does not have the lower scientific nutritional score. "Horizon Organic Whole Milk" and "364 Whole Milk" have a lower score than their chocolate milk alternatives that are reduced fat. Products that are organic tend to be ranked higher than similar products featuring conventional farming. For example, "365 Organic Soymilk Chocolate" is ranked consistently higher than its counterpart "Silk Chocolate Soymilk", even though their RRR scores are the same.

Under all information treatment, consumers appear to rely most on the nutritional information found on product label to make decisions. Table 12 presents the most cited reasons for consumer ranking (where each participant could choose up to three reasons).

(Insert Table 12 here)

When the RRR score is available, its usage is second to other nutritional information contained on the product. Familiarity with the product and other reasons (such as medical conditions or organic farming) are less frequently used than the nutrition information and the RRR score. Product brand and attractiveness of the label are used the least in making nutrition outcome decisions.

The coefficient of concordance Kendall's W, measuring ranking agreement amongst consumers under different label information treatments, is presented in Table 13. The statistic is accompanied by a p-value associated with the null hypothesis that there is no agreement between judges (in other words, when the p-value lacks statistical significance, W=0). The W reveals that when participants are only exposed to the front label of the product, their agreement on ranking products according to their perceived healthiness is under average. On a scale of 0 to 1 with 0 expressing no agreement and 1 denoting complete agreement, participants agree with a coefficient of 0.4 when exposed to the front label only.

(Insert Table 13 here)

When the back label is also available, participants tend to make more consistent decisions (amongst each other) and the concordance score is as high as 0.6. Adding the RRR score to the front and back label maintains the concordance at 0.6. An interesting result, however, is that when the RRR score is added to the front label only, the concordance coefficient is 0.6 suggesting that the RRR score may provide equivalent to the information on the back of the label.

Examining the results from the different specifications of the rank ordered logistic model we observe the effect of product attributes and nutrition characteristics on perceived nutrition outcomes for consumers.

The effect of product attributes (whole milk, organic, chocolate, and soy milk) on consumer health ranking derived from Model (1) is presented in Table 14.

(Insert Table 14 here)

Whole milk has a positive sign consistently across treatments, meaning that an increase in fat content of milk increases the health rank of that milk. An increasing rank (for example, going from number 1 to number 2) represents a lower nutrition outcome the product brings to consumers. In this case, milk that is whole or with chocolate flavor tends to be ranked lower. On the other hand, there is consensus that milk that is organic and soy milk tend to be better for human health and are ranked relatively higher.

The effect of product attributes on perceived nutrition outcomes changes under different information treatments. When RRR information is revealed, whole milk is penalized more than under front label only or front and back panel information is available (its estimate increases from 0.798 to 1.16 and 1.27). Organic farming improves nutritional perception. However, its positive effect on perceived nutrition outcomes is diminished by almost half under the RRR score (decreases from 0.27 to 0.14). The effect of chocolate flavoring on nutrition ranking remains consistent under different information treatments. Its effect on health outcomes remains negative and is accentuated slightly under the RRR regime (from 1 to 1.18). Soymilk has a stronger positive effect on nutrition outcomes when the back label or the RRR score are revealed (increasing from 0.1 to 0.38).

The effect of the back label nutritional attributes on health ranking is summarized from Model (3) in Table 15. Increasing the amount of total fat and carbohydrates in milk makes the product less healthy in the eyes of consumers. Increasing the amount of protein and iron in milk results in higher ranking as these products are perceived to be healthier.

(Insert Table 15 here)

When participants only have access to the front label, the detailed nutritional information is not available to them. However, guided by the product attributes reported on the front label, nutritional elements such as fats, carbohydrates, protein and iron have underlying effects on their health rankings. When participants also have access to the back label, the effect of nutritional information of product ranking becomes stronger. Fats and carbohydrates have a stronger effect in ranking products lower, with coefficients increasing from 0.07 to 0.095, and 0.116 to 0.150 respectively. Iron has a stronger effect in ranking the products as healthier (from 0.23 to 0.30) when the back nutrition panel is revealed.

When the RRR score is revealed (in conjunction with the front and back or only with the front label) the effect on nutrition outcomes is similar in magnitude with the front and back label treatment.

The cumulative effect on ranking of all information available under different information treatments is revealed in Model (4) results presented in Table 16. Under the front label information treatment, the only information available to consumers are the product attributes whole, organic, chocolate, and soy. These results are identical with those from Model (1).

(Insert Table 16 here)

Under the front and back treatment, consumers are exposed to nutrition attributes in addition to the binary product attributes on the front. There is a high correlation between front binary attributes and back nutritional characteristics, documented in Table 17. For example, carbohydrates are highly correlated to chocolate, fat is correlated to whole, and soy correlates with protein. Despite these issues, when consumers are exposed to the front and back labels we see an increase in significance of the nutritional information on the back label and a decrease in importance of the binary attributes contained on the front.

(Insert Table 17 here)

When the RRR score is added to the front and back labels, there is hardly any significance probably due to collinearity.

(2) Results for the Environment

Regarding environmental outcomes, the results consist of product ranking based on product cues such as packaging (plastic/cardboard), method of farming (organic/conventional), origin of production (local/not local), and type (milk/soy milk).

Agreement among consumers is also measured, as well as if and how product cues affect ranking.

Table 18 illustrates the overall ranking of 10 milk product according to their perceived environmental impact. Unlike for nutrition, there is no environmental measure similar to the RRR score to scientifically assess the environmental impact of these products. However, consumers agree with a margin of 60 “best” votes that “Organic Valley Reduced Fat Milk (Cardboard)” has the lowest negative impact on the environment.

(Insert Table 18 here)

All the cardboard products are situated in the upper half the ranking spectrum, except for “Lucerne Reduced Fat Milk (Cardboard)” which is ranked in 9th place. Local products are located both at the top and in the mid-range of the ranking. The product with the most negative environmental impact as perceived by consumers is “Lucerne Reduced Fat Milk (Plastic)”, by a margin of 172 “worst” votes. While the most and least environmentally friendly products are identified by a high vote margin, products in ranks 3 through 7 have close voting scores.

Agreement in rankings across consumers is measured by the Kendall W concordance coefficient presented in Table 13. In this case, the W statistic is low, 0.245. Lacking clear environmental labeling and using only product cues to inform their ranking, consumers appear to be in disagreement about what the true environmental effect of milk products is.

Participants use product cues to infer the environmental impact of a product. The effect of product cues on ranking is presented in Table 19. Results show that the product is ranked higher (it is better for the environment) if it is obtained by organic farming (as opposed to conventional), it has a cardboard (as opposed to plastic) packaging, it is local (versus non-local), and it is soy milk (as opposed to cow milk).

(Insert Table 19 here)

Soy milk has the biggest effect (0.093) on perceived environmental outcomes. The second largest effect is from local (0.057), followed by cardboard (0.039) and organic (0.032).

Similar results relative to consumer attitudes towards the environment are presented in Table 20. We measured participants’ concern for the environment using a subset of the questions in the New Environmental Paradigm questionnaire (Kotchen et al., 2007).. The environmental concern score obtained this way follows a scale from 0-25, with higher numbers representing less concern for the environment. With the sample split on the median of the score (which is 15), 35 people are identified to be less concerned for the environment (with a score >15), and 61 are relatively more concerned for the environment (with a score <15). Consumers that are more concerned about the environment in general display a higher sensitivity towards product cues such as organic farming and soy. For example, while the positive effect organic has on the environmental impact of a product is only -0.239 for people who are less concerned for the environment, this effect increases to -0.367 for people who are more concerned for the environment. Similarly for soy, the effect increases from -0.87 to -0.96. Cardboard packaging and local products have a similar effect regardless of the consumers' environmental attitudes.

(Insert Table 20 here)

6. Discussion

This study finds that the amount and type of information on the product label can change consumer nutrition perceptions about the product. When the product search and comparison process is limited to the front label, there is less agreement regarding nutrition outcomes compared to situations where the back panel label and/or the RRR score are revealed. Chocolate and whole milk are generally ranked lower, and this negative effect on perceived nutrition is accentuated for whole milk under the RRR treatment. Organic and soy milks are generally ranked higher. While for soy this positive effect is enhanced under more information (back label, RRR), for organic it is reduced by half.

Generally, consumers have a low level of consensus about the environmental impact of food based on product cues. Soy milk has the biggest effect on perceived environmental outcomes. The second largest effect is from local, followed by cardboard and organic. For participants with higher concern for the environment, soy and organic have a higher positive effect on perceived environmental outcomes than for participants with less environmental concern.

A direct implication of our research is that, while nutrition labels are tightly regulated by the government with the purpose of uniform communication of nutrition information, consumers still make choices that are inconsistent with scientific nutrition indices (such as the RRR) regarding the healthiness of food products. When the information available is limited to the front label, only two products (out of 10) are ranked "correctly" when compared to the scientific RRR ranking of products. This number increases to 4-6 products correctly ranked when the RRR score is revealed.

Claims made on the front label both highlight and augment the information available in the nutrition facts panel. In some cases, however, front label claims can be misleading with respect to the overall perceived healthiness of the product. Here, claims such as organic farming play an important role in decisions about nutrition when the back panel information is not available or not consulted. The positive impact of organic on perceived nutritional outcomes is second highest (-0.271), after whole (0.798). However, the link between healthier products and organic farming is inconclusive at best. Some studies have found that organic farming does not directly contribute to a product's nutritional makeup (Woese, 1997), while others have found a possible connection between the two (Worthington, 2001). When more nutrition information is revealed, the importance of organic decreases (-0.205 when back panel is also available and -0.142 when the back panel and the RRR are also available), but it never disappears.

In the meantime, the importance of other product claims such as soy is undermined in a front label situation. The effect soy has on perceived nutritional outcomes (0.099) is the lower than whole (0.798), chocolate (1.00), or organic (0.271) attributes. While soy signals low fat, increased protein and fiber content, and an overall healthy product, stronger perceived nutrition outcomes result from organic claims that are scientifically unsubstantiated (0.27) rather than the soy claims that are factual in nature (0.09).

While tastes and preferences also play a role in food purchase decision, we specifically asked the consumers in our study to select products based only on their nutritional/health impact. Inspecting consumer reasons behind their health ranking, we notice that their most quoted reason is the nutrition information on the label. Since they were allowed to choose more than one reason underlying their choice (generally there are multiple factors affecting consumer choice), for the front label treatment familiarity with the product is quoted next, along with "other" reasons (for example: "medical conditions", "organic or not", "personal wellness goals", "sugar" and "fat" contents) as detailed in table 12.

If consumers are generally using nutrition information to motivate their choice of healthy products, it may be that either the overall labels or the process of buying are misleading in some way.

First, the overall product label can be misleading in several ways. Panel nutrition information can be difficult to comprehend and read (Black et al., 1992) or only one item on the nutrition label (usually fat or sugar) is used to guide judgments on the healthiness (Black et al., 1992; Higginson et al., 2002). Comparing different products based on an entire list of attributes is generally time-consuming. According to (Roe et al., 1999), the presence of health claims (on the front label) or positive product claims (such as organic farming) are associated with (1) a positivity bias, in which consumers provide a product better ratings merely because a health claim is present; (2) a halo effect, in which the presence of a health claim induces the consumer to rate the product higher on other attributes not mentioned in the claim; (3) a magic-bullet effect, in which consumers attribute inappropriate health benefits to the product.

Second, the process of buying may also be misleading when only part of the information available is used (for example, the front label) while other sources (such as the back panel) are ignored. Respondents in a study by Roe et al. (1999) who either truncated information search (to front label only) or viewed claims on front label were more likely to purchase the product, regardless of whether a real claim is present and are less likely to health benefits not mentioned in the claim. When exposed only to the front labels, consumer concordance is low in ranking products according to nutritional values (W coefficient is 0.4). Front label attributes correlate to underlying nutritional attributes on the back panel, but is less informative than actually inspecting the back panel or consulting the RRR score. Additional information in the form of the RRR score or the product back nutrition panel corrects the asymmetric information and results in more concordant rankings across consumers. When the RRR score is posted on the front label of the product, it yields the same results (in terms of agreement across consumers) as thoughtful inspection of the back panel information.

In order to improve the information asymmetry or truncated search behavior related to the product front label, the RRR score may be an easy-to-read add-on to the front label that yields similar results as exposure to product back nutrition panel.

Similar to nutrition, the environmental impact of a product is a credence outcome that cannot be evaluated even after consumption. Government regulation is the most effective way of correcting the information asymmetry problems related to credence attributes (Caswell, 1996), although reputations have also been known to help. In lack of government mandates on environmental labeling, product cues can be used as a proxy for environmental impact. However, consumers are unsuccessful in determining the environmental impact based on these cues. The Kendall W coefficient of agreement amongst consumers regarding these ranking is 0.245, which indicates almost no agreement about the environmental impact of these products. Our results show that out of the four cues investigates in this study (organic, cardboard, soy, local), consumers generally believe that soy milk has the biggest impact on whether a milk product is environmentally friendly or not (estimate is 0.093). However, there is no consensus in the scientific community on this matter yet (Silverman, 2010, Nicholson et al, 2011). Soy beans have more ”direct” impacts, such as deforestation, while regular milk has more long term impacts, such as acidification and eutrophication (contamination of aquatic ecosystems).

On the other hand, the smallest perceived positive impact on the environment quantified by study participants is organic farming (0.032). Research comparing LCA for organic versus conventional farming methods is more conclusive than that comparing soy to cow milk. Findings show that in terms of acidification, both methods yield the same impact on the environment (Thomassen et al., 2008; de Boer, 2003), but lower impact of organic farming is found in terms of eutrophication (due to low fertilizer and pesticide use) and energy use (Thomassen et al., 2008; de Boer, 2003). While organic farming can be better for the environment than conventional farming, consumers in this study associate it to the weakest environmental outcome. On the other hand, soy milk may not be better for the environment than cow milk, but generates the highest gain in utility for consumers. In this case, environmental product cues are found to be misleading and regulation in this area is necessary if consumers are to be correctly informed of these environmental consequences.

Informing consumers through a list of attributes (for example, by listing the product impact on air, water, soil, energy use, etc) may suffer from the same shortcomings as the nutritional list of attributes highlighted above. Here, we suggest that indices summarizing a list of attributes are just as accurate as and perhaps easier to interpret and compare than the former.

7. Conclusions

This study uses best-worst scaling in a survey with a total of 244 participants to evaluate the effectiveness of current nutrition labels and compare communication outcomes in an area that is regulated (nutrition labeling) to those in an area that is not regulated (the environmental impact of food).

The use of front label information only in making nutritional decisions leads to "incorrect" choices (8 out of 10 products are ranked incorrectly) and low agreement between consumers regarding these choices (Kendall's W is only 0.4 on a scale of 0 to 1 where 1 implies complete agreement). Increasing the information resolution by adding the back nutrition panel or the RRR nutrition score to the front label improves ranking (only 4-6 products are assigned a "wrong" rank) and agreement (W coefficient increases to 0.6).

We suggest using the RRR score on the front label to help alleviate the information asymmetry derived either from a faulty product search process (i.e., truncated searches that only use front labels) or from the nature of labels themselves (lists of attributes are hard to compare across products). Other similar approaches, such as the "traffic light" sign have been suggested as possible solutions to this information problem (Drichoutis, 2006). By "traffic light" labeling, producers place colors next to each nutrient of a product, similar to traffic lights, which will indicate low, medium and high assessments of the nutrient (Drichoutis, 2006). However, this can make it hard for some "fat" products to sell even though they might be beneficial as part of the whole diet (Hawkes, 2004). Also, this form of labeling would just indicate the lack of "bad" components rather than the presence of "good" components (Drichoutis, 2006). For example components that might increase good cholesterol are not indicated by this labeling format. The RRR, on the other hand, summarizes the information on the back label in an Index and only penalizes the “bad” components (calories, sugars, cholesterol, saturated fat, and sodium) that surpass an upper limit set by the Dietary Guidelines for Americans (Schdeit et al., 2004).

While regulated nutritional information is more consistently interpreted across consumers when the full extent of information is available (back nutrition label and/or RRR score), interpretation of the environmental impact remains more subjective. Agreement between consumers in ranking 10 milk products according to their perceived environmental impact is low (W coefficient equals 0.2). In the context where consumers make purchase decision based on environmental impact, this is an indication that more regulated labeling of environmental outcomes is needed.

Tables and Figures

Table 1. Design Matrix for Health

Nutrition and Health Focus (# Products=10)				
	Milk		Soymilk	
	Whole	Reduced Fat	Unflavored/unsweetened	Chocolate
Organic	(1)	(3) Chocolate (4)	(7)	(9)
Not Organic	(2)	(5) Chocolate (6)	(8)	(10)

Note: Products that fit design characteristics are: (1) Horizon Organic Whole Milk, (2) 365 Whole Milk, (3) Horizon Organic Fat Free Milk, (4) O Organics Organic Reduced Fat Chocolate Milk, (5) 365 Fat Free Milk, (6) Lucerne Reduced Fat Chocolate Milk, (7) Silk Organic Unsweetened Soymilk, (8) Silk Unsweetened Soymilk, (9) 365 Organic Soymilk Chocolate, (10) Silk Chocolate Soymilk

Table 2. RRR Score of identified products for nutrition

Product Ref. No.	**Alternatives**	**RRR Score**
Milk		
(5)	365 Fat Free Milk	8.0
(3)	Horizon Organic Fat Free Milk	7.7
(4)	O Organics Organic Reduced Fat Chocolate	5.9
(6)	Lucerne Reduced Fat Chocolate Milk	5.2
(1)	Horizon Organic Whole Milk	4.5
(2)	365 Whole Milk	4.5
Soymilk		
(7)	Silk Organic Unsweetened Soymilk	10.0
(8)	Silk Unsweetened Soymilk	9.9
(10)	Silk Chocolate Soymilk	5.7
(9)	365 Organic Soymilk Chocolate	5.7

Source: www.goodguide.com

Table 3. Design Matrix for Environmental Impact

Environmental Impact (# Products=10)					
	Milk Reduced Fat				Soymilk
	Cardboard		Plastic		Cardboard
Organic	CO proud (1)	Not CO proud (2)	CO proud (5)	Not CO proud (6)	(9)
Not organic	Not CO proud (3)	CO proud (4)	Not CO proud (7)	CO proud (8)	(10)

Note: Products that fit design characteristics are: (1) Organic Valley Reduced Fat Milk (Cardboard), (2) O Organics Reduced Fat Milk (Cardboard), (3) Lucerne Reduced Fat Milk (Cardboard), (4) Robinson Dairy Reduced Fat Milk (Cardboard), (5) Organic Valley Reduced Fat Milk (Plastic), (6) Horizon Organic Reduced Fat Milk (Plastic), (7) Lucerne Reduced Fat Milk (Plastic), (8) Farmer's All Natural Reduced Fat Milk (Plastic), (9) 365 Organic Soymilk (Cardboard), (10) Silk Original Soymilk (Cardboard)

Table 4. Subset of Index of Diet Quality Questionnaire

Subset of Index of Diet Quality Questionnaire
How many days per week do you eat whole-grain products (e.g., wheat bread, oatmeal)?
The milk you usually drink is: a) whole milk b) semi-skimmed with 2% fat c) milk with 1% fat d) fat free milk e) I don't drink milk
How many days per week do you consume dairy products (e.g., milk, cheese, sour cream, yoghurt, etc)?
How many days per week do you eat vegetables?
How many days per week do you eat fruits and/or berries?
How many days a week do you eat sweets (including chocolate)?

Source: Adapted from Leppala et al., 2010

Table 5. NEP statements to determine environmental attitudes

NEP scale questions subset:
1. Plants and animals have as much right as humans to exist.
2. The so-called "ecological crisis" facing humankind has been greatly exaggerated.
3. Human ingenuity will insure that we do not make the earth unlivable.
4. The earth is like a spaceship with very limited room and resources.
5. The balance of nature is strong enough to cope with the impacts of modern industrial nations.

Notes: The 6-point Likert response scale: Strongly Disagree, Mildly Disagree, Neither agree not disagree, Agree, Mildly Agree, Strongly Agree

Table 6. Sample Characteristics

Characteristic		Health % of Sample	Environment % of Sample
Gender	Male	28.38	26.04
	Female	71.62	73.96
Race	White, Non-Hispanic	92.57	83.33
	Black, Non-Hispanic	1.35	4.17
	Hispanic	2.03	5.21
	Asian	1.35	2.08
	Other	2.7	5.21
Education	Some technical, business school or college	12.16	29.17
	Completed B.S., B.A. or College work	37.84	9.38
	Some graduate work	7.43	10.42
	Graduate degree (Ph.D.,M.S.,M.D.,J.D., etc)	39.19	48.96
	High school graduate or equivalent	3.38	2.07
Household income	Less than $20,000	7.43	2.08
	$20,000 to 34,000	9.46	10.42
	$35,000 to 49,000	16.89	18.75
	$50,000 to 74,000	25.68	30.21
	$75,000-99,000	15.54	18.75
	$100,000-124,000	14.19	7.29
	$125,000- $149,000	5.41	7.29
	Over $150,000	5.4	5.21
Diet Score	Unhealthy (<=3)	70.95	NA
	Healthy (>3)	29.05	NA
Adults in HH	More than two	10.14	16.67

	Less than two, including two	89.86	83.33
Primary Shopper	Yes	79.73	88.54
	No	20.27	11.46
Kids	Yes	25.68	25
	No	74.32	75
Environmental Score (0-25)	High Concern (<=15)	NA	63.54
	Low Concern (>15)	NA	36.46

Table 7. Correlation Matrix for Nutrition Label Attributes

	Calo-ries	Calories from Fat	Total Fat	Cho-lesterol	Sodium	Carbo-hydrates	Protein	Iron
Calories	1							
Calories from Fat	0.51	1						
Total Fat	0.12	0.79	1					
Cholesterol	0.68	0.74	0.34	1				
Sodium	0.77	0.26	0.09	0.44	1			
Carbohydrates	0.91	0.12	-0.23	0.4	0.7	1		
Protein	0.35	0.14	-0.08	0.59	0.6	0.25	1	
Iron	-0.09	-0.086	0.12	-0.64	-0.14	0.01	-0.7	1

Table 8. Product ranking under Front label treatment (N=101)

Front					
Best	**Worst**	**Best-Worst**	**Rank**	**Product Name**	**RRR Score**
345	-10	335	1	Horizon Organic Fat Free Milk	7.7
289	-28	261	2	Silk Organic Unsweetened Soymilk	10
274	-39	235	3	365 Fat Free Milk	8
242	-43	199	4	Silk Unsweetened Soymilk	9.9
119	-203	-84	5	Horizon Organic Whole Milk	4.5
80	-140	-60	6	365 Organic Soymilk Chocolate	5.7
42	-184	-142	7	O Organics Organic Reduced Fat Chocolate	5.9
55	-262	-207	8	365 Whole Milk	4.5
33	-242	-209	9	Silk Chocolate Soymilk	5.7
36	-364	-328	10	Lucerne Reduced Fat Chocolate Milk	5.2

Table 9. Product ranking under Front and back label treatment (N=51)

Front Back					
Best	**Worst**	**Best-Worst**	**Rank**	**Product Name**	**RRR Score**
175	-2	173	1	Silk Organic Unsweetened Soymilk	10
157	-17	140	2	365 Fat Free Milk	8
150	-12	138	3	Horizon Organic Fat Free Milk	7.7
139	-12	127	4	Silk Unsweetened Soymilk	9.9
52	-27	25	5	365 Organic Soymilk Chocolate	5.7
33	-68	-35	6	Silk Chocolate Soymilk	5.7
21	-106	-85	7	365 Whole Milk	4.5
21	-129	-108	8	Horizon Organic Whole Milk	4.5
12	-141	-129	9	O Organics Organic Reduced Fat Chocolate	5.9
5	-246	-241	10	Lucerne Reduced Fat Chocolate Milk	5.2

Table 10. Product ranking under Front and RRR label treatment (N=47)

Front RRR					
Best	**Worst**	**Best-Worst**	**Rank**	**Product Name**	**RRR Score**
178	-4	174	1	Silk Organic Unsweetened Soymilk	10
160	-12	148	2	Silk Unsweetened Soymilk	9.9
136	-5	131	3	365 Fat Free Milk	8
128	-3	125	4	Horizon Organic Fat Free Milk	7.7
36	-54	-18	5	365 Organic Soymilk Chocolate	5.7
11	-63	-52	6	O Organics Organic Reduced Fat Chocolate	5.9
19	-92	-73	7	Silk Chocolate Soymilk	5.7
18	-143	-125	8	Horizon Organic Whole Milk	4.5
11	-165	-154	9	365 Whole Milk	4.5
8	-163	-155	10	Lucerne Reduced Fat Chocolate Milk	5.2

Table 11. Product ranking under Front, Back and RRR label treatment (N=97)

Front RRR Back					
Best	**Worst**	**Best-Worst**	**Rank**	**Product Name**	**RRR Score**
393	-10	383	1	Silk Organic Unsweetened Soymilk	10
314	-5	309	2	365 Fat Free Milk	8
308	-23	285	3	Silk Unsweetened Soymilk	9.9
229	-10	219	4	Horizon Organic Fat Free Milk	7.7
57	-89	-32	5	365 Organic Soymilk Chocolate	5.7
47	-148	-101	6	Silk Chocolate Soymilk	5.7
27	-183	-156	7	O Organics Organic Reduced Fat Chocolate	5.9
23	-287	-264	8	365 Whole Milk	4.5
44	-297	-253	9	Horizon Organic Whole Milk	4.5
13	-400	-387	10	Lucerne Reduced Fat Chocolate Milk	5.2

Table 12. Reasons for ranking (multiple choices per person)

	Reasons For Best-Worst Answers (%)					
	Familiarity with Product	Nutrition Info. On Label	Brand	RRR Score	Attractiveness of Label	Other
Front	22.16	36.60	11.86	NA	7.73	21.65
FrontBack	13.98	49.46	8.60	NA	4.30	23.66
FrontRRR	18.58	32.74	11.50	19.47	6.19	11.50
FrontBackRRR	13.18	37.73	5.45	25.00	3.64	15.00

Table 13. Agreement in ranking within information treatments

Treatment	Kendall's W	P-value	Sample Size
Front	0.4154	0.000	101
Front Back	0.6168	0.000	51
Front Back RRR	0.6155	0.000	97
Front RRR	0.6051	0.000	47
Environment	0.2452	0.000	96

Table 14. The effect of product attributes on ranking under different information treatments

Model (1)	Front	Front Back	Front Back RRR	Front RRR
Whole	0.798***	0.593***	1.159***	1.27***
	(0.085)	(0.071)	(0.080)	(0.122)
Organic	-0.271***	-0.205***	-0.142***	-0.181***
	(0.031)	(0.043)	(0.024)	(0.033)
Chocolate	1.000***	1.093***	1.181***	1.101***
	(0.053)	(0.079)	(0.043)	(0.047)
Soy	-0.099***	-0.507***	-0.381***	-0.323***
	(0.070)	(0.064)	(0.053)	(0.089)
No. people	101	51	97	47
No. Obs.	6060	3060	5820	2820

Note: ***Significant at 1%, **5%, *1*; Robust SE in parentheses

Table 15. The effect of back label nutrition attributes under different information treatments

Model (3)	Front	Front Back	Front Back RRR	Front RRR
Fat	0.07***	0.095***	0.094***	0.099***
	(0.007)	(0.009)	(0.006)	(0.009)
Carbs.	0.116***	0.150***	0.143***	0.132***
	(0.009)	(0.012)	(0.008)	(0.009)
Protein	-0.077***	-0.002	-0.048***	-0.092***
	(0.011)	(0.012)	(0.011)	(0.014)
Iron	-0.023***	-0.030***	-0.055***	-0.077***
	(0.009)	(0.010)	(0.009)	(0.014)
No. people	101	51	97	47
No. Obs.	6060	3060	5820	2820

Note: ***Significant at 1%, **5%, *1*; Robust SE in parentheses

Table 16. The cumulative effect on ranking of all information available under different information treatments

Model (4)	Front	Front Back	Front Back RRR	Front RRR
Whole	0.798***	-0.023	-2.854	1.165***
	(0.085)	(0.057)	(4.698)	(209)
Organic	-0.271***	-0.018	-0.115*	-0.178
	(0.031)	(0.056)	(0.064)	(0.033)
Choco	1.000***	-1.778***	-0.315	1.008***
	(0.053)	(0.637)	(3.039)	(0.156)
Soy	-0.099***	-0.194	2.438	-0.288***
	(0.070)	(0.875)	(3.384)	(0.098)
Fat		0.094***	0.169	
		(0.009)	(0.191)	
Carbs.		0.341***	0.011	
		(0.052)	(0.215)	
Protein		-0.028	0.157	
		(0.059)	(0.264)	
Iron		-0.098	-0.321	
		(0.126)	(0.399)	
RRR			-0.636	-0.029
			(0.684)	(0.048)
No. people	101	51	97	47
No. Obs.	6060	3060	5820	2820

Note: ***Significant at 1%, **5%, *1*; Robust SE in parentheses

Table 17. Correlation between binary product characteristics and nutritional attributes

	Whole	Organic	Chocolate	Soy	Fat	Carbs	Protein	Iron
Whole	1							
Organic	0.206	1						
Chocolate	-0.277	0.166	1					
Soy	-0.275	0.166	0.284	1				
Total Fat	0.419	-0.262	-0.175	-0.330	1			
Carbs	-0.047	0.174	0.891	-0.027	-0.229	1		
Protein	0.267	0.322	-0.117	-0.647	-0.075	0.245	1	
Iron	-0.570	-0.083	0.445	0.65	0.121	0.005	-0.707	1

Table 18. Environmental product ranking

Environment				
Best	**Worst**	**Best-Worst**	**Rank**	**Product Name**
281	-31	250	1	Organic Valley Reduced Fat Milk (Cardboard, Local)
262	-72	190	2	365 Organic Soymilk (Cardboard)
186	-119	67	3	Robinson Dairy Reduced Fat Milk (Cardboard, Local)
116	-62	54	4	O Organics Reduced Fat Milk (Cardboard)
182	-135	47	5	Silk Original Soymilk (Cardboard)
149	-126	23	6	Organic Valley Reduced Fat Milk (Plastic, Local)
130	-157	-27	7	Farmer's All Natural Reduced Fat Milk (Plastic, Local)
71	-209	-138	8	Horizon Organic Reduced Fat Milk (Plastic)
44	-191	-147	9	Lucerne Reduced Fat Milk (Cardboard)
19	-338	-319	10	Lucerne Reduced Fat Milk (Plastic)

Table 19. The effect of product cues on environmental ranking

Model (2)	Estimate
Organic	-0.0321***
	(0.044)
Cardboard	-0.039***
	(0.084)
Local (CO Proud)	-0.057***
	(0.049)
Soy	-0.093***
	(0.121)
No. people	96
No. Obs.	5760

Note: ***Significant at 1%, **5%, *1*; Robust SE in parentheses

Table 20. The effect of environmental product cues on ranking with varying degrees of environmental concern

	Environmental Concern Score (0-25)	
	Less (>15)	More (<=15)
Organic	-0.239***	-0.367***
	(0.084)	(0.049)
Cardboard	-0.375***	-0.399***
	(0.122)	(0.133)
Local (CO Proud)	-0.576***	-0.574***
	(0.069)	(0.066)
Soy	-0.870***	-0.964***
	(0.199)	(0.154)
No. people	35	61
No. Obs.	2100	3660

Note: ***Significant at 1%, **5%, *1*; Robust SE in parentheses

Figure 1. RRR Score of products for nutrition

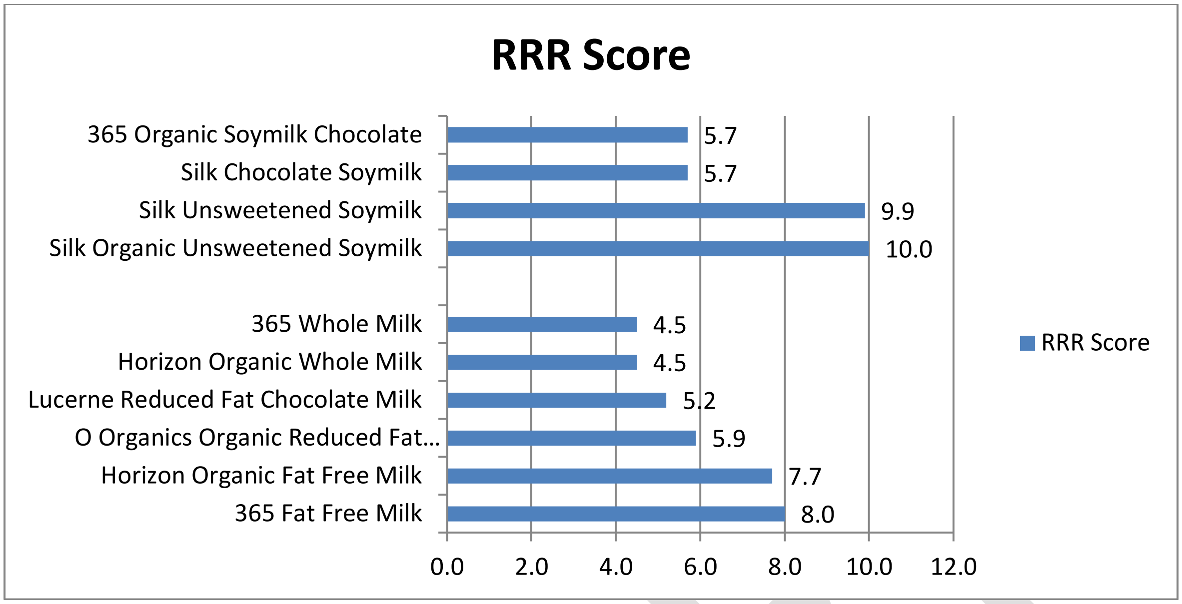


Figure 2. Label information treatments

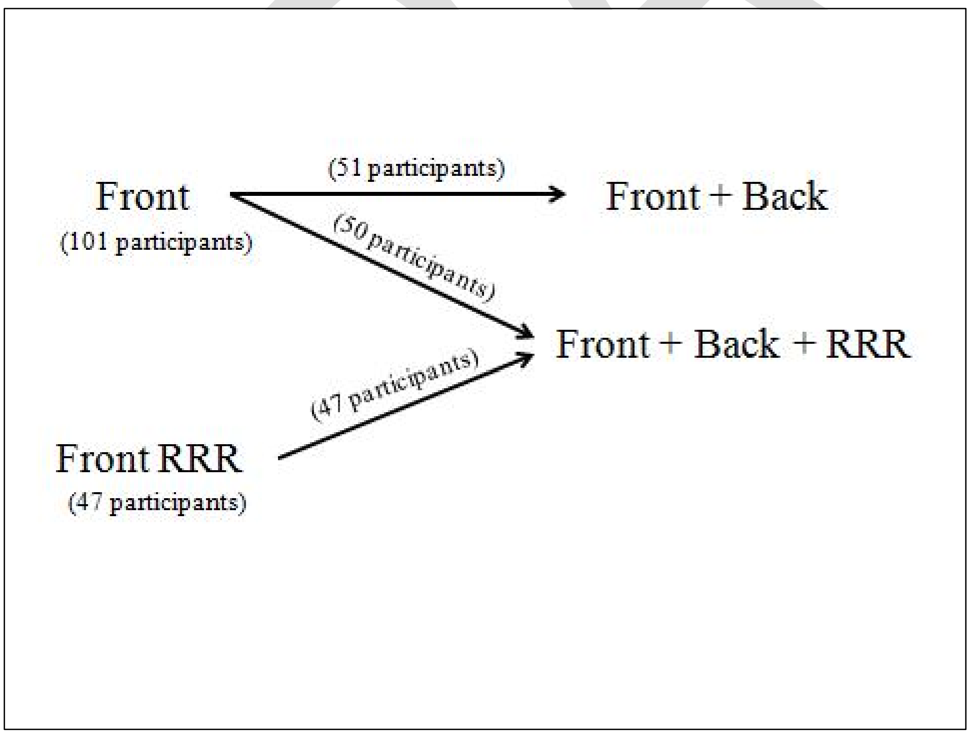


Figure 3. Best-worst question sample: Front Label treatment

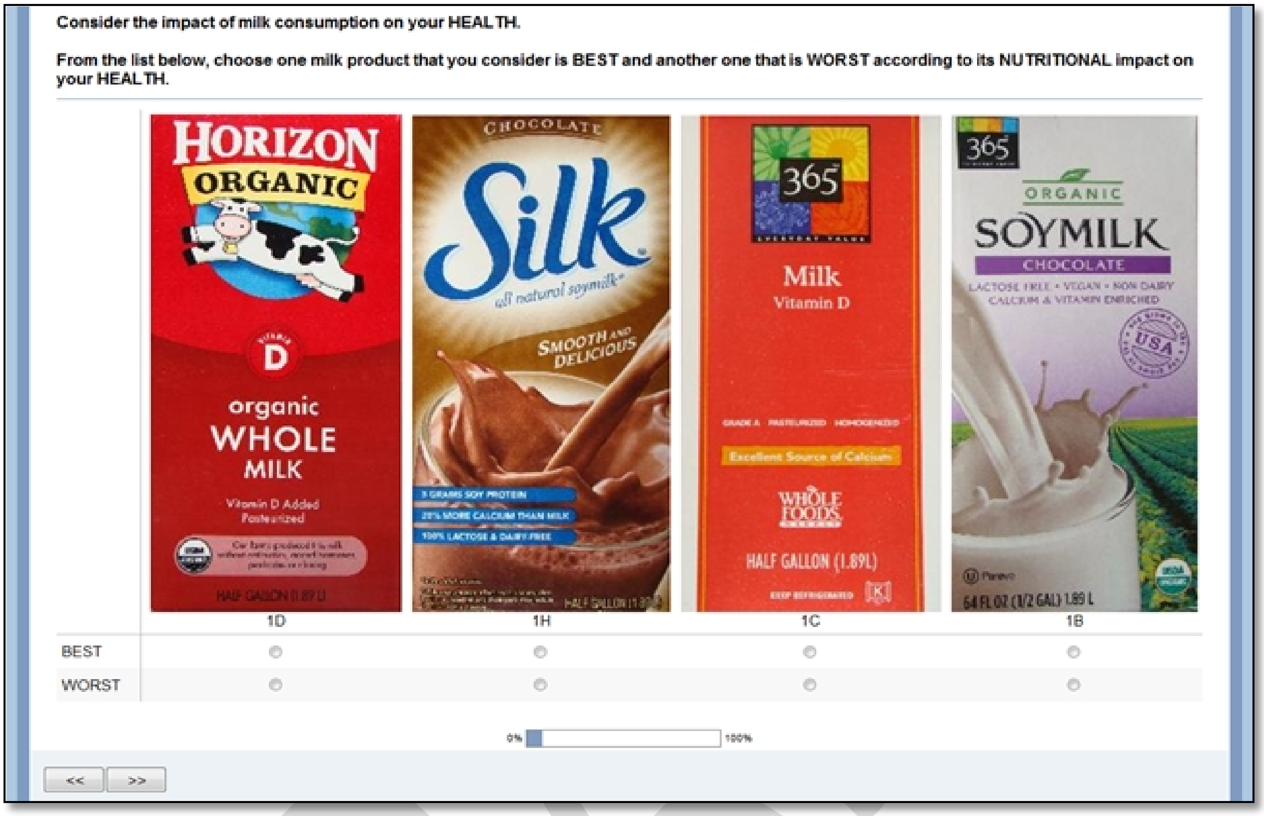
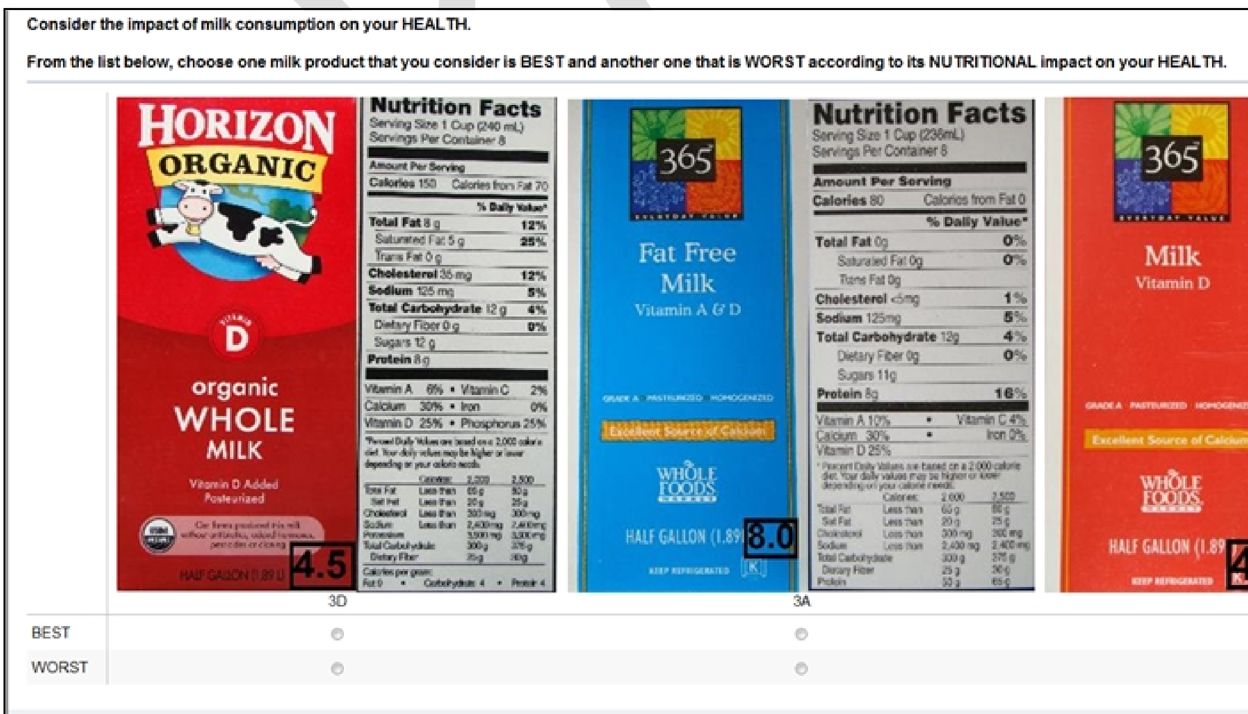


Figure 4. Best-worst question sample: Front label + RRR Score treatment



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