Modeling Expert Opinions on Food Healthiness:

A Nutrition Metric

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ABSTRACT

Background

Research over the last several decades indicates the failure of existing nutritional labels to substantially improve the healthiness of consumers' food and beverage choices. The obstacle for policy-makers is to encapsulate a wide body of scientific knowledge into a labeling scheme that is also comprehensible to the average shopper. Here, we describe our method of developing a nutrition metric to fill this void.

Methods

We asked leading nutrition experts to rate the healthiness of 205 sample foods and beverages, and after verifying the similarity of their responses, generated a model that calculates the expected average healthiness rating that experts would give to any other product based on its nutrient content.

Results

The form of the model is a linear regression that places weights on 12 nutritional components (total fat, saturated fat, cholesterol, sodium, total carbohydrate, dietary fiber, sugars, protein, vitamin A, vitamin C, calcium, and iron) to predict the average healthiness rating that experts would give to any food or beverage. We provide sample predictions for other items in our database.

Conclusions

Major benefits of the model include its basis in expert judgment, its straightforward application, the flexibility of transforming its output ratings to any linear scale, and its ease of interpretation. This metric serves the purpose of distilling expert knowledge into a form usable by consumers so that they are empowered to make healthier decisions.

Despite an increased standard of living in the U.S. and other developed countries, health problems attributable to poor nutrition persist in part due to consumers' inability to translate the dietary advice of nutrition experts into anything actionable. Citing the improvement of public health as a primary objective, numerous studies have highlighted the need for a nutritional scoring system that is both comprehensive in its coverage of food products and easily understood by consumers[1-5]. We aim to advance this objective by proposing a nutrition metric that is based on the current views of leading experts in the field and can be used to score any food or beverage for which several component nutrient quantities are known.

Regulatory efforts to improve nutritional labeling, such as the 1990 Nutrition Labeling and Education Act (NLEA), have had relatively limited impact in altering the behavior of individuals who were not already motivated to eat more healthily[6,7]. The complexity of processing nutritional information serves to limit the influence of point-of-purchase labeling[8], especially in fast-food settings[9] or when many options are available[10]. It may be especially difficult for consumers to interpret a food's contribution to overall diet[11] and to take into consideration the presence of favorable nutrients, given the tendency to focus disproportionately on avoiding negative components[6,12-13]. Furthermore, the positive impact of more transparent labeling practices may be obscured by promotional efforts of manufacturers[1,14]. Not only can food advertising result in misleading generalization by consumers[15], but it may even exacerbate negative behavior such as overeating in the case of "low fat" claims[16].

Despite the limited success described above, there are several indications that nutritional labeling might have greater potential to assist consumers in making healthy

food choices. For instance, direct comparability of nutrient information across options has been shown to induce more advantageous product selections[13,17], and nutrition labeling schemes may be more effective when they are better adapted to a target audience or when they employ simple messages that promote taste as well as healthiness[18]. Given specific behavioral recommendations, subsequent decision-making is evaluated more favorably according to both consumers' own judgments and expert standards[19]. In addition, though marketers will likely continue attempts to promote the healthiness of their products regardless of true nutritional value, unbiased nutritional information may influence consumers' beliefs independently from these claims[20,21], and consumer misperceptions may be mitigated by greater understanding of nutritional components[22].

Several recent studies have developed more detailed guidelines for accurate and effective nutritional labeling. Padberg[3] finds a large degree of consensus amongst experts regarding the relative nutrition of various foods, and calls for an Expert Rating System that appropriately weights various nutrient factors to summarize any food's nutritional value as part of a daily diet. Toward this end, Nijman et al.[2] designed a Nutrition Score to characterize foods and beverages based on their levels of four detrimental components (trans fat, saturated fat, sugar, and sodium) whose generic benchmark levels have been established by scientific evidence. However, the final Product Nutrition Score fails to take into consideration the presence of favorable nutrients that also affect an item's healthiness. Perhaps the most thorough attempt at outlining desirable features of a nutritional profiling system is provided by Scarborough, Rayner, and Stockley[5] who advocate "a systematic, transparent and logical process" to categorize foods by their nutritional composition. Scarborough, Boxer, Rayner, and Stockley[23]

evaluated each of eight existing nutrient profile models by the correlation of its ratings with healthiness categorizations of 120 foods by nutrition professionals. We agree with the implicit logic that expert assessments are in some sense the most comprehensive embodiment of current scientific knowledge on nutrition, but we go one step further than these other metrics by actually employing expert ratings to generate the model described.

METHODS

In this study, we surveyed leading U.S. nutrition experts about the healthiness of sample food and beverage products, estimated the regression equation that best predicts expert ratings from the nutrient information on a Nutrition Facts label, and finally analyzed the applicability of this model to rating the healthiness of products outside our initial sample.

Food/Beverage Sample

A large online grocer provided us with a database containing nutritional information for over 15,000 unique food and beverage stock-keeping units (SKUs). Also listed in the database were the 205 categories used by the grocer to classify items and the unit sales of each item in 2005. In order to create a sample of foods representative of the items that consumers consume most regularly but also covering a range of food/beverage types, we selected the most frequently purchased item in each of the categories to

comprise a sample of 205 foods and beverages for experts to rate. For each of these items, we collected any nutritional information that was missing from the grocer's database by searching for similar items on the USDA[24] and NutritionData[25] websites. In all cases, we were able to find very close matches in terms of product description and size.

Expert Sample

We requested participation from leading nutrition experts in rating the healthiness of these 205 sample foods/beverages. To mitigate bias in our responses, we contacted all 57 members of three groups that are widely recognized for their expertise in the study of nutrition: (1) Chairs of the top three schools of public health nutrition departments (Harvard University, John Hopkins University, and the University of North Carolina); (2) Directors of the eight U.S. Clinical Nutrition Research and Human Nutrition Centers; and (3) Directors of the 46 Coordinated Programs in Dietetics with accredited status from the American Dietetic Association. These experts – all of whom have earned doctoral degrees in related fields – were each offered $250 for their consultancy to the study, which required them to complete a one-hour online survey. The overall response rate was 23 percent (13 experts).

Data Collection

Our web-based survey asked that experts rate the healthiness of each of the 205 foods/beverages in our sample when they are consumed (or used as ingredients) in the recommended serving size. We displayed the item name provided by the online grocer in their database, a picture of the item found online, and a nutrition label that we generated

to look like a typical Nutrition Facts label shown on the package (see Figure 1 for a survey screenshot). The label listed serving size, servings per container, calories per serving, calories from fat per serving, and the amount per serving of the following 12 components: 1) Total fat (amount in grams and % daily value), 2) Saturated fat (amount in grams and % daily value), 3) Cholesterol (amount in milligrams and % daily value), 4) Sodium (amount in milligrams and % daily value), 5) Total carbohydrate (amount in grams and % daily value), 6) Dietary fiber (amount in grams and % daily value), 7) Sugars (amount in grams), 8) Protein (amount in grams), 9) Vitamin A (% daily value), 10) Vitamin C (% daily value), 11) Calcium (% daily value), and 12) Iron (% daily value).

Experts rated each of the 205 items on an 11-point scale from -5 ("very unhealthy") to 5 ("very healthy"). For each of the 13 experts surveyed, we ran an ordinary least squares (OLS) regression of the healthiness ratings they provided for the 205 sample foods/beverages on the 12 nutritional components of these items listed on a Nutrition Facts label. Note that for components typically shown in both absolute amount and percentage of daily value on a Nutrition Facts label, we included only the absolute amount since the latter is redundant. For the same reason, we excluded from our set of predictor variables "calories per serving", which is equal to 9 * fat grams + 4 * carbohydrate grams + 4 * protein grams + 7 * alcohol grams (alcohol was absent from the foods and beverages in our sample), and also excluded "calories from fat," which is equal to 9 * fat grams. It did not substantively change the predictive power of the models to replace the amounts of all nutritional components with their percentage daily values or to include the predictor variables "calories per serving" and "calories from fat", so we will not report the results of those models.

Data Analysis

We used each expert's linear model to predict what his/her ratings would be for the sample items and compared these predictions to the actual ratings given. We also used each expert's linear model to predict ratings for the remaining 9,393 items in our database for which we had access to all 12 predictor variables shown on a Nutrition Facts label. To measure similarity of the 13 experts' models for healthiness, we calculated Cronbach's alpha across both their original sample ratings and across their model predictions for other items in the database. Cronbach's alpha is a measure of inter-rater reliability, and values of Chronbach's alpha that approach 1 suggest that raters have very similar "underlying representations" of the construct they are rating (in this case, healthiness).

Next, we generated a single linear model to predict the *average* expert opinion about the healthiness of a given food/beverage, with the 12 nutritional components on each product's Nutrition Facts label as right-hand side variables, calculating robust standard errors to allow for the possibility of heteroskedasticity. As for the individual expert models, we compared this model's predicted average ratings for the 205 sample foods/beverages to the actual average ratings used as inputs. Finally, we used this model to predict average expert ratings for the other 9,393 foods/beverages in our database.

RESULTS

The 13 regression models resulting from our analyses of individual experts' survey responses indicate the implicit weighting (positive or negative) that each expert placed on various nutritional components in assessing their healthiness and account for a considerable amount of the variance in each expert's sample ratings (average R-squared of 0.48; average adjusted R-squared of 0.45). The average difference between an expert model's predicted rating for a sample food/beverage and actual rating was 1.56 on the 11-point scale (which decreased slightly to 1.51 when we cut off predictions at the upper and lower endpoints of the ratings scale, which were -5 and 5, respectively).

Indicating a high level of similarity between experts, Cronbach's alpha was 0.95 across their original sample ratings, and was 0.98 across their models' predictions for the other 9,393 items in the database. Coupled with the only moderately high R-squares of the raters' models, we can infer that the variation left unexplained by each rater's model was not caused by a large rating error but rather by the exclusion of predictors from the models that affect the healthiness of foods/beverages similarly for all experts. This suggests that the Nutrition Facts label may be missing some important variables that experts agree affect the healthiness of foods and beverages. Despite the limitations of the variables available on the Nutrition Facts label for inclusion in our model, the high levels of correlation across experts' judgments justify the generation of a single linear model to predict the *average* expert opinion about the healthiness of a given food/beverage.

To generate such a model, we first averaged the 13 expert ratings for each food/beverage. Across the 205 sample items, the average rating for experts had a mean of 0.30 and a standard deviation of 2.2 on the -5 to 5 scale. The results of our robust regression model to predict expert average ratings for a food/beverage based on the 12

nutritional predictors are shown in Table 1. To summarize, the best predictor for the average rating that experts would give to any other food/beverage based on its nutritional components (to three significant digits) is:

$$\text{Predicted rating} = 0.710 - 0.0538*fat - 0.423*satfat - 0.00398*chol - 0.00254*sod - 0.0300*carb + 0.561*fib - 0.0245*sug + 0.123*pro + 0.00562*vita + 0.0137*vitc + 0.0685*calc - 0.0186*iron$$

where the nutrient abbreviations correspond to the ordering in Table 1, and units for all components must be specified as in Table 1. See Appendix A for example calculations of predicted rating for sample foods that received relatively high (1.69) and relatively low (-1.77) average expert ratings, Brand X Meatless Breakfast Patties and Brand Y Double Chocolate Pudding, respectively.

Using the model to predict ratings for all 205 foods/beverages in our sample, we found that the output predictions had an average absolute difference of 1.06 and a correlation of 0.791 with the actual average ratings used as inputs (which improved slightly to a difference of 1.03 and correlation of 0.805 when predictions were cutoff at the endpoints). The model's R-squared of 0.626 suggests that it captures almost two-thirds of the variance in experts' average ratings of foods and beverages. We also used the model to predict the average rating that would be given by the population of experts to the other 9,393 foods/beverages in our database. Upon inspection, the predictions seemed very reasonable. The average predictions across items within each of the 205 product categories are shown in Appendix B, ordered from highest average rating to

lowest average rating. To give some sense of the usefulness of comparison within a single category, the predictions for all items listed under "All Other Salty Snacks" are shown in Appendix C, also ordered from highest average rating to lowest average rating.

DISCUSSION

Although the valence of impact that most nutrients have on the healthiness of a food may be common knowledge even to lay consumers, the clear contribution of our model is an assignment of a magnitude weighting to each nutritional component of a food/beverage. This allows for isolation of their separate impacts without compromising the ability to summarize their combined impact in a single metric. Indeed, the model outlined in Table 1 demonstrates that some nutritional components have significant positive effects on a food's healthiness while others have significant negative effects, implying that previous models focusing solely on either positive or negative nutrients have omitted critical information that experts take into account when assessing a food's healthiness. While we have necessarily made some tradeoffs between the explanatory power of our model and its simplicity, we argue that our model encompasses the most important inputs to the professional judgments of nutrition experts.

Indeed, we believe our metric for rating a food or beverage's healthiness meets many of the desired criteria that are described in the literature, yet widely lacking from prior research. First, our approach did not require experts to explicitly assign valuations

to different nutrients, which would be prone to imprecision if experts are not accustomed to making direct numerical tradeoffs between nutrients. Instead, expert ratings for a broad sample of foods and beverages captured their implicit judgments about the healthiness of different nutrients. Second, the decision to generate a model of a food's healthiness based on average expert ratings was validated by a high level of agreement across individual expert models, and the resulting predictions for average expert rating can be used to compare nutritional values of foods and beverages either across or within product categories. Lastly, the quantification of our model's predictions along a single linear spectrum allows for ease of interpretation, and the output ratings can be transformed to any continuous distribution or categorization that is deemed optimal for effectively conveying information to consumers in a particular context.

We foresee several possible applications for our model. Similar to the work of Scarborough, Boxer, Rayner, and Stockley[23], the predicted ratings of our model (or the actual sample ratings for that matter) could be correlated with ratings produced by other, competing metrics to determine whether these other measures actually incorporate the knowledge of experts into their proposed nutrient weightings. More importantly, we hope that our model will be used to generate healthiness ratings that are displayed on or near food and beverage labels, allowing consumers to make more informed choices about which products to purchase and consume. To this end, we plan to conduct controlled experiments to test the extent to which the output of our model helps consumers to make decisions that are more closely aligned with the recommendations of nutrition experts.

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TABLES AND FIGURES

Table 1 – Regression results for average expert rating of 205 sample foods/beverages

	Coefficient
(Intercept)	0.710 *** (0.207)
Total fat (g)	-0.0538 (0.0414)
Saturated fat (g)	-0.423 *** (0.0944)
Cholesterol (mg)	-0.00398 (0.00330)
Sodium (mg)	-0.00254 *** (0.000445)
Total carbohydrate (g)	-0.0300 ** (0.0110)
Fiber (g)	0.561 *** (0.109)
Sugar (g)	-0.0245 (0.0190)
Protein (g)	0.123 *** (0.0222)
Vitamin A (%DV)	0.00562 * (0.00234)
Vitamin C (%DV)	0.0137 *** (0.00399)
Calcium (%DV)	0.0685 *** (0.0137)
Iron (%DV)	-0.0186 (0.0186)

Significance codes: *** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$

Figure 1 – Survey screenshot

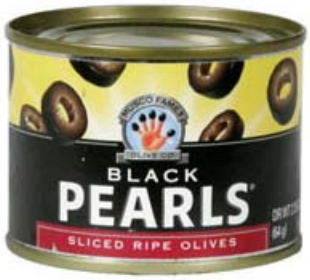
Food/Beverage 1 of 205

Black Pearls Ripe Olives Sliced

Nutrition Facts

Serving size 2 TBSP
Servings per container 4

Amount per serving	
Calories 25	Calories from fat 25
	% Daily Value
Total Fat 2.5g	4%
Saturated Fat 0g	0%
Cholesterol 0mg	0%
Sodium 125mg	5%
Total Carbohydrate 1g	0%
Dietary Fiber 0g	0%
Sugars 0g	
Protein 0g	
Vitamin A 0%	Vitamin C 0%
Calcium 0%	Iron 0%



How would you rate this food/beverage on a scale from -5="very unhealthy" to 5="very healthy"?

-5	-4	-3	-2	-1	0	1	2	3	4	5
○	○	○	○	○	○	○	○	○	○	○

Submit

APPENDIX A

Example calculations for sample foods that received relatively high (1.69) and relatively low (-1.77) average expert ratings, Brand X Meatless Breakfast Patties and Brand Y Double Chocolate Pudding, respectively:

Predicted rating for one Brand X Meatless Breakfast Patty

$$= 0.710 - 0.0538*3 - 0.423*0.5 - 0.00398*0 - 0.00254*270 - 0.0300*3 + 0.561*2 - 0.0245*1 + 0.123*10 + 0.00562*0 + 0.0137*0 + 0.0685*0 - 0.0186*10$$

$$= 1.70$$

Predicted rating for one 4oz. serving of Brand Y Double Chocolate Pudding

$$= 0.710 - 0.0538*7 - 0.423*4.5 - 0.00398*40 - 0.00254*170 - 0.0300*27 + 0.561*1 - 0.0245*22 + 0.123*4 + 0.00562*1 + 0.0137*3 + 0.0685*10 - 0.0186*3$$

$$= -1.78$$

APPENDIX B

The average model predictions across items within each of the 205 product categories, ordered from highest average rating to lowest average rating.

Category Name	Average Predicted Rating
DRIED BEANS (GENERIC)	7.87
NATURAL SUPPLEMENTS	7.86
CITRUS (FRESH)	3.68
INSTANT BREAKFAST	3.67
NUTRITIONAL FOODS/BEVRGE	3.37
SKIM MILK	3.35
DIET AIDS	3.34
SPINACH (FRESH)	3.26
ORGANIC FRUITS (FRESH)	3.26
BERRIES (FRESH)	3.17
SOY MILK	3.11
BAKED BEANS (GENERIC)	2.91
ORGANIC VEGETABLES(FRESH)	2.69
ALL OTHR FRESH VEGETABLES	2.67
MEAT SUBSTITUTE (FROZEN)	2.37
POTATOES/ONIONS (FRESH)	2.32
ALL OTHER RFG BEVRGE	2.12
PEARS (FRESH)	2.07
MILK SUBSTITUTES	2.07
CUCUMBERS/PICKLES (FRESH)	2.06
PKGED SALAD MIX (FRESH)	1.83
ALL OTHER VEGETABLES (GENERIC)	1.79
STONE FRUITS (FRESH)	1.79
LETTUCE (FRESH)	1.77
BAGELS	1.70
HOT CEREAL/OATMEAL	1.67
JUICE (RFG)	1.66
FLOURS/CORNMEAL	1.63
BANANAS (FRESH)	1.61
ORGANIC MILK	1.58
ALL OTHER FRESH FRUIT	1.57
CHILI (GENERIC)	1.56
LAMB/VEAL (FRESH)	1.54
TUNA (GENERIC)	1.50
FISH (FRESH)	1.49
ROLLS/BUNS (FRESH)	1.43
BREAD LOAVES	1.41
PASTA (GENERIC)	1.39

RTE CEREAL	1.39
TOMATOES (FRESH)	1.39
SOY/RICE DRINKS (GENERIC)	1.35
CONDNSD/EVAP/PWDRD MILK	1.27
ALL OTHER BAKERY (COMM.)	1.27
ALL OTHER FRESH MEAT	1.27
BAGELS (FRESH)	1.19
STANDARD MILK	1.16
RICOTTA CHEESE	1.13
APPLESAUCE (GENERIC)	1.11
ALL OTHER MILK	1.09
BAKING NUTS	1.08
BREAD (FRESH)	1.06
TOMATO PRODUCTS (GENERIC)	1.04
BUNS/ROLLS	0.84
SNACK NUTS/SEEDS	0.83
LAMB/VEAL (FROZEN)	0.80
SALAD TOPPINGS	0.77
HERBS (FRESH)	0.76
COTTAGE CHEESE	0.74
ALL OTHER FRUIT (GENERIC)	0.73
WATER - CARBONATED	0.72
WATER - NON-CARBONATED	0.72
WHOLE COFFEE BEANS	0.71
COOKING SPRAYS	0.71
APPLES (FRESH)	0.70
TURKEY (FRESH)	0.70
STRING CHEESE	0.66
SUGAR SUBSTITUTES	0.66
VINEGARS	0.62
DRIED FRUIT	0.60
DIET SODA	0.60
HOT/INSTANT TEA	0.59
PIE/PASTRY FILLINGS	0.58
BRKFST BARS/GRANOLA SNCKS	0.57
SHELLFISH (FROZEN)	0.57
TURKEY (FROZEN)	0.56
MUSTARD	0.54
POPCORN (UNPOPPED)	0.52
DRINKS (RFG)	0.51
ALL OTHER DRIED BREAD	0.51
COFFEE CREAMER (FROZEN)	0.49
RICE/CORN CAKES	0.46
SALSA	0.45
COOKING WINES	0.45
TORTILLA CHIPS	0.44
JUICE (FROZEN)	0.42
SEAFOOD ALL OTHER (GENERIC)	0.39
SALTINE CRACKERS	0.38
HOT CHOCOLATE MIX	0.37

ICE CREAM CONES	0.33
PANCAKE/WAFFLE MIX	0.33
GUM & MINTS	0.33
GELATIN SNACKS (RFG)	0.32
INSTANT POTATOES	0.30
GELATIN MIXES	0.29
PEANUT BUTTER	0.28
SLICED CHEESE	0.27
ALL OTHER PACKAGED DELI	0.27
SHREDDED/GRATED CHEESE	0.27
SUGAR	0.26
OLIVE/PICKLE/PEPPERS (GENERIC)	0.23
POPCORN (POPPED)	0.23
DELI MEATS (BULK)	0.22
BAGELS (FROZEN)	0.18
STUFFING/BRDCRMBS/CROUTNS	0.18
PUDDING MIXES	0.13
CHICKEN (FRESH)	0.11
KETCHUP	0.10
BREAD MIXES	0.10
JAM/JELLIES/SPREADS	0.08
SNACK/SPECIALTY CRACKERS	0.02
COFFEE CREAMER (RFG)	0.00
INSTANT COFFEE	-0.01
SNACK MIXES	-0.02
PRETZELS	-0.03
RTD TEA	-0.04
ALL OTHER SALTY SNACKS	-0.07
ALL OTHER CONDIMENTS	-0.07
DIPS (GENERIC)/DIP MIX	-0.11
CORN CHIPS/SNACKS	-0.13
ALL OTHER CRACKERS	-0.13
GRAHAM CRACKERS	-0.14
CONDENSED SOUP	-0.17
ALL OTHER FROZEN MEAT	-0.19
HONEY	-0.19
RICE/COUSCOUS	-0.21
MARSHMALLOWS	-0.21
COFFEE DRINKS (RTD)	-0.21
RTE SOUP	-0.27
DELI CHEESE (BULK)	-0.27
PASTA MIXES	-0.28
GROUND COFFEE	-0.28
DOUGH (FROZEN)	-0.29
MAYO/SANDWICH SPREADS	-0.31
CHUNK CHEESE	-0.32
ISOTONIC DRINKS	-0.34
ALL OTHER CHEESE	-0.34
CHICKEN (FROZEN)	-0.38
POTATO CHIPS	-0.38

COFFEE CREAMER (GENERIC)	-0.39
HALF & HALF/CREAM	-0.39
ALL OTHER FROZEN BREAD	-0.41
MARGARINE/SPREADS	-0.43
GELATIN SNACKS (GENERIC)	-0.43
DELI PREPACK	-0.44
BBQ SAUCE/STEAK SAUCE	-0.49
FISH (FROZEN)	-0.52
ALL OTHER FRZN SEAFOOD	-0.53
BROWNIES (FRESH)	-0.54
PUDDING SNACKS (RFG)	-0.59
BROWNIE/COOKIE/MUFFIN MIX	-0.60
DRINKS (FROZEN)	-0.62
MUFFINS (FRESH)	-0.62
FRZN WAFFLE/PANCAKE/TOAST	-0.64
RICE/COUSCOUS MIXES	-0.66
ALL OTHR PREPD FOODS (GENERIC)	-0.67
PUDDING SNACKS (GENERIC)	-0.72
ALL OTHER FRESH SEAFOOD	-0.74
HAM/PORK (FRESH)	-0.76
ALL OTHER COOKING OILS	-0.77
SOUP MIXES	-0.84
CANDY NON-CHOCOLATE	-0.84
DELI PREPARED SIDE DISHES	-0.85
OLIVE OIL	-0.89
DELI SALADS (BULK)	-0.90
DONUTS (FRESH)	-0.91
MAC & CHEESE MIXES	-0.97
CHEESE SNACKS	-1.00
REGULAR SODA	-1.02
ICE CREAM TOPPINGS	-1.02
BROTH/BOULLION	-1.04
SALAD DRESSINGS	-1.04
ALL OTHR DRY DINNER MIXES	-1.11
HAM/PORK (FROZEN)	-1.15
COOKIES (FRESH)	-1.18
SHORTENING/LARD	-1.20
TOASTER/TART PASTRIES	-1.28
FROZEN NOVELTIES	-1.33
BEEF (FRESH)	-1.34
ALL OTHER ICE CREAM	-1.36
CANNED PASTA (GENERIC)	-1.38
ALL OTHER FROZEN BEVRGE	-1.41
CREAM CHEESE	-1.42
ALL OTHER BAKING MIXES	-1.43
BREAKFAST SYRUP	-1.44
BAKING CHOC/MORSL/COCONUT	-1.47
DELI PREPARED ENTREES	-1.48
FROSTING	-1.63
SAUSAGE (FROZEN)	-1.67

ALL OTHER FRESH DELI	-1.70
DELI PREPARED DESSERTS	-1.78
MEAT (GENERIC)	-1.87
ICE CREAM/SORBET/FZN YGRT	-1.97
CAKE MIXES	-2.02
SWEET GOODS	-2.05
BACON/BREAKFAST SAUSAGE	-2.09
BEEF (FROZEN)	-2.26
CAKES (FRESH)	-2.29
CANDY CHOCOLATE	-2.40
ALL OTHER FRZN BREAKFAST	-2.46
BUTTER	-2.56
SAUSAGE (FRESH)	-2.70
HOT DOGS/SAUSAGE/BRATS	-2.84
PIES (FRESH)	-2.86
ALL OTHER FRESH BAKERY	-3.53
PRE-MADE LUNCH PACKS	-3.65

APPENDIX C

The model predictions for all items listed under the category “All Other Salty Snacks”, ordered from highest average rating to lowest average rating.

Food in the “All Other Salty Snacks” Category	Predicted Rating
Guiltless Gourmet Guiltless Carbs Chips Three Pepper	2.97
Guiltless Gourmet Guiltless Carbs Chips Southwestern Ranch	2.84
Guiltless Gourmet Guiltless Carbs Chips Salsa Verde	2.84
Snyder's of Hanover EatSmart Soy Teins Parmesan, Garlic & Olive Oil	2.29
Snyder's of Hanover EatSmart Soy Teins Tomato, Romano & Olive Oil	2.24
Glenny's Soy Crisps Barbeque Low Fat	1.96
Glenny's Soy Crispy Wispys White Cheddar	1.65
Glenny's Soy Crisps Light Low Fat Salted	1.51
Calbee Snack Salad Snapea Crisps Original	1.25
Calbee Snack Salad Snapea Crisps Caesar	1.16
Terra Vegetable Chips Exotic	1.13
Cedar's Hommus Pita Scoopers Plain	0.73
Cedar's Hommus Pita Scoopers Garlic	0.58
Frito-Lay Sun Chips French Onion	0.42
Frito-Lay Sun Chips Original	0.39
Snyder's of Hanover EatSmart Veggie Crisps Sundried Tomato & Pesto Natural	0.37
Frito-Lay Sun Chips French Onion	0.35
Frito Lay Sun Chips Cheddar Flavor	0.28
Frito-Lay Sun Chips Harvest Cheddar	0.27
Frito-Lay Sun Chips Original	0.23
Oberto Beef Jerky	0.23
Roberts American Gourmet Pirates Booty Puffed Rice Corn Snack Caramel	0.08
Snyder's of Hanover EatSmart Veggie Crisps 100% Natural	0.05
Oberto Beef Jerky Teriyaki	0.05
Oberto Beef Jerky Barbecue	-0.03
Utz Lunch Box Snack Packs Regular 12 Count	-0.31
Utz Mega Variety Snack Pack 1 oz ea - 42 ct	-0.31
Snyder's of Hanover EatSmart Veggie Crisps Jalapeno & Cheddar 100% Natural	-0.31
Funyuns 12-Sack	-0.32
Wild Oats Natural Rice Snacks Oriental	-0.36
Wild Oats Natural Sesame Sticks	-0.50
Frito-Lay Munchies Snack Mix	-0.52
Osem Bamba Snacks Peanut	-0.72
Nature's Promise Vegetable Chips All Natural	-0.84
Slim Jim Beef Jerky - 4 ct	-0.89
Nature's Promise Vegetable Sticks All Natural	-0.93
French's Potato Sticks Original	-0.98
Osem Bissli Snacks Barbecue	-0.99

Osem Bissli Snacks Taco	-1.00
Osem Bissli Snacks Smokey	-1.27
Osem Bissli Snacks Pizza	-1.28
French's Potato Sticks Original	-1.59
Slim Jim Smoked Snacks Spicy - 15 ct	-2.55
Slim Jim Smoked Snacks Mild - 15 ct	-2.55
Jays O-KE-DOKE Corn Puffs	-2.61
Slim Jim Smoked Snacks Spicy - 5 ct	-4.09
Slim Jim Smoked Snacks Mild - 5 ct	-4.09