An Indirect Approach to the Measurement of Nutrient-Specific Perceptions of Food Healthiness

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Abstract

Background Enhancing our understanding of food-related perceptions is critical to assist those with eating- and weight-related problems.

Purpose This study investigated normative and person-specific aspects of perceived food healthiness in terms of nutritional characteristics and the relevance of nutritional knowledge to perceived healthiness.

Methods Two hundred sixty-three undergraduate women judged the healthiness of 104 foods and completed nutrient knowledge tasks. Multilevel modeling estimated average and person-specific reliance on and knowledge about nutrients.

Results Participants relied substantially on fat and fiber, moderately on sugar, and minimally on protein. Disordered eating symptoms moderately predicted greater reliance on fat. Nutritional knowledge was highest for sugar and lowest for fiber. Nutritional knowledge and utilization were unrelated.

Conclusions Public health campaigns should educate college-aged women further on the health consequences of sugar and protein consumption. Explicit knowledge of nutrients may not be prioritized when judging food healthiness.

Keywords Healthiness • Nutrition • Individual differences • Disordered eating • Measurement

Individuals continuously face a number of potential influences on their dietary decisions, including food palatability, craving, availability, and affordability. Several studies suggest that the perceived healthiness of foods also has an impact on the food selection [1–5] and the food-consumption process [6, 7]. Moreover, the perceived healthiness of foods arguably is an increasingly important influence, given that many well-established approaches to addressing disordered eating (DE) and obesity explicitly encourage increased consumption of healthy food, alongside reduced consumption of unhealthy foods [8, 9]. Regardless of the specific intervention approaches used (e.g., modification of decision-making or cognitive behavioral weight-loss techniques), the provision of information about food healthiness is a central component [9]. Thus, obtaining a better understanding of what individuals perceive to be healthy or unhealthy has the potential to foster more informed and effective intervention strategies. To date, however, little attention has been given to investigating the perceived healthiness of foods [10].

“Food healthiness” has been quantified in different ways. First, it is possible to quantify the healthiness of specific foods using nutrient profiling to score foods based on their nutritional content [11]. The litany of formulas and algorithms that have been developed illustrate a variety of approaches, such as utilizing either beneficial or detrimental ingredients or a combination of both [12]. A second approach to quantifying food healthiness is to ask consumers to self-report the nutritional characteristics of foods that play a role in their food selection and consumption. Hoefkens, Verbeke, and Van Camp [13] refer to qualifying ingredients as those that provide some health benefits (e.g., fiber and protein) and to disqualifying ingredients as those that do not provide health benefits (e.g., fat and sugar). In European countries, consumers reported that the perceived healthiness of qualifying ingredients was significantly more important to their food selection, relative to the perceived unhealthiness of disqualifying ingredients [13]. It has been demonstrated that fat content is one of the most important characteristics of a food when judging its healthiness [14, 15]. Consumers across studies generally have reported that a healthy diet necessitates minimization of fat, sugar, and salt [10]. Notably, asking consumers to report what constitutes “healthy foods” assumes that consumers are aware

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of and can provide valid self-reports of the nutritional characteristics that influence their food selection. Inaccurate self-reports of the influence of specific nutrients on food healthiness perceptions, however, might result from inadequate knowledge of the nutritional content of foods, a lack of awareness of the relevance of various nutrients to food healthiness, or a combination of both.

A third approach to assessing perceptions of healthiness—and the approach we adopt in the current study—asks consumers to judge the healthiness of specific foods with known nutritional properties. Participants use a labeled magnitude scale with appropriately spaced descriptors to make ratio-scale healthiness judgments [16]. Subsequently, the extent to which each consumer relies on various nutrients when judging healthiness is quantified using multilevel modeling methods. In contrast to the previous direct strategy, the current approach provides an indirect assessment of consumer reliance on nutritional characteristics when judging food healthiness. Reliance on ratio-scale methods also provides a significant psychometric improvement over the ordinal-scale judgments typically obtained from Likert scales.

The aim of this study is to investigate normative and person-specific aspects of the perceived healthiness of foods in terms of their nutritional characteristics (i.e., fat, fiber, sugar, and protein) within a sample of college-aged women. Participants judge the perceived healthiness of 104 foods with known nutritional properties. Multilevel regression methods are used to estimate (a) participants’ average reliance on fat, fiber, sugar, and protein when judging healthiness; and (b) participant-specific predictors of the utilization of these nutrients when judging healthiness. We also provide a preliminary evaluation of the relevance of nutritional knowledge of fat, fiber, sugar, and protein to participants’ judgments of food healthiness.

The nutritional content of foods plays an undeniable role in quantifying food healthiness. Though it will be important to assess the influence of a multitude of nutrients, including vitamins and minerals, on healthiness judgments, the current study focuses on the roles of fat, fiber, sugar, and protein in perceptions of food healthiness. Extensive research documents the negative physical consequences of excessive consumption of fat or sugar [17, 18] and the health benefits associated with adequate consumption of fiber or protein [19, 20]. Given findings such as these, public health initiatives have been aimed at the reduction of fat and sugar intake and the increased consumption of fiber and protein [21–24]. Thus, we investigate the relevance of these four nutrients to participants’ healthiness judgments in the present study. This is not to deny the importance of other nutrients, such as sodium [25] and carbohydrates [26]. Rather, the focus on fat, fiber, sugar, and protein simply serves as a starting place from which to extend what is known about the perceived healthiness of foods.

Consideration of two well-established decision-making models leads to opposing sets of predictions about the extent to which persons will rely on fat, fiber, sugar, and protein when judging healthiness. Attribute framing theory [27] posits that individuals will make different decisions about logically equivalent choice situations depending on whether the choice is framed positively or negatively. The classic example from this literature is the “Asian disease problem,” in which participants must decide whether to save 200 out of 600 people or to kill 400 out of 600 people. Given the positive framing of the former, participants tend to choose the “saving option,” despite the equivalent consequences. From this perspective then, we would hypothesize that consumers would base healthiness judgments on qualifying (or positive) nutrients rather than on disqualifying (or negative) nutrients, consistent with the findings of Hoefkens et al. [13]. In contrast, prospect theory [28], a theoretical model rooted in behavioral economics, describes decision-making within risky situations from an opposing perspective. The theory suggests that consumers prioritize avoiding “losses” rather than approaching “gains.” Therefore, from this theoretical vantage, we would hypothesize that individuals would focus to a greater degree on the disqualifying nutrients associated with potential health “losses,” such as fat and sugar, than on the qualifying nutrients associated with potential health “gains,” such as fiber and protein.

Adopting a multilevel modeling approach allows us to explore perceptions of food healthiness at both normative and person-specific levels. At the normative level, these analyses essentially examine main effects of the four nutritional characteristics on healthiness judgments. Nutritional characteristics may exert not only main effects but also interactive influences on healthiness judgments, however. We are particularly interested in exploring the possibility that participants might rely less on disqualifying nutrients when judging the healthiness of foods with higher levels of qualifying nutrients, consistent with a positive framing of the food from the perspective of attribute framing theory. Thus, we include the six bivariate interactions between the four nutrients in our normative analyses.

At the person-specific level, we explore potential individual differences correlates of the extent to which people rely on various nutritional characteristics when judging food healthiness. The literature bearing on this question is limited. Thus, we examine on an exploratory basis whether either body mass index (BMI) or DE is related to differential reliance on fat, fiber, sugar, and protein. We also evaluate whether individual differences in nutrient reliance are related to individual differences in nutrient knowledge, consistent with the theoretical expectation that explicit knowledge of these nutrients is critical to their usage when judging healthiness [29].
**Method**

**Participants**

Participants for this study were 263 women with a mean age of 19.57 years (SD=1.85). The racial/ethnic breakdown of the sample was 80.2 % White/Caucasian, 14.8 % Asian American, 2.7 % Hispanic/Latino, 1.9 % Black/African American, and 0.4 % Other. BMI ranged from 15.55–47.38, with 3.58 % of the sample meeting criteria for underweight, 54.53 % of the sample meeting criteria for normal weight, 18.97 % of the sample meeting criteria for overweight, and 22.92 % of the sample meeting criteria for obesity. Six individuals were excluded from the current analysis because of missing BMI data, resulting in a final sample of 257. Participants either received partial course credit or were paid $15 for their participation.

**Stimulus Set**

**Food Stimulus Set** One hundred and four photos of moderate amounts of foods that varied along the dimensions of fat, fiber, total sugar, and protein were presented to participants. All food stimuli were 11.68 cm by 11.68 cm on the computer screen. Participants’ eyes were approximately 26.5 cm away from the screen, and the degree of visual angle was 24.86°. See Fig. 1a for sample stimuli (e.g., summer sausage and cheese, grilled pork chop, cinnamon roll, gummy worms, banana, baked tilapia, fried cheese sticks, steamed vegetables, loaded baked potato, apple slices, etc.). For each food, nutritional characteristics were obtained from either the nutritional label or the manufacturer. Pearson correlations of fat and fiber, sugar and fiber, and protein and fiber revealed no or small associations (rs=0.042, −0.123, −0.154, respectively), while the Pearson correlations of fat and sugar (r=−0.261), protein and fat (r=0.341), and protein and sugar (r=−0.439) revealed medium-to-large magnitude associations.

**Healthiness Rating Task**

Participants used a labeled magnitude scale to rate the healthiness of each food stimulus on a scale anchored by “the most healthy food imaginable” (100) and “the most unhealthy food imaginable” (−100). Intermediate anchors were spaced appropriately to obtain ratio-scale judgments. Unlike Likert-scale measures, this measure allows for valid comparisons of participants’ healthiness judgments; asking participants to rate each food relative to their own examples of the healthiest and unhealthiest foods eliminates potential individual differences confounds in anchor interpretations [16]. The food stimuli were presented in a new random order for each participant. See Fig. 1b for a screen shot of a judgment trial.

**Measures**

**Eating Disorder Examination-Questionnaire** The Eating Disorder Examination-Questionnaire (EDE-Q) [30–32] is a 39-item questionnaire, from which a global DE score is calculated from the average of four subscales: Restraint, Eating Concern, Weight Concern, and Shape Concern. Participants endorsed answers on a 0 to 6 Likert-type scale, with higher global scores indicating greater pathology. 6.3 % of the sample scored a 4 or higher on this measure, which is the recommended cutoff for clinically significant DE symptoms [30].

**Nutritional Knowledge Questionnaire** This measure asks participants to rank order seven different sets of seven foods each from least to greatest, in terms of amount of fat, fiber, sugar, or protein. The correlation of participant rankings with the correct rankings produces a knowledge index for each nutrient.

**Personal Information Questionnaire** This self-report measure assesses demographic data including age, education, race/ethnicity, and current height and weight. Height and weight were used to generate each participant’s BMI.
Procedure

After obtaining informed consent, participants completed the Healthiness Rating Task, the Nutritional Knowledge Questionnaire, the EDE-Q, and the Personal Information Questionnaire.

Results

Hierarchical linear modeling [33] with robust standard errors was used to analyze women’s perceptions of food healthiness. A two-level regression analysis was conducted, consisting of participants’ ratings of the healthiness of 104 foods at level one, which were nested within 257 participants at level two. Use of this analytic approach allowed us to evaluate simultaneously but separately the normative influences of food-specific characteristics on participants’ ratings of food healthiness (at level one) and the influences of individual-specific characteristics on each participant’s utilization of the food-specific characteristics when judging healthiness (at level two).

The level-one equation specified ten linear predictors of each participant’s food healthiness ratings: four main effects of fat, fiber, sugar, and protein, and six bivariate interactions between those four predictors. All nutritional data were centered. Therefore, the intercept for the level-one equation ($\beta_0$) reflected a participant’s healthiness rating for a food with average fat, fiber, sugar, and protein content. The first four partial slopes in the level-one equation ($\beta_1, \beta_2, \beta_3, \text{ and } \beta_4$) corresponded to each participant’s utilization of the four nutrients when judging healthiness. For example, a value of $-4.2$ for $\beta_1$ indicates that a one-gram increase in the food’s fat content was associated with a 4.2-unit decrease in a participant’s food healthiness rating. The remaining partial slopes ($\beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \text{ and } \beta_{10}$) indicated utilization of the bivariate combinations of the four nutrients. The six bivariate interactions were included to contextualize the main effects of these nutrients within commonly occurring nutrient combinations. This allowed us to examine the possibility that in the presence of other qualifying nutrients, respondents may no longer be considering the health consequences of excessive fat or sugar content.

Chi-square tests revealed significant variation across participants in the intercept and the four main effect parameters at level one, $\chi^2 (250)=1,794.34, 802.32, 434.47, 484.47, \text{ and } 432.57$, respectively, all $p<0.001$. Thus, the intercept and four main effect parameters were treated as random in the level-two equations below, and participant-specific predictors of these random effects were examined. Significant variability did not emerge in the six bivariate interaction parameters. The bivariate interaction parameters, therefore, were treated as fixed in the level-two equations, and predictors of their variation were not examined.

The level-two equations examined the participant-specific predictors of variability in the five random level-one parameters (i.e., the intercept and four main effects). Three participant-specific predictors were evaluated: BMI (centered), EDE-Q (centered), and the interaction between BMI and EDE-Q. The regression coefficient for the EDE-Q effect on fat ($\gamma_{12}$), for example, indicated the model-predicted change in fat utilization associated with a one-unit increase in DE, controlling for other participant characteristics. The intercept term in each level-two equation indicated the model-predicted values of the relevant level-one parameter, assuming mean values for all level-two predictors. For example, $\gamma_{10}$ indexed average utilization of fat for a participant with average BMI and EDE-Q scores.

Table 1 presents the results of the modeling, organized by the five main effect level-one parameters (i.e., the intercept and the four main-effect utilization coefficients) and the six bivariate interaction parameters. Effect sizes were computed using recommend procedures [34]. The average healthiness rating, $\gamma_{00}=4.745$, indicating that the average participant judged the healthiness of the average food to be 4.745 units above zero, the midpoint of the healthiness scale.

Examination of the intercepts for the five main-effect utilization coefficient parameters suggests significant normative effects of nutritional content on the average participant’s judgments of food healthiness. The average utilization of fat, $\gamma_{10}=-1.364 (d=-6.315)$, indicating that participants’ healthiness ratings significantly decreased by 1.364 for each one-gram increase in the food’s fat content. The magnitude of this effect indicated that participants relied substantially on fat content when judging healthiness, such that high-fat foods were judged to be far less healthy than low-fat foods.

Participants relied to a similar, but positive, degree on fiber when judging healthiness ($\gamma_{20}=4.780, d=5.529$), making markedly higher healthiness ratings for high-fiber foods, relative to low-fiber foods. Negative reliance on the sugar content of foods was reliable but far less robust than fat and fiber influences on healthiness judgments ($\gamma_{30}=-0.183, d=-1.401$). Participants also relied on protein to a significant and negative, but more negligible, degree ($\gamma_{40}=-0.108, d=-0.443$).

All six bivariate interactions between nutrients were reliable. Although the main effect of sugar was large ($d=-1.401$), further investigation of the bivariate interactions revealed that there are critical conditions under which sugar is not being utilized as heavily. First, a large interaction emerged between sugar and protein ($d=2.179, p<0.001$). The utilization of sugar was large and negative when protein was low (e.g., candy vs. raspberries) but smaller and positive when protein was high (e.g., barbequed meat vs. fish), which suggested that individuals did not recognize the relevance of sugar to food
healthiness to the same degree when protein was high. Second, a large cross-over interaction emerged between fiber and sugar ($d=5.257$, $p<0.001$). When fiber was low, participants relied positively on sugar (e.g., candy vs. white bread), but participants relied minimally on sugar when fiber was high (e.g., fruits vs. vegetables). Greater reliance on protein and fiber in the presence of high sugar exemplifies the down-weighting of the disqualifying nutrient of sugar in the presence of the qualifying nutrient of either protein or fiber.

A similar pattern emerged across the bivariate interactions that included fat. First, a large cross-over interaction between fat and protein ($d=3.737$, $p<0.001$) indicated that participants relied substantially more on fat content when judging healthiness if the food was low in protein (e.g., cake vs. sugared cereals), rather than high in protein (e.g., fried fish vs. grilled chicken). Second, a similarly strong two-way interaction emerged between fat and fiber ($d=3.19$, $p<0.001$), such that fat was utilized more when fiber was low (e.g., pepperoni vs. apple sauce), rather than high (e.g., potato wedges vs. broccoli). Overall, these four bivariate interactions indicated that sugar and fat utilization increased when either protein or fiber was low and decreased when either protein or fiber was high.

### Table 1 Multilevel modeling results for healthiness rating task

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Standard error</th>
<th>$t$ value</th>
<th>df</th>
<th>$p$ value</th>
<th>$d$ value</th>
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<td>−1.638</td>
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<td>0.103</td>
<td>−0.208</td>
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<td>EDE-Q, $\gamma_{02}$</td>
<td>−0.891</td>
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<td>−2.233</td>
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<td>−0.284</td>
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<td>0.951</td>
<td>0.008</td>
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<td>−6.315</td>
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<td>0.757</td>
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<td>−30.059</td>
<td>25451</td>
<td>&lt;0.001</td>
<td>−3.825</td>
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In Table 1, parameters $\beta$ represent the effect sizes, and $\gamma$ represents the intercepts. The $d$ value indicates the magnitude of the effect, while the $p$ value indicates the statistical significance. The $t$ value and degrees of freedom (df) are used to calculate the $p$ value. The Table includes estimates for various interactions, such as FatxFib, FatxSug, FatxPro, SuxxPro, and SuxxFib, which reflect the complex interactions between the nutrients in assessing healthiness.

The $d$ value for the FatxFib interaction ($d=3.19$, $p<0.001$) indicates a strong interaction between fat and fiber, suggesting that participants utilized fat more when fiber was low (e.g., pepperoni vs. apple sauce), rather than high (e.g., potato wedges vs. broccoli).

The $d$ value for the FatxPro interaction ($d=3.737$, $p<0.001$) indicates a strong interaction between fat and protein, suggesting that participants relied heavily on fat content when the food was low in protein (e.g., cake vs. sugared cereals).
These results are consistent with the theoretical expectations of decision-making for positively framed foods, such that individuals’ reliance on a disqualifying nutrient lessens in the presence of a qualifying nutrient.

A large interaction emerged between fiber and protein, indicating that fiber utilization was substantially greater when protein was low (e.g., vegetables vs. saltine crackers) than when protein was high (e.g., steak vs. eggs; $d=−3.825$, $p<0.001$). A small interaction between fat and sugar indicated that fat utilization increased moderately when sugar was high (e.g., donuts vs. licorice) rather than low (e.g., French fries vs. celery; $d=−0.342$, $p=0.007$).

Only one significant participant-specific predictor of variability in the five-level one random parameters emerged. EDE-Q emerged as a moderate-magnitude predictor of the utilization of fat ($d=−0.560$, $p<0.001$); those who reported more DE symptoms relied more on fat content when judging food healthiness. Surprisingly, BMI was not a reliable predictor of utilization across all four nutrients.

Four multilevel regression models were used to compute participant-specific indices of nutritional knowledge for fat, fiber, sugar, and protein from the Nutritional Knowledge Questionnaire. The level-one equation specified the correct rankings of the seven stimuli as a predictor of each participant’s rankings of the seven stimuli. Both the correct and judged rankings were standardized, so that the estimated slope for the correct rankings was the correlation between the correct and judged rankings. These correlations were used as participant-specific indicators of nutrient knowledge. The level-two equation did not contain any predictors.

On average, participants showed substantial knowledge of sugar ($r=0.643$, $r(252)=32.83$, $p<0.001$), moderate knowledge of fat ($r=0.457$, $r(252)=20.41$, $p<0.001$) and protein ($r=0.483$, $r(252)=23.19$, $p<0.001$), and minimal knowledge of fiber ($r=0.260$, $r(252)=11.32$, $p<0.001$). Chi-square tests revealed significant variability across participants at a trend-level for fat ($\chi^2(252)=289.19$, $p=0.053$) and sugar ($\chi^2(252)=298.46$, $p=0.023$) but did not reveal significant participant-specific variability for protein ($\chi^2(252)=187.84$, $p>0.500$) and fiber ($\chi^2(252)=121.95$, $p>0.500$). In other words, significant individual differences in knowledge about sugar and fat emerged, whereas knowledge about fiber and protein was very similar across participants. Subsequently, we correlated knowledge of sugar and fat with reliance on sugar and fat, respectively, when judging healthiness. No associations were observed between nutritional knowledge and nutrient utilization during the Healthiness Rating Task for fat ($r=0.04$) and sugar ($r=0.01$). Thus, those participants who relied heavily on fat or sugar when judging healthiness were not more knowledgeable about the fat or sugar content of foods, contrary to expectations.

**Discussion**

This study explored both nutrient-specific (i.e., fat, fiber, sugar, and protein) and subject-specific (i.e., BMI, EDE-Q, and their interaction) predictors of the perceived healthiness of 104 foods within a sample of college-aged women. Multilevel modeling techniques were used to estimate both (a) participants’ average reliance on fat, fiber, sugar, and protein when judging healthiness; and (b) person-specific predictors of the utilization of these nutrients when judging healthiness.

Consistent with expectations, participants relied significantly on both fat and sugar content when judging the healthiness of food, such that foods with higher fat and sugar content were perceived on average to be less healthy. This finding is consistent with prospect theory, which would predict that individuals rely heavily on detrimental nutrients in an effort to avoid potential losses, such as compromised health or weight gain. However, reliance on fat and sugar within this sample is inconsistent with expectations stemming from an attribute framing theory perspective, which suggests that disqualifying (or negatively framed) nutrients would be utilized less. This finding provides indirect support for national educational campaigns that highlight the potential negative health consequences of the consumption of fat and sugar [22]. Additionally, this finding is consistent with Paquette’s review of the perceptions of food healthiness [10], which suggests that individuals believe diets to be healthy when they are low in fat and sugar.

Notably, however, participants relied to a far stronger degree on fat than sugar when judging healthiness: participants’ reliance on fat was 6.3 SDs above the mean, whereas reliance on sugar was only 1.4 SDs above the mean. One potential explanation for the greater reliance on fat than sugar when judging healthiness is that consumers have less knowledge of the sugar content of foods than the fat content, which would make reliance on sugar content when judging healthiness far more error-ridden. Results from our nutritional knowledge task suggest that this is not the case, however. On average, nutritional knowledge of sugar content was notably higher than knowledge of any other nutrient, yet participants relied less on sugar than on fat when judging healthiness, and individual differences in reliance on sugar when judging healthiness were unrelated to individual differences in nutritional knowledge about sugar. This suggests that consumers may not have internalized messages about the harmful effects of excessive sugar intake to the same degree as they have messages about excessive fat intake, which may be due to their lack of exposure to, noticing, understanding, recalling, or applying this information.

On average, participants’ perceptions of food healthiness relied on fiber content to a surprising extent. Fiber provides the human body with multiple benefits, including decreasing the rate at which sugar is absorbed into the bloodstream,
increasing the duration of the feeling of satiety, and cleaning out the colon [35]. While there are some public health campaigns encouraging the increased consumption of fiber [36], these messages are less ubiquitous than those regarding undue fat and sugar consumption. Therefore, the large effect of fiber utilization when judging food healthiness is both noteworthy and encouraging. Interestingly, participants demonstrated only minimal explicit knowledge of fiber, suggesting that such knowledge may be implicit (i.e., participants may have learned that specific foods with high fiber are healthier than foods with low fiber, but cannot articulate why). Participants’ lack of explicit knowledge of fiber is particularly noteworthy considering theoretical expectations that overt knowledge is essential to evaluating food healthiness [3].

Further, this sample of college-aged women relied to a limited and negative degree on protein content when judging food healthiness, such that higher-protein foods were deemed to be less healthy than lower-protein foods. Both the magnitude and direction of this finding are disappointing, as it is essential that individuals consume enough protein each day. For example, the USDA Dietary Guidelines recommend that women, ages 19–30, should consume 46 g of protein daily [22]. Participants’ limited reliance on protein content when judging healthiness is particularly interesting in light of their moderate knowledge of protein, similar to their level of knowledge of fat. This disconnect between knowledge about protein and reliance on this knowledge when judging food healthiness suggests that more salient messages about the benefits of adequate protein consumption may prove helpful.

The current findings differ from those of Hoefkens et al. [13] who showed that Europeans believed the perceived healthiness of qualifying nutrients to be more important than the perceived unhealthiness of disqualifying nutrients when selecting foods to consume. The discrepancy in findings may reflect differences in methodology, however, as Hoefkens et al. relied on participants’ direct report of the influence of nutrients when making healthiness judgments. In contrast, our indirect measurement strategy, when used in combination with multilevel modeling methods, may provide a more valid assessment of reliance on nutrients.

The current study also addressed whether nutrients exerted an impact on healthiness judgments not only as main effects, as discussed above, but also in combination with one another. This allowed us to evaluate the theoretically interesting possibility that reliance on disqualifying nutrients might depend on whether qualifying nutrients are present or absent. Interestingly, all six bivariate interactions were reliable, and some were substantial in magnitude. As expected, reliance on fat and sugar was reduced in the presence of the qualifying nutrients of fiber and protein. Overall, our fat and sugar-related main effect findings suggest that college-aged women appropriately consider the negative effects of fat and sugar, when judging the healthiness of foods, which is consistent with expectations stemming from prospect theory. However, this population is relying less on fat and sugar content to judge healthiness when presented with foods that also contain relatively high amounts of qualifying nutrients, such as protein and fiber, or low amounts of the disqualifying nutrients of fat or sugar. Future research should evaluate whether this indicates that the presence of other disqualifying nutrients cues the consumer to the detriments of fat or sugar content, whereas the presence of qualifying nutrients conceals it. For example, it is possible that the presence of qualifying nutrients obscures the presence of disqualifying nutrients, such as in a Caesar salad or a fully loaded baked potato.

At a participant-specific level, only one significant predictor emerged. Participants who endorsed high levels of DE symptoms utilized fat to a moderately greater degree than other participants. This suggests that those with higher levels of DE attitudes and behaviors may find detrimental nutrients to be more salient, relative to their peers. However, it is important to note that this is not the case for sugar. Moreover, BMI was not linked to differential focus on qualifying (e.g., protein) versus disqualifying (e.g., fat) nutrients. Thus, perceptions of food healthiness do not appear to be compromised to a greater degree among those with higher BMIs, at least in the current sample of undergraduate women. These findings suggest that exacerbated misperception of food healthiness may not be playing a central role in the obesity epidemic. However, there is more to food consumption than food perception. Other potential influences, such as decision-making and availability or cost of unhealthy relative to healthy foods, may play a more central role.

The sample under investigation places constraints on the generalizability of the current findings. This sample is limited by the lack of variation across age, the absence of males, and the use of a college student sample. Although variation was present in BMI (18.97 % overweight and 22.92 % obese) and eating-related symptomatology (6.3 % reporting clinically significant difficulties), future research will need to evaluate whether the current findings hold for samples of women who report more serious eating- and weight-related difficulties. Moreover, the current study focused on only four characteristics of foods, although it is a near certainty that other characteristics also exert important main effect and moderating influences on perceptions of the healthiness of foods.

However, this investigation includes a number of strengths. First, reliance on photographic, rather than semantic, stimuli enhances the ecological validity of our methods. Second, the indirect assessment approach that we used presumably provides a more accurate representation of the extent to which people rely on various nutritional characteristics when judging food healthiness than a direct approach that asks consumers to self-report how various nutrients influence their perceptions of food (e.g., Hoefkens et al.) [13]. This is particularly true to the extent that consumers show lower explicit awareness of the
nutrient content of foods, such as was observed for fiber in the present study. The indirect approach also provided ratio-scale judgments of food healthiness that are less susceptible to individual differences confounds in anchor interpretation (see Bartoshuk et al. [16]), which increases our confidence in the validity of both observed and null findings. Finally, the use of multilevel modeling allows for separate, but simultaneous, examination of food- and participant-specific predictors of food healthiness judgments.

Future work should examine experimentally the extent to which exposure to various educational messages, such as the current dietary guidelines [22], influences the basis of consumers’ judgments for food healthiness. The effects of modifications of these messages designed to enhance focus on sugar and protein also could be examined. It may also be useful to emphasize such messages to a greater degree within the psychoeducational components of behavioral weight-loss treatments. Although these programs typically rely on behavioral techniques, such as self-monitoring and supportive reinforcement [37], their success hinges in part upon clients’ accurate perceptions of food healthiness. Given the reliability and utility of this indirect assessment strategy, it may prove fruitful clinically to evaluate clients’ utilization of nutrients when judging food healthiness pre- and post-treatment. Additionally, future work should investigate the utilization of other important nutrients, such as sodium, carbohydrates, and saturated fat, when judging healthiness. It is quite possible that alternative food characteristics might exert main effects or interactive effects with reliance on fat, fiber, sugar, or protein when judging food healthiness. It would also be useful to evaluate in the future whether this cost-effective, easily disseminable, indirect approach, particularly when used in conjunction with a nutritional knowledge assessment, proves useful in applied contexts. Finally, it is imperative that future work continues to evaluate the link between the perceived healthiness of foods and food consumption.

Conflict of Interest Statement The authors have no conflict of interest to disclose.

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