CALIFORNIA STATE UNIVERSITY, NORTHRIDGE

Examining the Role of Nutritional Knowledge and Food Packaging

on Health Perceptions

A thesis submitted in partial fulfillment of the requirements

For the degree of Masters of Arts in Psychology, General Experimental

By

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Dedication

I would first and foremost like to dedicate my work to my committee advisor, Erica Wohldmann. No amount of words or expressions could capture the utmost appreciation and gratitude that I feel towards all the work that we put into this project together. Thank you so much for all your support, patience, and faith in me. You have shaped me into becoming a better writer, researcher, and thinker. I hope our paths will cross once more in the near future.

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The thesis of Anahid C. Bajikian is approved:

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Abstract

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Unhealthy food consumption has steadily increased over the past few decades, and as a result, so has obesity. Globally, obesity has tripled since 1975 (World Health Organization, 2018), and seven out of ten Americans are overweight or obese (Centers for Disease Control and Prevention, 2016). Nutritional knowledge and food packaging, which contains attributes such as health claims and health-related words, may be partly to blame because both play a role in influencing health perceptions and food choices. In the present study, participants were assigned to one of three conditions that varied in the healthfulness of side images presented on the food package, and were asked to estimate the number calories and make a health judgement for those foods. Half of the participants were nutrition majors (expert) and half were introductory psychology students (novice). In general, side images had a stronger impact on health judgments than on calorie estimates, but evidence of a health halo effect was limited for all measures. Moreover, like novices, experts were influenced by side images, suggesting nutritional knowledge is not sufficient for making accurate health ratings and calorie estimates.

Keywords: health perception, calorie estimates, package attributes, nutritional knowledge

Introduction

Since 1975, obesity rates have tripled in both children and adults (World Health Organization, 2018), and seven out of ten Americans are either overweight or obese (Centers for Disease Control and Prevention, 2016). In addition, four out of the five leading causes of death in the U.S. are diet- and obesity-related (National Vital Statistics Report, 2008). The overconsumption of foods high in calories, fat, salt, and sugar may be partly to blame. According to the U.S. Drug Administration Economic Research Service (2017), the consumption of grains, fats and oils, and sugars has increased substantially since the 1970s, the same time-period as the rise in obesity rates. Ultra-processed foods containing multiple ingredients, including added sugars, trans fats, and artificial flavors and colors result in extremely appealing food that is hard to resist. These foods are easy to purchase and consume because they are heavily marketed and packaged for convenience. Moreover, packaging often highlights the healthfulness of its contents, even when there are limited to no health benefits.

Several regulations have been put into place to help ensure consumers are informed and not misled by false health claims. For example, the 1967 Fair Packaging and Labeling Act (FPLA) by the Food and Drug Administration (FDA) required that all consumer commodities, such as any food, be labeled to disclose the net content by weight, quantity of items within the package, the name and place of business of the product's manufacturer, packer, or distributor, and the identity of the commodity (e.g., orange juice; Federal Trade Commission, 2018). Also, to minimize consumer deception or value comparisons, the FPLA regulates other product attributes such as the description of ingredients, characterization of package sizes, and slack fill of packages. In 1973, the FDA imposed additional regulations requiring, for example, the number of calories, grams of

protein, carbohydrates, and fat, and the percent of the U.S. Recommended Daily Allowance (RDA) for these and other nutrients (Wartella, Lichtenstein, & Boon, 2010).

Almost two decades later, in 1990, the Nutrition Labeling and Education Act (NLEA) was created and more changes were made to food packages (U.S. Food & Drug Administration [USFDA], 2018b). Specifically, the NLEA expanded the requirements for nutrition labeling on packaged foods and defined certain nutrient content claims, such as low fat and high fiber, in a way that required these health claims meet FDA standards. In 1994, the Nutrition Facts Panel (NFP) had to be posted on most packaged foods and the NFP included calories (total, from fat, saturated fat), cholesterol, sodium, and certain vitamins (Wartella, et al., 2010). No additional nutrient information could be presented on the NFP other than those that were approved.

More recently, additional requirements were imposed on packaged foods. For example, labels are now required to include information about trans-fats, and changes were made to the type-font, the actual daily value vitamin amount, and the Percent Daily Value (PDV), previously known as RDA, on the Nutrition Facts Label (USFDA, 2018a). More specifically, the font for calories, servings per container, and serving size was enlarged, the number of calories and serving size was bolded, and alongside the PDV (e.g., Vitamin D 10%), the actual amount of Vitamin D, potassium, calcium, and iron are reported (e.g., Vitamin D 2mcg). Furthermore, the explanation of the PDV at the bottom of the nutrition label now states the amount of nutrients per serving of the food item and how it contributes to the 2,000 calorie per day guideline recommended by the U.S. government. These changes were meant to increase the ease of consumer understanding and use of nutritional information.

Despite the plethora of information available, it is still difficult for consumers to make informed choices. Serving sizes of packaged foods vary and, thus, require calculations to obtain

the actual caloric content from the whole package. Moreover, to use this information properly, one must know the number of calories required to maintain current body weight, how to calculate their Body Mass Index (BMI) (dividing weight by height and dividing this value by height again), resting metabolic rate, and daily caloric expenditures. Thus, understanding how and what kind of information is used to inform food choices and purchasing behaviors is important.

Factors that Influence Food Choices, Health Perceptions, and Purchasing Behaviors

One factor that influences health perceptions and food choices is the package design, including attributes such as the label, brand name, and other design features (e.g., Chandon & Wansink, 2007). Font and color can also impact health perceptions. For example, in one study, participants were asked to make health ratings for various cans of soda marked with different pairings of typeface (i.e., AncientScript, SunSplash) and colors (i.e., yellow, red; Karnal, Machiels, Orth, & Mai, 2016). Yellow cans were rated as healthier than red cans and AncientScript (thin) was perceived as having fewer calories than SunSplash (thick). Also, yellow cans paired with AncientScript were judged to be healthier than red cans paired with SunSplash. In addition, participants who were focused on improving their health through a healthy diet (health-promotion focused condition), were more influenced by the typeface and color than participants who were focused on protecting their health by avoiding unhealthy foods (health-prevention focused condition). These findings suggest that package color and font, as well as individual differences, influence health perceptions and possibly purchasing behaviors.

Food branding and brand familiarity has also been shown to influence food choices and health perceptions. For example, in a study conducted by Werle, Balbo, Caldara, and Corneille (2016), participants rated their consumption intentions, attitudes toward the brand, product, and packaging, and made calorie estimates for Peanut M&M's. The candies were placed into zip-lock

bags and labeled in one of two ways, either a classic, branded label or a plain, unbranded label. Consumption intentions and attitudes towards the unbranded packages were lower than branded packages, and participants believed unbranded packages contained fewer calories than branded packages. However, surprisingly, package branding did not influence the quantity of M&M's consumed by participants, suggesting that participants either did not perceive differences in flavor or did not care about those differences. In a third experiment, three package types were shown to three groups of participants: branded packages labeled as low-fat, branded packages without a low-fat label, and unbranded packages without a low-fat label. The researchers found that participants consumed more Peanut M&M's from unbranded packages and from low-fat labeled branded packages than from branded packages with no label. In addition, females consumed more Peanut M&M's from the low-fat label package than from the two other packages, whereas males consumed more from the unbranded package than from either the branded or low-fat labeled packages. These findings suggest brands influence food consumption less than they do food attitudes, and that females may be more likely to use health claims (in this case, low-fat) than males.

Pictures also influence food perceptions and choices. For example, participants rated the quality, attractiveness, and healthiness of a juice carton with images of either a whole orange with a straw or a cup of orange juice with a straw, as well as rated the taste of those food images (Machiels & Karnal, 2016). Ratings for the quality, attractiveness, and healthiness of those food images were not significantly different, but the image of the cup of orange juice was rated as having a purer taste than the image of the whole orange. These results suggest that presenting images in different forms (i.e., whole orange, cup of orange juice) of an item on a food package could influence participants' impression of the taste, such as a bitter orange peel, for those items,

and thus, potentially influence future purchase and consumption of those foods. In addition, it is possible that a certain image is more preferred over the other due to the functionality of the way it is presented, meaning that orange juice is generally consumed from a cup and not from a whole orange. The presentation of product images on a food package may also help consumers determine whether they want a food item or not, as well as the overall healthiness of the item (e.g., Garcìa-Madariaga, López, Burgos, & Virto, 2019).

The presentation of congruent and incongruent pictures have also been shown to influence food perceptions. More specifically, participants tasted and rated orange juice samples paired with images that were either congruent (e.g., orange peel) or incongruent (i.e., non-food object; e.g., baby duck) with the juice; also, these images varied in valence, either pleasant (i.e., as shown above) or unpleasant (e.g., orange with insects, pile of trash), across conditions (Mizutani et al., 2010). Ratings for palatability and freshness were higher for pleasant images compared to unpleasant images; also, ratings for aroma were higher for congruent than incongruent images. These results suggest that pleasant images relating to the food product (congruent) may increase future purchase and consumption of those foods. In contrast, Sakai and Morikawa (2006) found a smaller difference in palatability and perceived intensity ratings between congruent and incongruent images, perhaps because both congruency items were food-related. More specifically, when congruent images (e.g., apple for apple juice) were shown, foods were rated as more palatable than when either incongruent images (e.g., orange for apple juice) or no images were presented. However, incongruent food images did influence food perceptions compared to when no images were shown.

Health and nutrition claims have also been shown to influence health assessments, food choices, and purchasing behaviors. Health claims refer to specific health benefits that are provided

through consuming the product and nutrition claims refer to the ingredients of the product. Some examples include text (e.g., good source of calcium) or symbols (e.g., heart) found on a food package, which represent various health concepts (e.g., healthy) and activate the concept of health. When the concept of health is activated by health claims, healthy images, or beliefs about a specific food, that food and even others around it may be perceived as healthier than they truly are, a phenomenon known as the 'Health Halo Effect.' For example, in one study, participants reported lower calorie estimates for Subway meals (i.e., sandwich, soft drink, side order) compared to McDonald's meals, demonstrating the role of health halos (Chandon & Wansink, 2007). Also, when asked to estimate the number of calories in a six-inch ham and cheese sandwich and 12-inch turkey sandwich (Subway) and cheeseburger and Big Mac (McDonald's), consumers with higher nutritional involvement (e.g., it is important that nutrition information is available) made more accurate calorie estimates for both items compared to consumers with lower nutritional involvement. In a third experiment, participants who were given Subway coupons were more likely to order higher calorie side dishes (e.g., large soda, cookies), possibly to compensate for being given the presumed healthier meal, compared to participants who were given McDonald's coupons. Surprisingly, there was little to no difference in the calorie estimates for these meals across the two restaurant conditions. Overall, these results suggest that having prior misconceptions of the overall healthiness of certain food items due to health halos could result in greater underestimation of the number of calories contained in those meals, as well as potential overconsumption of those presumed healthier low-calorie meals.

In another study, Klepacz, Nash, Egan, Hodgkins, and Raats (2016) asked participants to recall various health claims (i.e., nutrition, health, generic) paired with a skimmed milk carton. Half of the packages also contained a health-related function image (i.e., stretching human figure).

Overall, participants were better at recalling health claims than nutrition or generic claims, and this was especially true when the claim was paired with the function image. These results suggest that function images primed participants to infer certain health benefits for the food item, making it easier to remember them. In a real-world setting, these results would suggest that presenting health-claims in the form of symbols or images on food packaging may be easier to understand when trying to make healthier food purchases, such as nut-clusters that could be advertised as heart-healthy (i.e., symbol of a heart) compared to chocolate waffles that are not as healthy. It is important to consider what range of foods are influenced by images, health claims, or other attributes found on packages.

Current Research: Package Attributes

The role of package attributes on food perceptions and choices has been studied extensively (e.g., Gil-Pérez, Rebollar, & Lidón, 2019). The present study explored this topic further in a novel way. That is, in our study, we examined the impact of irrelevant images on food packages, more specifically, whether or not those images caused a health halo effect, especially when there is uncertainty in the healthfulness of the actual contents of the package. All participants were shown a series of packaged foods with a picture (primary image) of the contents of those packages. Half of those packages contained healthy foods and half contained unhealthy foods. Moreover, healthy and unhealthy foods shown were relatively easy to categorize as such (e.g., raw pistachios, toaster pastries) and half were more ambiguous (e.g., veggie chips, fruit cookies), creating uncertainty in determining the healthfulness (see Illustration 1). For some participants, those in the side-image conditions, the packages also included irrelevant food images, which were either clearly healthy (healthy side-image condition) or clearly unhealthy (unhealthy side-image condition; see

Illustration 2). Packages shown to participants in the control condition included only the primary

food images, no irrelevant side images (see Illustration 1).

Illustration 1. Sample stimuli of both healthy (left) and unhealthy (right) food image by healthfulness (high, moderate).

Illustration 2. Sample stimuli for healthy (left) and unhealthy (right) side-image conditions by food image type.

Participants were asked to make calorie estimates and health judgements for each food

presented. If irrelevant side images impact people's perceptions and beliefs about food, then we

expected to find different health judgements and calories estimates across the three conditions. In

addition, regardless of the healthfulness (i.e., food image condition) of the actual package contents,

when foods were paired with healthy side images, we expected calorie estimates for those foods

to be lower and health perceptions to be higher than when they were paired with unhealthy side

images. This would demonstrate a health halo effect. We also hypothesized that the influence of

the side images would be stronger for foods that were relatively difficult to categorize (ambiguous) than for those that were relatively easy to categorize.

The Role of Knowledge on Food Choices and Judgement Tasks

In addition to package attributes, nutritional knowledge also influences food choices and health perceptions. For example, in a study conducted by Backstrand, Wootan, Young, and Hurley (1997), dieticians and nutritional professionals (nutrition experts) were presented with standard portions of various restaurant foods (e.g., milk, lasagna, tuna sandwich), and were asked to estimate the number of calories in each food. It was expected that nutrition experts would make more accurate calorie estimates, but that was not the case for every item presented. More specifically, whole milk was more accurately estimated than foods such as lasagna and tuna salad sandwiches. In fact, experts underestimated the number of calories contained in some items, such as a Porterhouse steak dinner (i.e., steak, Caesar salad, vegetable of the day, baked potato with butter), by more than 600 calories. These results suggest that it is easier to estimate the number of calories in single-ingredient foods, such as milk, than multiple-ingredient foods, such as tuna sandwiches, even for nutrition experts. Importantly, expertise in nutrition does not always guarantee accurate calorie estimates.

In another study that explored the role of nutritional knowledge on food choices, participants where shown two food product names, pasta, which is considered relatively unhealthy, and salad, which is considered relatively healthy (Experiment 1), as well as two other foods names, candy chews (unhealthy) and fruit chews (healthy, Experiment 3; Irmak, Vallen, & Robinson, 2011). Holding the pictures constant across the food product names, participants were asked to rate the food as either healthy or unhealthy, and to complete a dieting scale (e.g., "I have used the nutritional labels on foods to determine if I will eat a certain food or not") to assess their dieting

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behaviors and nutritional knowledge. Overall, as dieting tendency increased, perceived healthfulness for pasta decreased, but dieting tendency did not significantly impact ratings for salad. The researchers also investigated how different information processing strategies (cognitive processing, shortcut solutions) influenced health ratings across dieting tendency. For participants who engaged in cognitive processing (i.e., rely on understanding of food healthfulness), no difference in perceived healthfulness (healthy, unhealthy) was found across product names (i.e., fruit chews, candy chews) and dieting tendency (dieters, non-dieters). However, when participants engaged in shortcut solutions (i.e., rely on package attributes), candy chews were perceived as less healthy, but only for dieters. There was no difference in ratings for fruit chews across dieting tendency. In addition, cognitive processing mitigated the impact of dieting tendency on health ratings for unhealthy food names more so than shortcut solutions. These findings suggest that people who report attending to their diet (e.g., read nutrition labels) may be more attentive or sensitive to food-related cues when categorizing the healthfulness of certain foods relative to those who do not attend to their diet.

Researchers have also examined the role that dietary behaviors and nutritional knowledge play when making food choices, health inferences, and physiological responses to certain foods. Specifically, Yegiyan and Bailey (2016) used facial movements (using EMG) as a measure of emotional responses (i.e., increased desire, increased avoidance) to examine differences in eating habits (healthy, unhealthy) and food knowledge (high, low). Participants were asked to view pairs of healthy (e.g., carrot sticks) and unhealthy (e.g., French fries) images together in six-second intervals while their emotional responses were being collected. They were also asked to complete an eating habit questionnaire that measured their frequency of consumption of healthy and unhealthy foods, as well as a food knowledge questionnaire. Overall, high knowledge participants

with unhealthy eating behaviors showed an increased desire for unhealthy foods relative to healthy foods, but were able to increase avoidance across intervals. Low knowledge participants with unhealthy eating behaviors also showed an increased desire for unhealthy foods relative to healthy foods, however, their desire only increased across intervals. High knowledge participants with healthy eating behaviors showed no differences in emotional responses and little to no desire for either healthy or unhealthy foods. However, low knowledge participants with healthy eating behaviors showed an increased desire for healthy foods over unhealthy foods. Taken together, the results suggest that high knowledge can reduce desire and potentially increase avoidance of unhealthy foods.

Researchers have also examined the role of anchoring effects in health judgements. The anchoring and adjustment heuristic is a strategy utilized in probability judgement tasks where participants start with an initial value (either provided or estimated), then adjust that value to reach the final answer (Tversky & Kahneman, 1974). Anchoring and adjustment is a strategy employed in many quantitative tasks, but only when an initial estimate is available (Caverni & Peris, 1990). For example, in a study conducted by Forwood, Ahern, Hollands, Fletcher, and Marteau (2013), participants were shown two types of meals, a reference meal (e.g., hamburger) that was paired with either a healthy side (e.g., carrot slices) or no side, and a main meal (e.g., cheeseburger) that was paired with either a healthy side (e.g., celery sticks) or no side. They were asked to estimate the caloric content of the main meals. Reference meals were labeled with the caloric content and, thus, could be used as an anchor for the main meal. Estimates based on reference meals without a side were lower for main meals with healthy sides than when no sides were paired with the main meal, suggesting that both the healthy side and the reference meal drove estimates to be lower than when no sides were shown. In addition, when reference meals were paired with a healthy side,

estimates were higher for main meals with healthy sides than when no sides were paired with the main meal, demonstrating the opposite effect. In fact, both healthy sides (reference meal and main meal) and the reference meal influenced these estimates. Overall, these results suggest that calories are used as anchors, and estimates vary based on the presence of side images.

Current Research: Knowledge

In the current study, although we were not studying the impact of anchors, anchoring and adjustment may still occur. Because participants were shown images of food packages and were asked to estimate the number of calories contained in those packages, it seemed possible that their previous knowledge and exposure to calorie information for similar foods could be used as an initial anchor. In that case, estimates would be adjusted from that value. However, participants with limited knowledge of calorie information might rely on the images on the food package and their perceptions of healthfulness as the anchors to categorize foods and make their estimates.

While many studies have explored the role of nutrition knowledge on calorie estimates and health perceptions, there is little to no research exploring the relationship between knowledge and the health halo effect. Thus, the present study sought to address this issue. More specifically, participants who were recruited for this study were either knowledgeable about nutrition (nutrition majors) or not (other majors not related to nutrition or health). Surveys that measure nutritional knowledge were used to verify proper placement into the two categories (expert, novice). Participants with high levels of nutritional knowledge were expected to rely more on their knowledge about nutrition, and less on the package images, than those with low levels of nutritional knowledge. Thus, nutrition experts were expected to show a smaller health halo effect than novices.

Experiment 1 was conducted to create appropriate stimuli, that is, to obtain agreement across both health categories (healthy, unhealthy). More, specifically, the goal was to obtain high (easy to categorize) and moderate (difficult to categorize) agreement for images that could be used as either primary (package contents) or secondary (side images) food package images. High agreement was defined as agreement that ranged between 80 and 100 percent across participants. Moderate agreement was defined as agreement that ranged between 50 and 79 percent across participants. Items for which agreement was lower than 50 percent were not used.

Methods

Participants

Three-hundred and seventy-nine California State University, Northridge, undergraduate students participated in this online study. All the participants were enrolled in an introductory psychology course and received course credit for participation.

Materials and Apparatus

The stimuli used in this experiment included common packaged foods, both sweet and savory (e.g., toaster snacks, cheese puffs, granola bar, raw pumpkin seeds). Images intended to be used as primary images were located in the center of the food package and were somewhat larger than images that were intended to be used as side images, which were located closer to the edges of the food packages.

Seventy-three images were selected to be potentially used as primary images, with roughly half deemed as healthy and half deemed as unhealthy by the experimenters. Sixty images were

selected to be potentially used as side images, again, with roughly half of each being deemed as either healthy or unhealthy by the experimenters. Each image was shown only once, and the images were shown in the same order to all participants. All primary images were shown first, one at a time, followed by all side images, again, one at a time.

Qualtrics was used to display all instructions, images of food package, and to collect health judgments. Participants were recruited to this online experiment through SONA.

Procedure and Design

Participants were shown 133 (73 primary images, 60 side images) different packaged foods, one at a time, and were asked to make health judgements for each item by checking a box indicating the item was either healthy or unhealthy. Participants were given no indication of how many items would appear; however, they were told that the experiment would take approximately 20 minutes. They were also instructed to read the instructions on Qualtrics carefully and to complete the entire survey without any pauses. The instructions for the health judgement task were as follows:

> You will be asked to judge various images of food items as either healthy or unhealthy. Do not think about it, just choose the first thought that comes to mind. Each question should take only one to two seconds to respond to. After each response, click next to move onto the next question.

After completing the health judgement tasks for both all food items, participants answered some demographic questions (age, gender, academic rank), and were thanked for their participation.

When 80 percent or more participants rated an item as healthy or unhealthy, that image was placed in the appropriate high agreement healthy category. When 50-79 percent of participants rated an item as healthy or unhealthy, that image was placed in the appropriate moderate agreement healthy category. These categories were used to select primary and side images in Experiment 2.

Results

Descriptive statistics were used to appropriately categorize each food image. Of the 73 primary images shown, 17 were categorized as high agreement healthy images ($M = 85.76$), 23 as high agreement unhealthy images ($M = 91.97$), 21 as moderate agreement healthy images ($M = 67.28$), and 12 as moderate agreement unhealthy images ($M = 66.47$). Thus, 12 primary images from each category were available to use in Experiment 2. Of the 60 of the side images shown, 19 were categorized as high agreement healthy images ($M = 89.16$), and 26 as high agreement unhealthy images ($M = 92.89$). Images with less than 80 percent agreement were not used.

Experiment 2

Previous research has shown that when a healthy food image (e.g., salad) is paired alongside another food image (e.g., bowl of chili), that food is rated as having fewer calories and as being healthier than when no image is presented alongside it (Chernev, 2010). This is an example of the health halo effect. In the present study, we hypothesized that side images would influence health judgements and calorie estimates for the packaged foods being shown. That is, we expected calorie estimates to be lower and health judgements to be higher (health halo effect) for participants who saw healthy side images, especially when categorizing foods as either healthy or unhealthy was relatively difficult. In contrast, when unhealthy or no side images were shown on packages, we did not expect to see a health halo effect. In fact, it seemed possible that unhealthy

side images could cause participants to overestimate the calories and underestimate the healthfulness of food, which would be the opposite of a health halo effect. However, if nutritional knowledge helps to reduce the health halo effect, then we expected to see little to no health halo effect in nutrition majors compared to non-nutrition majors.

Methods

Participants

One-hundred and fifty-one California State University, Northridge, undergraduate students participated in this study. A little more than half of the participants were enrolled in introductory psychology and received course credit for participation, and a little less than half were nutrition majors who participated for a $10.00 campus store gift card. More specifically, there were 81 psychology students (38 females, *M* age = 19; 43 males, *M* age = 21) and 70 nutrition students (57 females, *M* age = 24; 13 males, *M* age = 29).

Materials and Apparatus

The stimuli used in this experiment included common packaged foods, both sweet and savory, and were selected using the results of Experiment 1 described above. All packages contained a primary image. Packages used in the two experimental conditions also included an additional side image.

Forty-eight images were used as primary images, 12 healthy with high agreement, 12 unhealthy with high agreement, and 12 healthy with moderate agreement, and 12 unhealthy with moderate agreement. Twenty-four side images, 12 healthy and 12 unhealthy, were also used, and each image was used four times (paired once with each type of primary image). To control for potential order effects, six unique orders of each stimulus list were constructed using a random

number generator. Each version was shown to approximately the same number of participants. In addition, to control for the potential influence of calorie estimates on health judgements (and vice versa), half of the participants completed the calorie estimation task first, and half completed the health judgement task first per list.

Four Dell computers were used for this experiment, and Qualtrics was used to display all instructions, images, and to capture health judgements and calorie estimates.

Procedure and Design

Participants were assigned by fixed rotation to one of three conditions that differed with respect to the side image presented alongside the primary food image. All participants were asked to make calorie estimates and health judgements of 48 different packaged foods (the food depicted in the primary image), shown one at a time. Half of the primary images from each category had moderate agreement and half had high agreement. Participants in the side-image conditions were shown 24 healthy and 24 unhealthy food items. In addition to the primary image shown on each package, the packages contained side images that were either all healthy (healthy side-image condition) or all unhealthy (unhealthy side-image condition). Participants in the control condition were shown images of the same 24 healthy and 24 unhealthy food items; however, no side images surrounded the primary image for this condition.

Participants were not aware of the number of items being presented during this part of the experiment and before the start of the next part, they were told to read instructions on a computer screen and were given verbal instructions by the experimenter to be sure that they understood. The instructions for the calorie estimation task were as follows:

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Packages of food will be shown on the screen, one at a time. Please estimate the number of calories in the food items using the number keypad. If you are uncertain, please try your best to guess for each of those items. Once you have made your calorie estimate, please click on the arrow and the next item will appear on the screen. When you are finished with this part of the experiment, the computer will prompt you to get the experimenter.

The instructions for the health judgement task were as follows:

Packages of food will be shown on the screen, one at a time. Please rate the food items as either healthy or unhealthy by checking the appropriate box. If you are uncertain, please try your best to guess for each of those items. Once you have made your rating, please click on the arrow and the next item will appear on the screen. When you are finished with this part of the experiment, the computer will prompt you to get the experimenter.

After completing both health perception tasks, all participants were given a modified version of the General Nutrition Knowledge Questionnaire (Kliemann, Wardle, Jonhson, & Croker, 2016; see Parmenter & Wardle, 1999) to assess their knowledge about food labels, nutrition, and the healthiness of food items based on caloric content and ingredients. Though half of the participants were presumed to be novices (introductory psychology students) and half experts (nutrition majors), results from this survey were used to verify knowledge. Finally, participants answered some demographic questions (age, height, weight, gender, academic rank, major) and questions regarding physical activity, daily recommended caloric needs, and nutritional awareness, and were thanked for their participation. All participants were tested individually in separate rooms.

Some responses were coded prior to conducting analyses of the final data. To measure food categorization for the health judgements, healthy items were scored as one and unhealthy items were scored as zero. To measure accuracy of health judgements, correct responses were scored as one and incorrect responses were scored as zero. Lastly, for the nutrition questionnaire, all items were scored out of one point, where multi-answer questions were split up accordingly (e.g., 4 answers, each answer .25 points). Points were not deducted for any incorrect answers in multi-part questions, meaning, if an incorrect answer was selected in a multi-answer question and a correct answer was also selected, then participants would get the point for the correct answer and would not be penalized for the incorrect answer. For single answer questions, if an answer was incorrect, the score would be zero for that question and if the answer was correct, the score would be one. For question five (i.e., guess individual daily recommended calorie intake [DRCI]), participants demographic information (gender, height, weight, age, level of physical activity) was used to calculate their actual DRCI using an online calorie calculator program (https://www.calculator.net/calorie-calculator.html). This information could be used to compare participants actual DRCI to their estimated DRCI, which could be used as another way to assess nutritional knowledge.

The design for Experiment 2 was a 3 x 2 x 2 x 2 mixed factorial including side-image condition (healthy, unhealthy, control) and expertise (novice, expert) as between-subjects variables, and food image (healthy, unhealthy) and healthfulness (high, moderate) as within-subject variables. Two dependent variables were used to assess performance, calorie estimates and health judgements.

Results

General Nutritional Knowledge Questionnaire

Descriptive statistics were conducted on the knowledge questionnaire in order to assess whether participants were properly placed into the two expertise categories, experts (nutrition majors) and novices (non-nutrition majors). The highest score possible on the questionnaire was 27. Mean scores and standard deviations were calculated for each expertise category. Experts scored higher ($N = 70$, $M = 20.84$, $SD = 13.10$) on the survey than novices ($N = 81$, $M = 14.92$, $SD = 25.31$), confirming that nutrition majors were, indeed, more knowledgeable about nutrition than introductory psychology students. In fact, a t-test confirmed that experts were significantly more knowledgeable than novices, $t(149) = 11.68$, $p < .01$. Lastly, it is important to note that only one novice was majoring in Family and Consumer Sciences (and, therefore, could have been exposed to nutrition training). However, that participant's score on the questionnaire was 12.5, which was substantially lower than the mean score for experts.
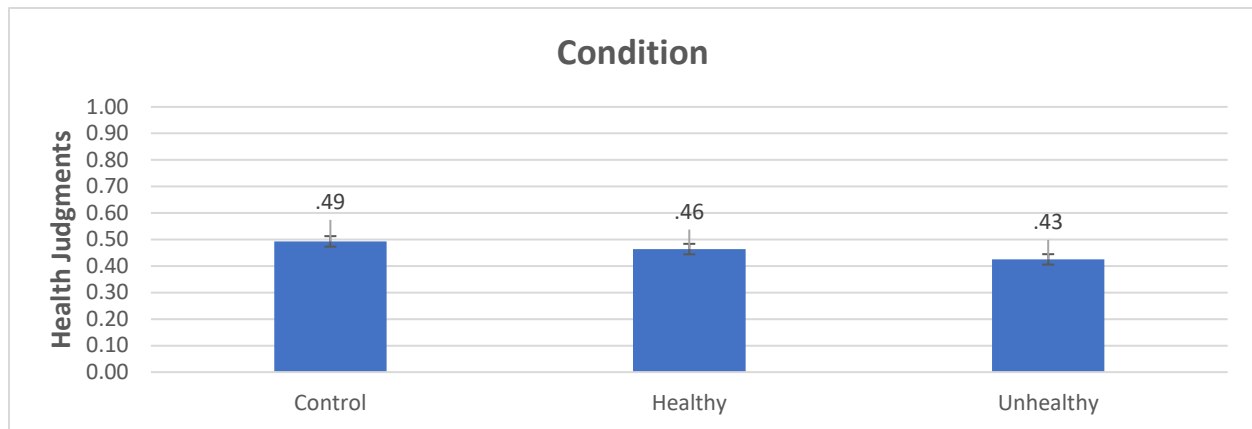
Health Judgements by Food Categorization

A repeated measures ANOVA was conducted on average health judgements and included condition (control, healthy, unhealthy) and expertise (expert, novice) as between-subjects variables and food image (healthy, unhealthy) and healthfulness (moderate, high) as within-subjects variables. We hypothesized that side images would influence health judgements for the packaged foods being shown. Specifically, health judgements were expected to be higher (healthy items coded as one) for participants in the healthy side-image condition than for those in either the control and unhealthy side-image conditions, demonstrating a health halo effect.

Results indicated that side images did influence health judgements differently across the three conditions; the main effect of condition was significant, $F(2, 145) = 4.17$, $p = .02$, $MSE = 0.78$ (see Figure 1). More specifically, judgements were highest in the control condition and lowest in the unhealthy side-image condition. As predicted, health judgements were higher for participants in the healthy side-image condition than those in the unhealthy side-image condition; however, a planned comparison between the two experimental conditions showed the advantage was not statistically significant, $F(1, 97) = 2.41$, $p = .12$, $MSE = 0.90$.

While we expected health judgements to be higher for the healthy side-image condition than the other conditions, we especially thought this would be true for unhealthy items, which would demonstrate a more typical health halo effect. The interaction between condition and food image was significant, $F(2, 145) = 7.90$, $p = .001$, $MSE = 0.41$, however, judgements for unhealthy food images were highest for participants in the control condition relative to those in the experimental conditions (see Figure 2). As can be seen in Figure 2, judgements for unhealthy items were higher for participants in the healthy side-image condition than for those in the unhealthy side-image condition; however, a planned comparison between the two conditions revealed no interaction of condition and food image, $F(1, 97) < 1$. Thus, at least in terms of health judgements, the results did not provide support for a health halo effect.

Figure 1. *Health Judgement Food Categorization*

Note. Mean health judgement as a function of condition.

**Figure 2.** *Health Judgement Food Categorization*
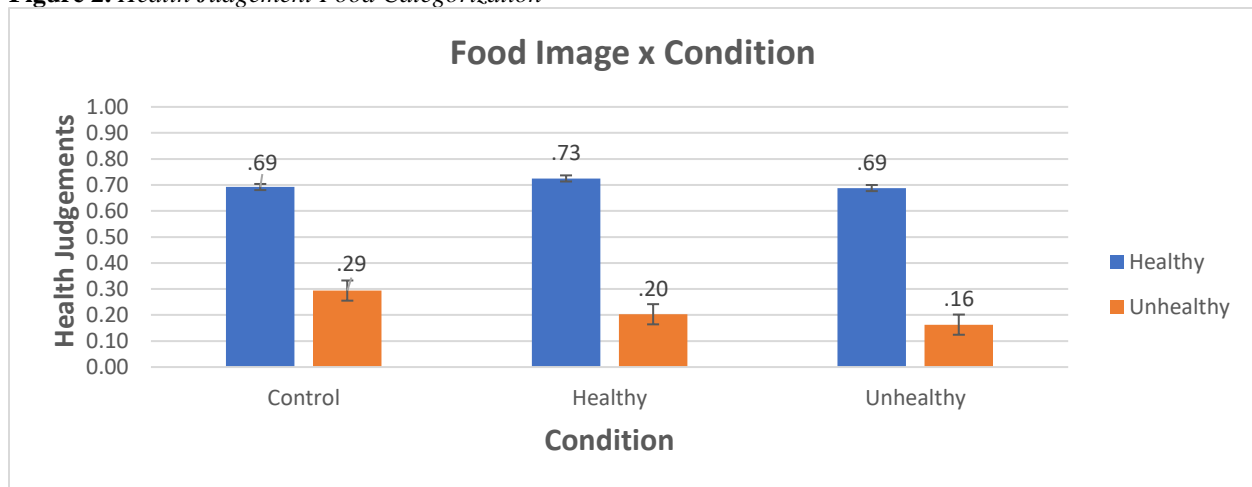
Note. Mean health judgement as a function of food image and condition.

We also hypothesized that nutritional knowledge would reduce (or eliminate) the health halo effect, again, because nutrition experts were expected to rely more on knowledge than on package attributes than novices. Thus, we expected to see a smaller impact of condition for experts than for novices. Although the main effect of expertise was not significant, $F(1, 145) = 2.54$, $p = .11$, $MSE = 0.78$, the interaction between expertise and condition was, $F(2, 145) = 3.63$, $p = .03$, $MSE = 0.78$ (see Figure 3). Contrary to our prediction, as can be seen in Figure 3, health judgements for novices did not differ across conditions, whereas for experts, they did. In fact, an

analysis of experts only revealed that participants in the control condition had higher judgments than those in the unhealthy side-image condition, $F(1, 43) = 14.05$, $p = .001$, $MSE = 0.78$, but judgements for the control and healthy side-image conditions did not differ from one another, $F(1, 45) = 2.30$, $p = .14$, $MSE = 1.00$. Moreover, the planned comparison between the healthy and unhealthy side-image conditions was marginally significant, $F(1, 46) = 3.53$, $p = .07$, $MSE = 1.01$, with lower judgments for participants in the unhealthy side-image condition and somewhat higher judgements for those in the healthy side-image condition. Taken together, these results provide evidence to suggest that experts were more influenced by side images than novices, especially by unhealthy side images.

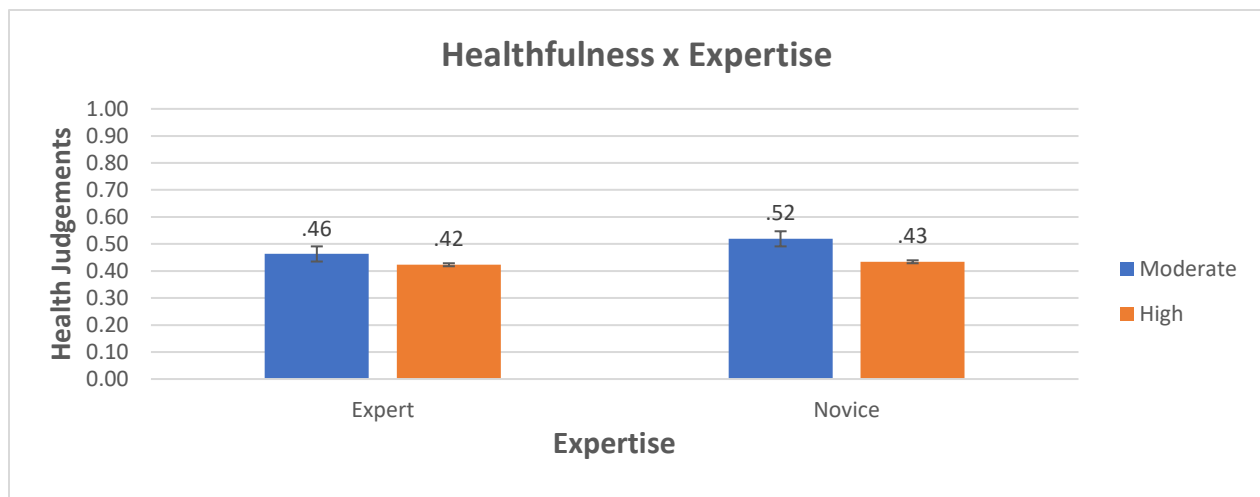**Figure 3.** *Health Judgement Food Categorization*
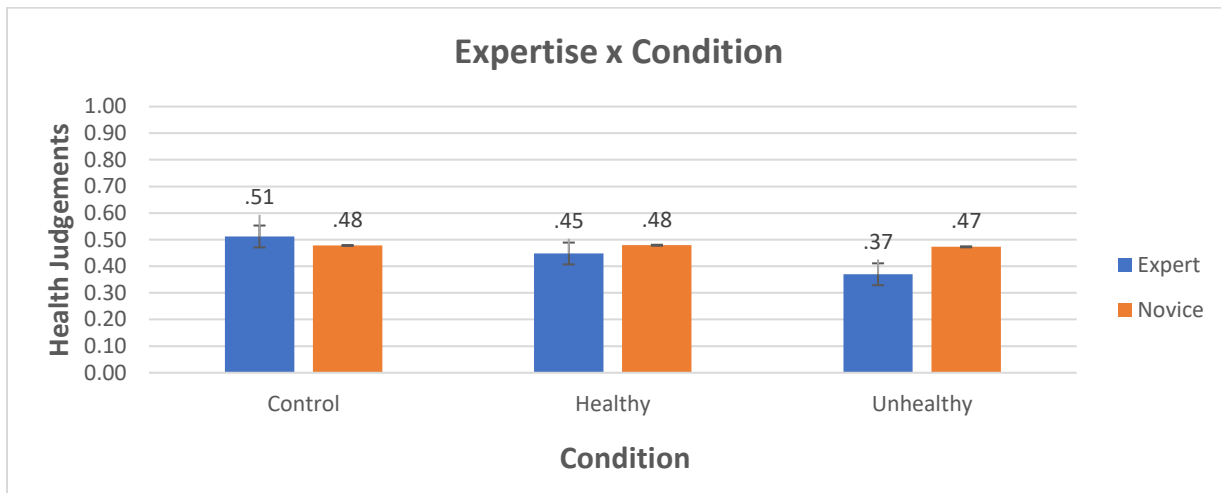
Note. Mean health judgement as a function of expertise and condition.

We also hypothesized that a health halo effect would be more prominent for items that were relatively difficult to categorize (i.e., moderate healthfulness items) than for items that were relatively easy to categorize (high healthfulness items), again, especially for participants in the healthy side-image condition. Further, novices were expected to be more susceptible to health halo effects on moderate items than experts. As predicted, in the overall analysis, $F(1, 145) = 4.48$, $p =$

.04, *MSE* = 0.19 (see Figure 4), and in the planned comparison between the experimental conditions, $F(1, 97) = 4.72$, $p = .03$, *MSE* = 0.20, a significant interaction of expertise and healthfulness was found. As can be seen in Figure 4, novices had higher health judgments for moderate items than experts, suggesting that experts were less influenced by healthfulness than novices. However, importantly, the predicted interaction of healthfulness, expertise, and condition was not significant, $F(2, 145) = 1.65$, $p = .20$, *MSE* = 0.19 (see Figure 5). Furthermore, the planned comparison between the experimental conditions also did not reveal a significant interaction of healthfulness, expertise, and condition, $F(1, 97) = 2.55$, $p = .11$, *MSE* = 0.20.

Looking at Figure 5, however, there is an interesting trend. Namely, for both moderate and high healthfulness items, novices seemed to be less impacted by side images (i.e., condition) than were experts. Especially for moderate healthfulness items, experts' judgements varied across condition. When comparing just the two experimental conditions, experts' health judgements demonstrated a health halo effect, with judgments being higher for participants shown healthy side images and lower when shown unhealthy side images. That said, these differences were weak.
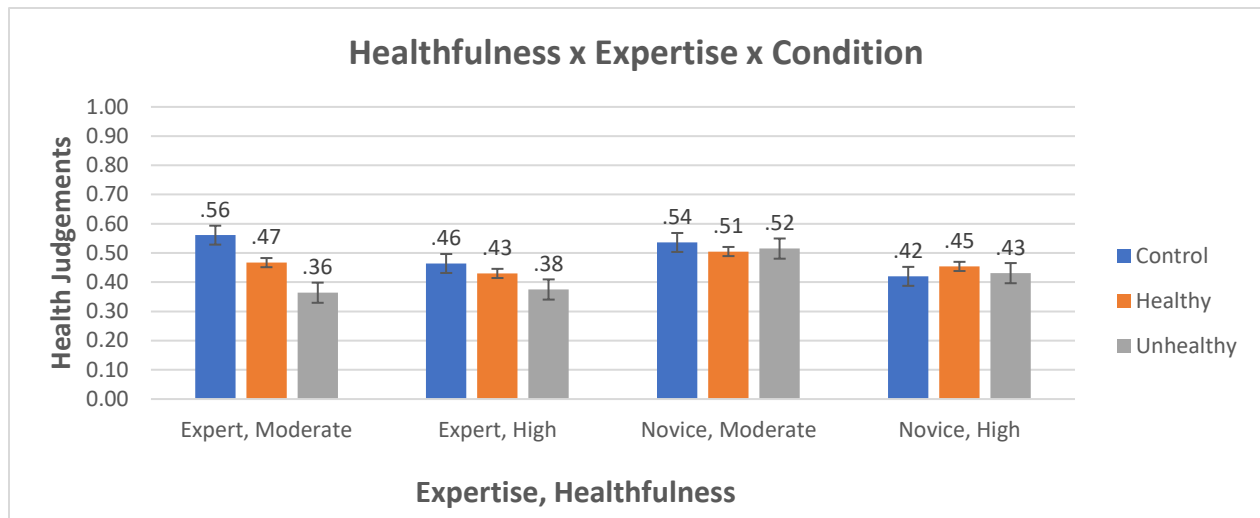
Figure 4. *Health Judgement Food Categorization*

Note. Mean health judgement as a function of healthfulness and expertise.

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Figure 5. *Health Judgement Food Categorization*

Healthfulness x Expertise x Condition

Note. Mean health judgement as a function of healthfulness, expertise, and condition.

Lastly, we hypothesized that health judgements would be higher for moderate healthfulness items than high healthfulness items (high agreement about their healthfulness), particularly when paired with healthy side images. Results indicated that moderate and high healthfulness items did influence health judgements differently; the main effect of healthfulness was significant, $F(1, 145) = 37.25$, $p < .001$, $MSE = 0.19$, with moderate healthfulness items being judged as healthier (i.e., higher) than high healthfulness items. Furthermore, as expected, a significant interaction of condition and healthfulness was found, $F(2, 145) = 4.60$, $p = .01$, $MSE = 0.19$ (see Figure 6). More specifically, we found larger differences in health judgments between moderate and high items in the control condition than in the experimental conditions, suggesting, averaging across expertise, side images help to reduce uncertainty about the healthfulness of the food being judged.

Figure 6. *Health Judgement Food Categorization*

Healthfulness x Condition
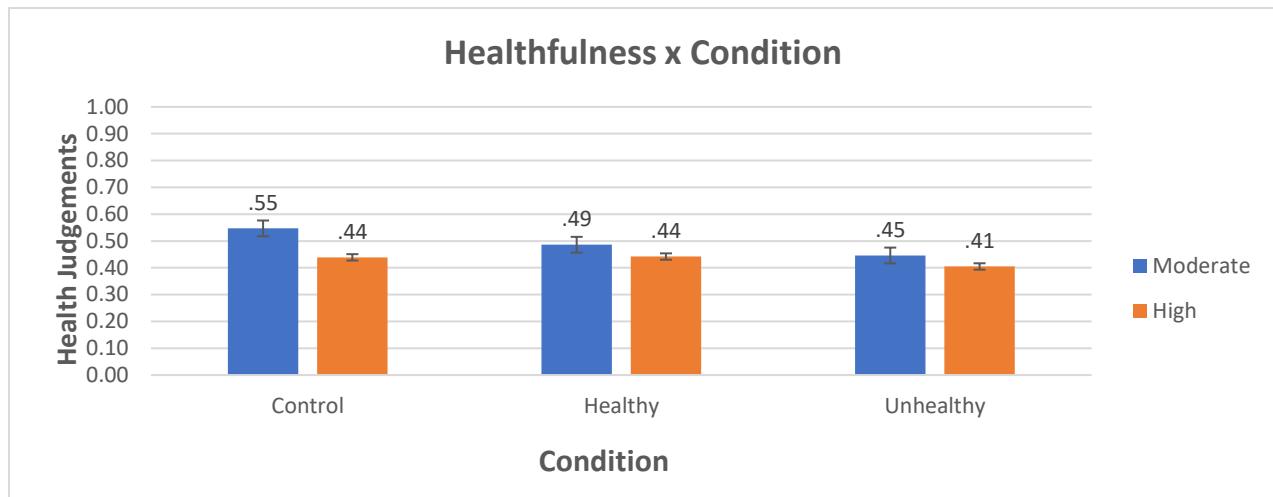
Note. Mean health judgement as a function of healthfulness and condition.

Health Judgments by Accuracy

A repeated measures ANOVA was conducted on average health judgements based on accuracy (correctly categorized responses) and included condition (control, healthy, unhealthy) and expertise (expert, novice) as between-subjects variables and food image (healthy, unhealthy) and healthfulness (moderate, high) as within-subjects variables. We hypothesized that healthy side images would reduce accuracy of health judgements for the packaged foods shown, especially for unhealthy items. Similarly, unhealthy side images were expected to reduce the accuracy of health judgements for healthy items being shown. In this case, then participants in the control condition were expected to show greater accuracy than those in either the healthy or unhealthy side-image conditions; no difference in accuracy was expected between the experimental conditions.

Results indicated that side images influenced accuracy of health judgements differently across the three conditions, but not in the predicted direction, $F(2, 145) = 10.64$, $p < .001$, $MSE = 0.41$ (see Figure 7). More specifically, accuracy was higher for both side-image conditions than

for the control condition and, as predicted, the planned comparison between the experimental conditions was not significant, $F(1, 97) = 4.09$, $p = .99$, $MSE = 28.84$.

In addition, a significant interaction of condition and food image was found, $F(2, 145) = 5.39$, $p = .01$, $MSE = 0.77$ (see Figure 8), partially supporting our hypothesis. More specifically, participants shown unhealthy side images were less accurate at categorizing healthy food images than unhealthy food images; however, this was also true for participants shown healthy side images, but to a lesser extent. No difference in accuracy between healthy and unhealthy food images were found for the control condition, who overall, performed the worst. As expected, a planned comparison between the two experimental conditions revealed no significant interaction of condition and food image, $F(1, 97) = 2.37$, $p = .13$, $MSE = 0.90$, supporting our hypothesis that the side-image conditions would not differ in health judgement accuracy. Contrary to what we expected, however, side images proved to be more helpful than harmful, perhaps because they encouraged participants to process the healthfulness in a deeper way.

Figure 7. *Health Judgement Accuracy*
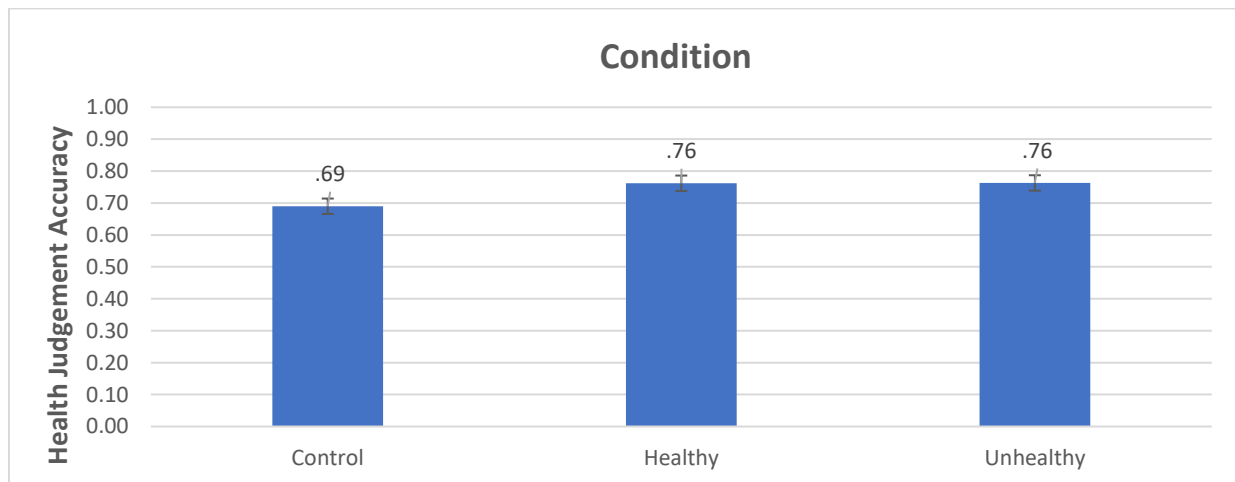
Note. Mean health judgement accuracy as a function of condition.
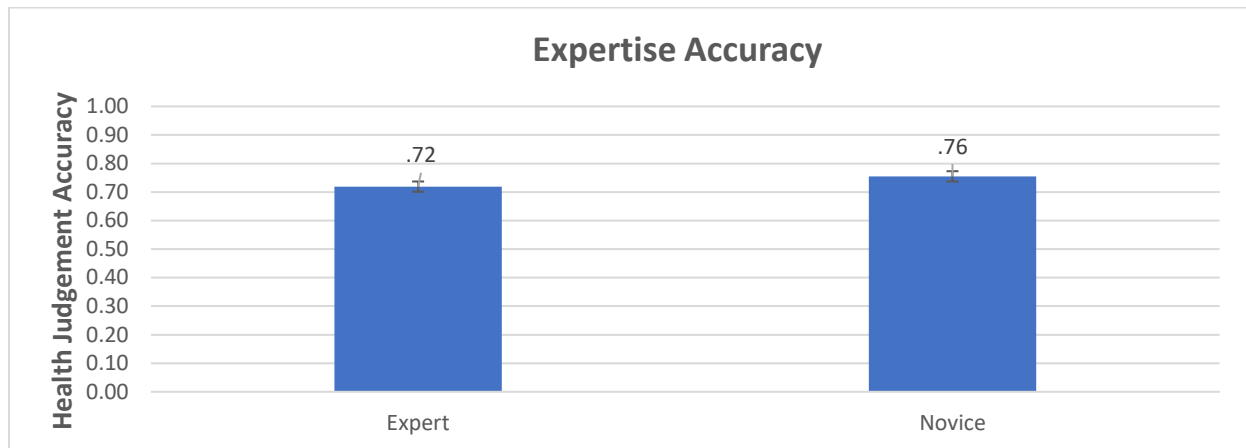
Figure 8. *Health Judgement Accuracy*
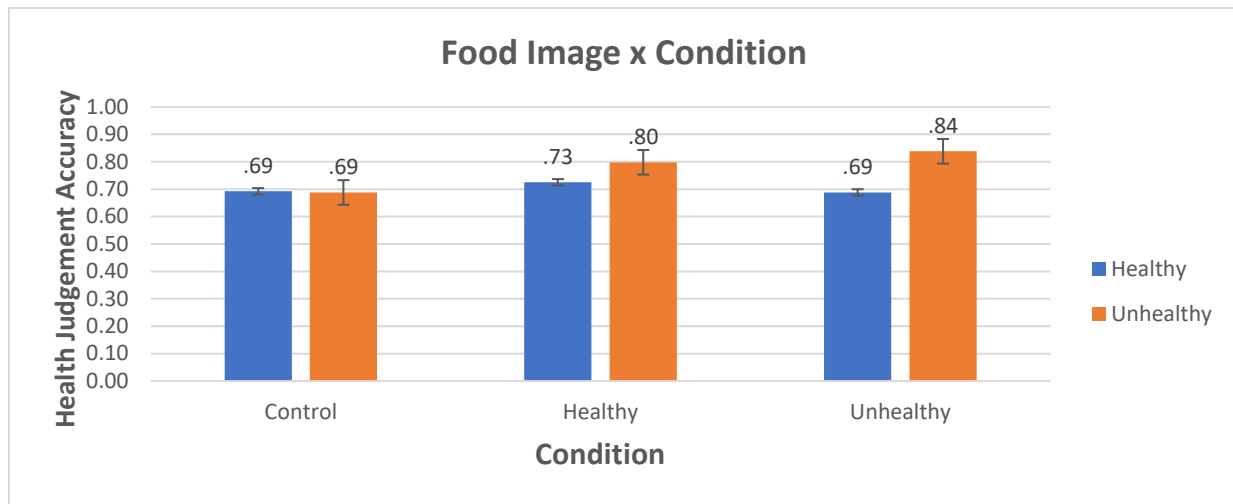
Note. Mean health judgement accuracy as a function of food image and condition.

We also hypothesized that, regardless of side-image condition, nutritional knowledge would reduce the impact of side images on health judgements, therefore, resulting in greater accuracy for experts than for novices. Contrary to our prediction, experts did not demonstrate greater accuracy than novices; the main effect of expertise was significant, $F(1, 145) = 6.25$, $p = .01$, $MSE = 0.41$ (see Figure 9), but novices proved to be more accurate in categorizing the foods than experts. It is possible that experts judged the foods used in this study as less healthy in general than did novices. This explanation will be discussed further in the Discussion.

In addition, neither the overall analysis, $F(2, 145) < 1$ (see Figure 10), nor in the planned comparison between the experimental conditions, $F(1, 97) < 1$, revealed a significant interaction of expertise and condition. As can be seen in Figure 10, health judgement accuracy did not differ between experts and novices across the three side-image conditions. Again, across conditions, novices had higher accuracy than experts, at least numerically speaking. Also, as shown previously, both of the side-image conditions demonstrated higher accuracy than the control
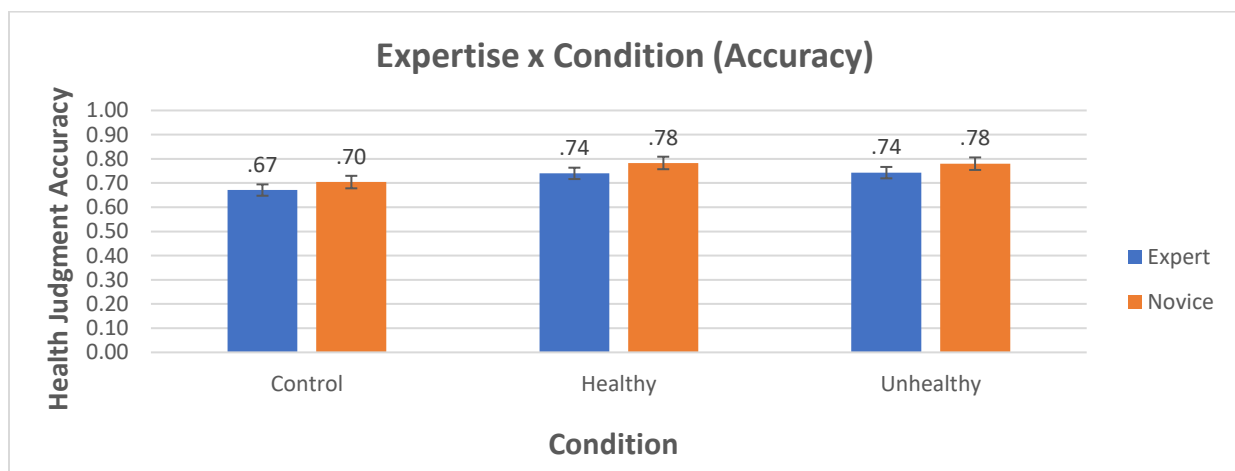
condition, again, at least numerically speaking. Taken together, we did not find experts to be more

knowledgeable (i.e., more accurate) than novices and, if anything, the opposite was true.

Figure 9. *Health Judgement Accuracy*

Note. Mean health judgement accuracy as a function of expertise.

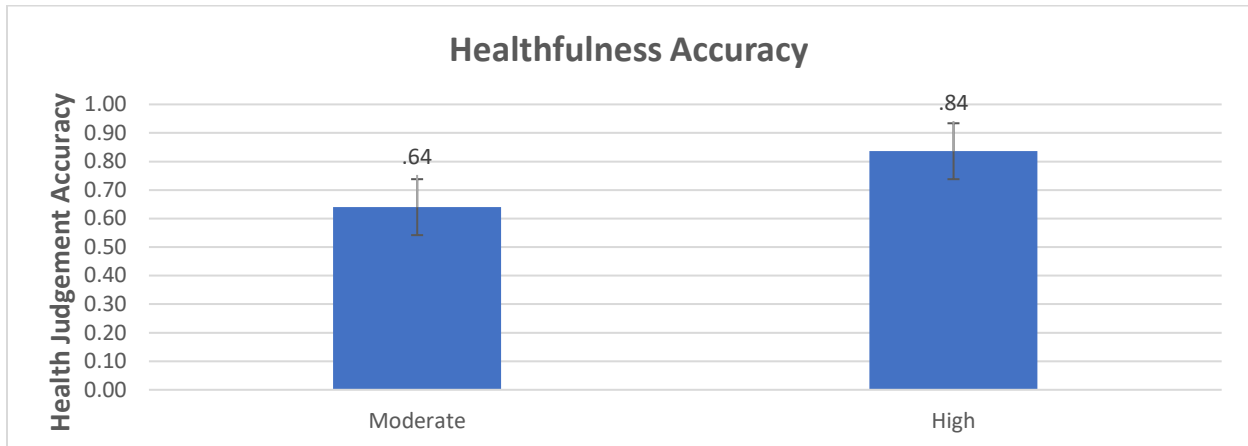**Figure 10.** *Health Judgement Accuracy*

Note. Mean health judgement accuracy as a function of expertise and condition.

Lastly, we hypothesized that accuracy in health judgements would be lower for moderate

healthfulness items than high healthfulness items, especially when paired with a side image.

Results indicated that accuracy for moderate and high healthfulness items did, in fact, differ; the

main effect of healthfulness was significant, $F(1, 145) = 347.79$, $p < .001$, $MSE = 0.20$ (see Figure

11). As can be seen in Figure 11, participants made less accurate health judgements for moderate
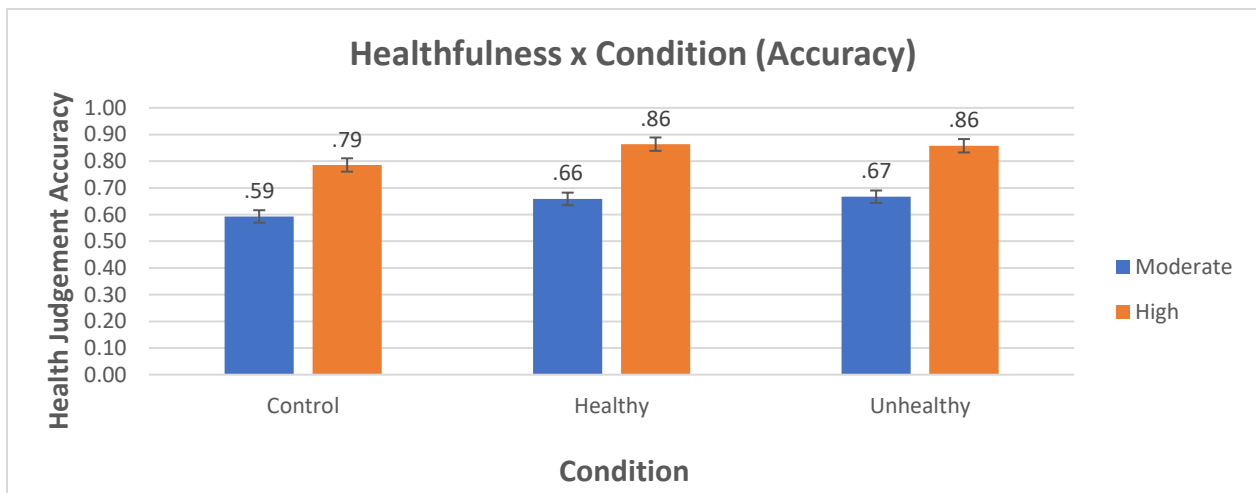
items than for high items. However, contrary to our prediction, no interaction was found between healthfulness and condition, $F(2, 145) < 1$ (see Figure 12).

Figure 11. *Health Judgement Accuracy*

Note. Mean health judgement accuracy as a function of healthfulness.

Figure 12. *Health Judgement Accuracy*

Note. Mean health judgement accuracy as a function of healthfulness and condition.

Calorie Estimates Proportional Relative Error (PRE)

A repeated measures ANOVA was conducted on the proportional relative error (PRE) of calorie estimates, and included condition (control, healthy, unhealthy) and expertise (expert, novice) as between-subjects variables, and food image (healthy, unhealthy) and healthfulness

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(moderate, high) as within-subjects variables. We hypothesized that calorie estimates would be lower for participants in the healthy side-image condition than for those in either the control or unhealthy side-image conditions. Again, this would demonstrate a health halo effect.

Participants across all three conditions tended to overestimate the number of calories shown (as reflected by positive PRE). In fact, this pattern was consistent across healthfulness and expertise (see Figures 15 through 18). Contrary to our predictions, side images did not influence calorie estimates differently across conditions; the main effect of condition was not significant, $F(2, 145) = 1.27$, $p = .28$, $MSE = 22.77$ (see Figure 13). However, as can be seen in Figure 13, numerically speaking, participants in the healthy side-image condition produced lower calorie estimates than those in either the control or unhealthy side-image conditions, and participants in the unhealthy side-image condition produced higher estimates than those in the control condition. A planned comparison between the healthy and unhealthy side-image conditions revealed a marginal effect of condition, $F(1, 97) = 3.02$, $p = .09$, $MSE = 19.03$.

We also predicted healthy side images would be more influential when estimating unhealthy food images than for healthy food images, demonstrating the typical health halo effect. In fact, the interaction between food image and condition was significant, $F(2, 145) = 3.28$, $p = .04$, $MSE = 1.83$ (see Figure 14). As can be seen in Figure 14, for both healthy and unhealthy foods, participants in the healthy side-image condition produced much lower calorie estimates than those in either the control or unhealthy side-image conditions. Moreover, participants in the unhealthy-side image condition tended to overestimate the number of calories in unhealthy foods relative to those in the other conditions. These results support a health halo effect. The planned comparison between the experimental conditions revealed a marginal interaction of condition and food image, $F(1, 97) = 2.69$, $p = .10$, $MSE = 1.79$. Importantly, regardless of condition, calorie estimates were

significantly higher for unhealthy food images than healthy food images; the main effect of food

image was significant, $F(1, 145) = 153.72$, $p < .001$, $MSE = 1.83$, suggesting participants could

clearly tell the difference between these food categories.

Figure 13. *Calorie Estimate PRE*
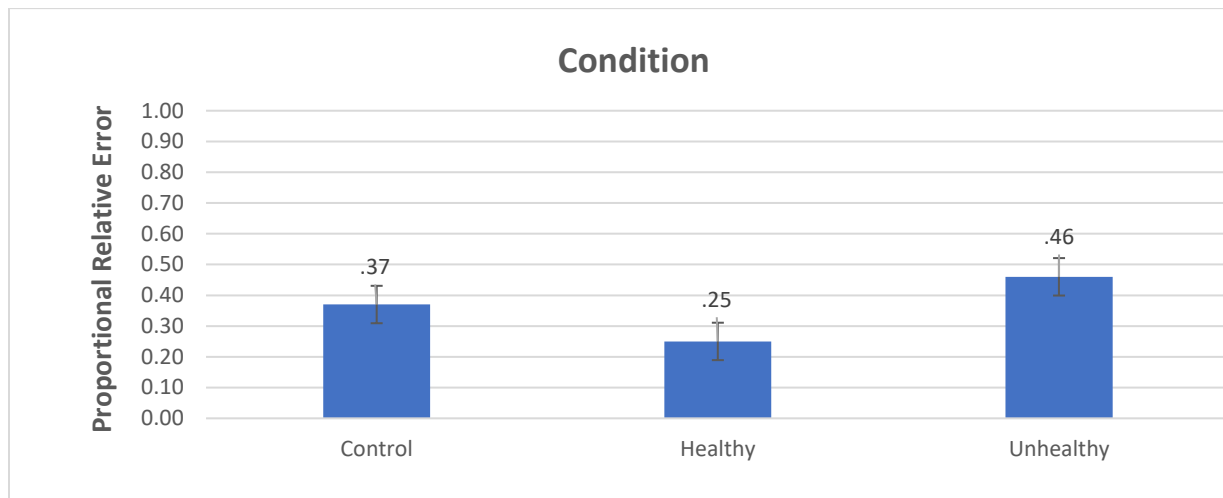
Note. Mean calorie estimate PRE as a function of condition.

Figure 14. *Calorie Estimate PRE*
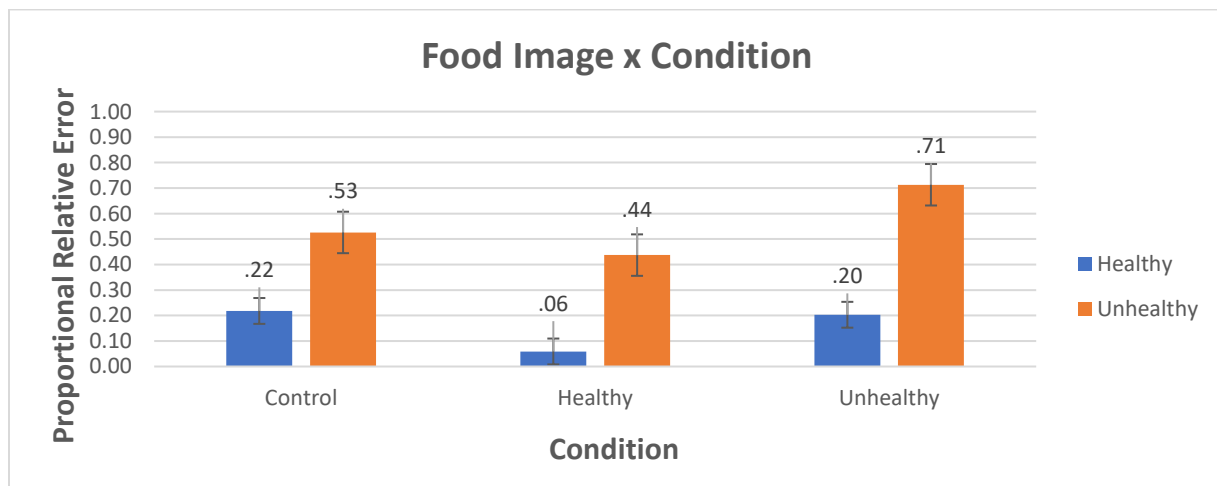
Note. Mean calorie estimate PRE as a function of food image and condition.

As for previous measures, we expected that nutritional knowledge would reduce the health

halo effect and, thus, proportional relative error would be more consistent across conditions for

experts than for novices. However, neither the main effect of expertise, $F(1, 145) = 2.41$, $p = .12$,

$MSE = 22.77$ (see Figure 15), nor the interaction between expertise and condition, $F(2, 145) < 1$, was significant. Contrary to our prediction, side images influenced experts just as much as they did novices. As can be seen in Figure 15, both experts and novices produced somewhat lower calorie estimates when food images were paired with a healthy side image than when paired with either an unhealthy side image or no side image.

Figure 15. *Calorie Estimate PRE*
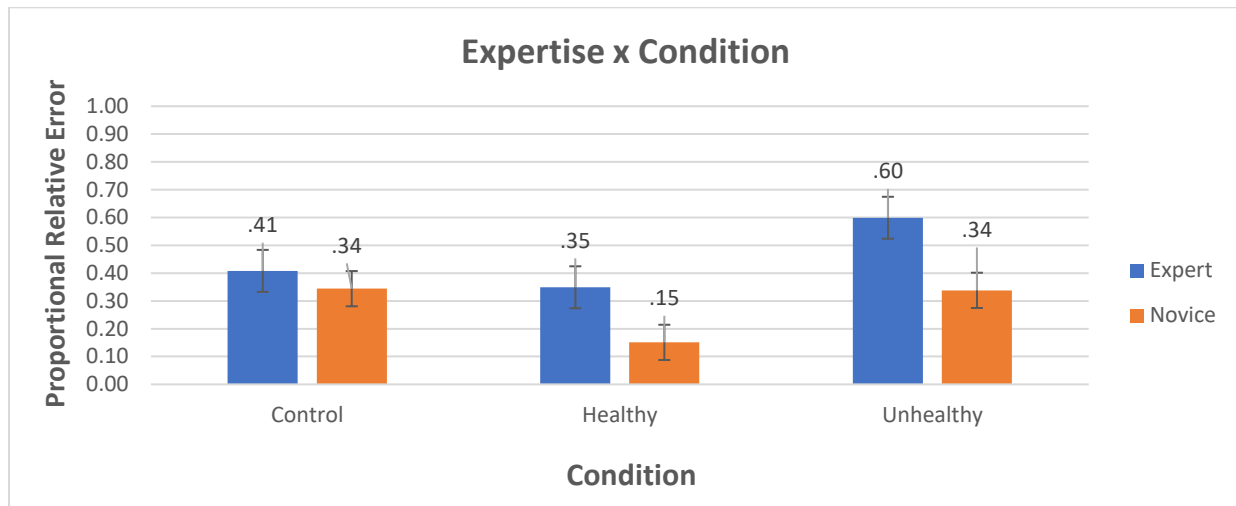
Note. Mean calorie estimate PRE as a function of expertise and condition.

In addition, we expected to see more consistent calorie estimates across healthfulness and condition for experts than novices (again, because moderate healthfulness items are presumably harder to categorize than high healthfulness items we expected moderate items to be highly influenced by side images, especially healthy side images, and more so for novices than for experts). Contrary to our prediction, however, the overall analysis revealed no interaction between expertise and healthfulness, $F(1, 145) < 1$ (see Figure 16), and the planned comparison between the experimental conditions revealed only a marginal interaction of expertise and healthfulness, $F(1, 97) = 3.12$, $p = .8$, $MSE = 0.44$. Thus, both experts and novices judged moderate healthfulness as having more calories than high healthfulness items.

The overall analysis also revealed a significant interaction of healthfulness, expertise, and condition, $F(2, 145) = 5.83$, $p = .004$, $MSE = 0.44$ (see Figure 17); however, that interaction was not significant in the planned comparison of the experimental conditions, $F(1, 145) = 2.10$, $p = .15$, $MSE = 0.44$. As can be seen in Figure 17, experts showed a health halo effect (i.e., lower calorie estimates for participants in the healthy side-image condition than the other conditions) for moderate healthfulness items, but not for high healthfulness items, whereas novices showed a health halo effect for both types of items. Taken together, these results suggest that experts were influenced somewhat more than novices by the presence of side images, which is contrary to what we expected.

Figure 16. *Calorie Estimate PRE*
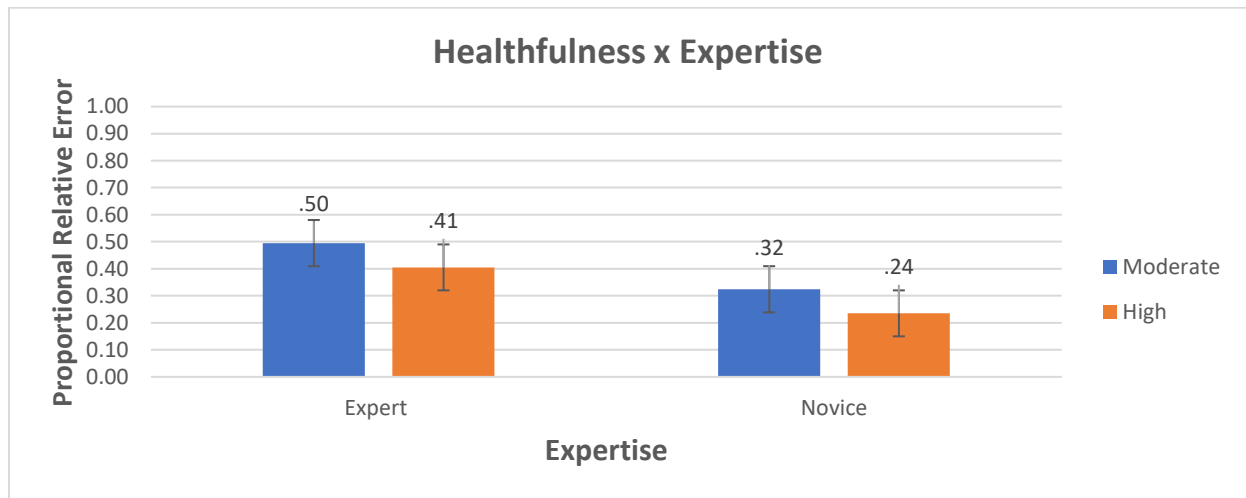
Note. Mean calorie estimate PRE as a function of healthfulness and expertise.

Figure 17. *Calorie Estimate PRE*
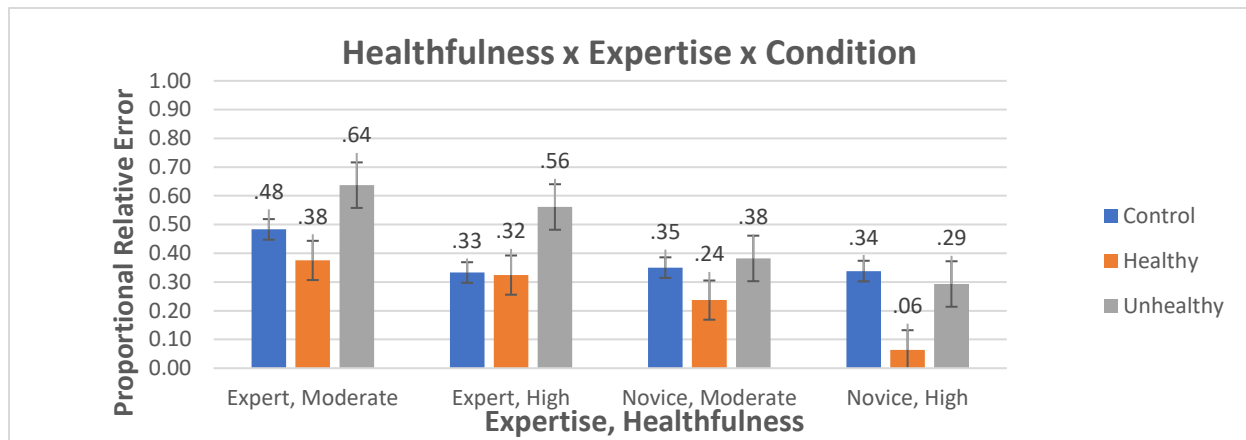
Healthfulness x Expertise x Condition

Note. Mean calorie estimate PRE as a function of healthfulness, expertise, and condition.

Lastly, we hypothesized that side images would be more influential for moderate healthfulness items than for high healthfulness items, especially when paired with a healthy side image. That is, we expected to see more error for moderate than for high items, especially in the healthy side-image condition. The main effect of healthfulness was significant $F(1, 145) = 34.20$, $p < .001$, $MSE = 0.44$. However, the interaction of healthfulness and condition was not significant, $F(2, 145) < 1$ (see Figure 18). Even still, as can be seen in Figure 18, numerically speaking, error was higher for moderate items than for high items, especially for the healthy side-image condition, supporting our hypothesis to a limited extent.

Figure 18. *Calorie Estimate PRE*

Healthfulness x Condition
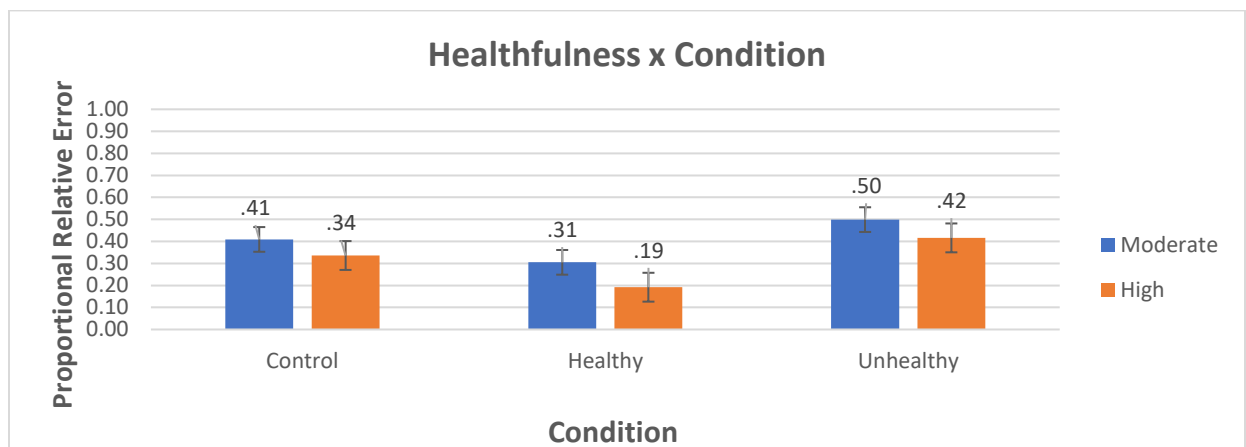
Note. Mean calorie estimate PRE as a function of healthfulness and condition.

Discussion

The role of various package attributes (e.g., font, color, pictures) on food perceptions and choices has been studied fairly extensively. However, the role of irrelevant images on food packages to influence health perceptions, especially in the context of uncertainty, is unknown. Further, limited research aimed at understanding how nutritional knowledge impacts health halo effects exists. Thus, the purpose of the present study was to better understand how knowledge, package attributes, and levels of healthfulness (i.e., uncertainty around categorization in terms of healthfulness) interact with one another when participants were tasked with making health judgments and calorie estimations.

Based on previous studies of the health halo effect, we hypothesized that side images would influence health judgements and calorie estimates for primary images, especially when healthy side images were paired with unhealthy foods (resulting in higher health judgements and lower calorie estimates). In addition, we expected the impact of healthy side images would be especially pronounced for moderate healthfulness items compared to high healthfulness items, because moderate items were more difficult to categorize than high items. Lastly, we hypothesized that nutrition majors would rely more on their knowledge of nutrition than on package attributes when making health judgements and calorie estimates compared to participants who were not knowledgeable in nutrition.

We expected healthy side images to influence health judgments and calorie estimates more than either unhealthy side images or no sides, especially for unhealthy foods. In terms of health judgments, we found that healthy side images did result in higher health judgments, especially for unhealthy foods, but only relative to unhealthy side images. In terms of accuracy of judgments, contrary to our hypothesis, we found that being shown no side images resulted in lower accuracy

across food (healthy, unhealthy) compared to healthy and unhealthy side images, therefore side images improved accuracy of health judgments. Finally, for calorie estimates, we found that healthy side images influenced calorie estimates, resulting in lower estimates for both healthy and unhealthy foods than either unhealthy side images or no sides. This pattern of results, however, was not always statistically significant and, thus, provide limited support for previous research on the health halo effect.

We also expected nutrition knowledge to reduce the reliance on side images. That is, experts were expected to make more accurate health judgments and show less error on calorie estimates than novices, and experts were expected to differ across conditions less than novices. In terms of health judgments, contrary to our hypothesis, we found that experts were significantly more influenced by side images, especially unhealthy side images, than novices, who did not differ across condition. In terms of accuracy of judgments, again, we found that experts were significantly less accurate than novices, overall, but only numerically less accurate than novices across condition. Finally, for calorie estimates, participants in the unhealthy-side image condition tended to overestimate the number of calories in unhealthy foods relative to those in the other conditions, however, contrary to our hypothesis, this effect did not differ across levels of expertise. Neither the main effect of expertise nor the interaction between expertise and condition was significant, suggesting nutritional knowledge was not useful for these tasks.

Finally, we expected side images to be more influential for foods that were relatively difficult to categorize compared to those that were relatively easy to categorize, especially for novices. In terms of health judgments, we found that judgements were significantly higher for foods harder (moderate) to categorize than easier (high) to categorize, and this was especially true for participants in the control condition. In addition, supporting our hypothesis, novices were

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significantly more influenced by foods that were harder to categorize than those easier to categorize regardless of condition. In terms of accuracy of judgements, we found that accuracy was significantly lower for foods that were harder to categorize than easier to categorize; however, contrary to our hypothesis and as discussed previously, both healthy and unhealthy side images resulted in greater accuracy, at least numerically, than when no side images were shown. Finally, for calorie estimates, we found that error was significantly higher for foods that were harder to categorize than those easier to categorize, but only when unhealthy side images were shown. Error was actually reduced by the presence of healthy side images, which is what we expected. In addition, contrary to our hypothesis, both experts and novices had higher error for foods that were harder to categorize than those than foods that were easier to categorize, especially when healthy or unhealthy side images were present, but novices benefited greatly from healthy side images when estimating the calories for items that were easy to categorize. In fact, numerically, novices showed almost no error for high healthfulness items, and experts had higher error than novices across both levels of healthfulness.

Previous research found that pairing an image of a healthy side dish (e.g., salad) with primary images of food (e.g., chili) caused participants to rate the primary images as being healthier than they actually were (Chernev, 2010). This is a demonstration of a health halo effect. In line with these findings, we were also able to demonstrate a health halo effect across multiple tasks and hypotheses, however, many of our effects were not statistically significant. Thus, it is possible that we did not have a sufficient number of participants in our study to find significant effects, and that our study lacked statistical power. In fact, numerical trends were often in the direction of our predictions. For example, in the calorie estimation task, we found that when healthy side images were paired with either healthy or unhealthy foods, these estimates were much

lower than when unhealthy side images or no side images were paired with these same foods. The opposite was also true for unhealthy side images. Specifically, when unhealthy side images were paired with unhealthy foods, calorie estimates were much higher than when no sides or healthy side images were shown. Taken together, our results replicated the pattern of those found by Chernev (2010).

Sakai and Morikawa (2006) found that pairing a picture of an apple (i.e., congruent) with apple juice resulted in higher palatability ratings than pairing a picture of an orange (i.e., incongruent) with the same juice, however when no picture was paired with the juice, incongruent pairings had higher ratings than the control condition. These results demonstrate that side images, whether congruent or incongruent with the primary image, had a greater influence on food perceptions than when no side images were shown. In the present study, we found that side images sometimes improved performance across tasks or resulted in greater error, especially with primary images that varied in certainty of healthfulness. Specifically, there was higher accuracy in health judgments when side images were present than when no side images were present. It's possible that side images encouraged a deeper level of cognitive processing than when no side images were present (Craik & Lockhart, 1972).

In fact, familiar meaningful stimuli are processed in a deeper way than less meaningful stimuli. For example, Diemand-Yauman, Oppenheimer, and Vaughan (2011) found that hard to read fonts (i.e., curly) were more accurately remembered than easier to read fonts (i.e., clean) because they required greater cognitive engagement. These findings suggest that disfluency (e.g., irrelevant side images; i.e., metacognitive difficulty associated with a task) in the stimuli shown may lead to greater retention and recall of those items than when there is fluency (e.g., no side images) in the items shown. In the current study, side images may have caused participants to be

more attentive of the food packages by processing information more deeply, resulting in higher accuracy. However, side images did not result in more accurate calorie estimates. This could be because health judgements are easier to make than precise calorie estimates, as they require less specific knowledge. That is, knowledge about calories has been shown to be highly specific to the trained items (e.g., Wohldmann, 2015).

In regards to knowledge, Irmak et al. (2011) found that being more knowledgeable in nutrition (i.e., dieter) resulted in rating unhealthy foods as less healthy compared to participants who were less knowledgeable in nutrition (i.e., non-dieters). These findings suggest that higher knowledge may increase sensitivity to food cues, whether erroneous or not, compared to lower knowledge. We found a similar pattern between experts and novices. Specifically, experts demonstrated greater sensitivity to side images than novices, especially when side images were unhealthy. This extra attention to side images may have resulted in greater error, such as in the calorie estimation task for experts shown unhealthy side images. However, we were able to find more significant differences between experts and novices for health judgments than calorie estimates. One potential explanation for why experts and novices showed similar patterns of performance could be that making health judgments is highly subjective, relative, and based on personal opinions rather than objective facts. In contrast, calorie estimates are more objective, and based on a factual understanding of calories and exposure to this information. That said, it is possible that experts and novices have had similar levels of exposure to calorie information, especially given it is presented on packaged foods and at many restaurants.

In retrospect, the fact that our so-called "experts" did not outperform novices is not entirely surprising. Backstrand et al. (1997), for example, also found that nutritionists and dieticians significantly underestimated the number of calories for ambiguous meals containing both healthy

and unhealthy components. However, this was not true for single ingredient foods, such as milk, which resulted in more accurate estimates compared to the former. A possible driving force behind these errors could be the influence of health halos. Specifically, if ambiguous foods contain healthy (e.g., fruits) or unhealthy (e.g., chocolate) ingredients or images, this may cause individuals to use those foods as indicators of healthfulness, therefore resulting in higher estimates and lower judgments when unhealthy side images are shown and lower estimates and higher judgments when healthy side images are shown. The present study also used complex foods with multiple ingredients. Future studies might explore these questions using simple foods.

Research has also shown that low levels of familiarity with a food brand resulted in both higher health judgments and lower calorie estimates than branded food products (Werle et al., 2016), however, those judgments and estimates were not always accurate. That is, low familiarity with a food product resulted in greater error, both overestimating and underestimating the healthfulness of the food. The same could be true for ambiguous foods compared to easy to categorize foods. Specifically, we found greater error in estimates, as well as higher judgments for foods harder to categorize (e.g., fruit cookies) than those easier to categorize (e.g., raw pistachios). It could be the case that foods were harder to categorize, in part, because participants were less familiar with those foods.

Overall, the present study showed that side images influenced health perceptions, their influence varied relatively little between experts and novices, and their influence was greater for ambiguous foods than for foods that are widely considered to be either healthy or unhealthy. To what extent would we find this similar pattern when looking at actual food packages of ultra-processed foods in the real world is still unknown. Regardless, however, the current study builds on previous literature on health perceptions and nutrition, and provides some novel findings. First,

our findings extend to prior research that package attributes do influence health perceptions, and can cause a health halo effect, but unexpectedly, these attributes sometimes improved performance across tasks compared to when no side images were shown.

Contrary to what we expected, both experts and novices demonstrated patterns of a health halo effect. We expected experts to use their knowledge to increase accuracy of responses rather than rely on package attributes, and novices were expected to use package attributes (e.g., side images, food name, primary image) to make their health judgements and calorie estimates. It is possible that, despite the fact that experts scored higher on the nutrition questionnaire than novices, that they were unable to generalize their knowledge to these tasks. It is also possible that our selected stimuli could have made the tasks more difficult for experts than novices. That is, when developing our stimuli in Experiment 1, we had introductory psychology students judge whether the food images shown were either healthy or unhealthy, and only one licensed nutritionist verified those health judgements to make sure they fit into the correct health category. As discussed above, health judgments are very subjective and, thus, having multiple nutrition experts verify our categories might have been useful.

It is also possible that experts and novices utilized the same anchoring strategy (rather than knowledge) to come to their final answers (e.g., Forwood et al., 2013). In fact, it is possible that side images could have been used as anchors on which participants based their health judgements or calorie estimates when assessing the primary images; also, each trial could have served as anchor for the consecutive trial. For example, for the health judgment task, participants were shown one package per question and could not go back after their answers were submitted. When judging the healthfulness of each package, participants could have used previous packages shown as anchors to judge the latter questions. That is, if they were previously shown an image of tortilla

chips (anchor) that they judged as unhealthy, and then they were shown a protein bar, they would question whether this food is healthy or unhealthy compared to what they previously saw. Therefore, a protein bar would be judged as healthier than tortilla chips. This process could also be used for the calorie estimation tasks. Specifically, anchors could either be estimates for previous questions or side images for the current question, which are then adjusted to the final answer. Additional research is needed to explore this question further.

Another possible reason for these findings for experts could align with previous research that studied differences in responses based on both eating behaviors and food knowledge (Yegiyan & Bailey, 2016). Specifically, regardless of knowledge, participants with unhealthy eating behaviors had higher and more positive responses to unhealthy than healthy foods. In the context of the present findings, it is possible that if experts had unhealthy eating behaviors, then regardless of their knowledge, unhealthy food items could be judged as being healthier than they actually are.

Although we found that package attributes may be used as cues when judging the healthfulness of the foods, it is also possible other factors were at play. For instance, we also had the name of the food item at the top of the food package, which could have been the first piece of information participants looked at prior to the side images to make their judgments and estimates. However, that may not be the case. Previous research on eye-tracking and food packaging studied what attributes found on the front of a wine bottle attracted consumers attention, as well as in what order (Gofman, Moskowitz, Fyrbjork, Moskowitz, & Mets, 2009). Findings revealed that participants gazed at the center of the bottle where the pictures (e.g., wine bottle, grapes) were located longer than the label located at the top of the bottle. Therefore, there was more attention on the picture and less on the text when making health perceptions; also, visual aids may be the first piece of information that individuals take in before any other package attribute because they

may be easier to process when making health perceptions. Taken together, it is possible that the primary image and/or side images did have a greater influence on health judgments and calorie estimates than the name of the food item.

Future studies should investigate other factors that influence health perceptions for food packages presented. Although we did not study the impact of anchoring and adjustment based on provided or estimated anchors, this concept should definitely be studied in the context of knowledge (e.g., Smith & Windschitl, 2015) and health perceptions. In addition, regarding individual differences, researchers could also examine the impact of eating behaviors on health perceptions and how these health behaviors are influenced by health halos and knowledge. Lastly, researchers could study differences based on actual packages created by food marketing industries and removing just the brand names, as well as examining the impact of congruency of images, both food-related and non-food objects (e.g., Mizutani et al., 2010). While we have learned a great deal over the last couple of decades, so much is still unknown about the role of knowledge and the impact of health halos on food and health perceptions, but investigating these variables and factors above may help food manufacturers and public policy makers develop packages and educational campaigns aimed at improving food choices and increasing the likelihood that consumers will rely on knowledge rather package information, which is often misleading.

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