Nutrient-Specific System v. Full Fact Panel: Understanding Nutritional Judgment Using Lens Model Analysis

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ABSTRACT

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Nutrient-Specific System v. Full Fact Panel: Understanding Nutritional Judgment Using Lens Model Analysis

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Current food labels include comprehensive nutritional information, but evaluations of their effects on judgments of nutritional quality and food choice are scarce. Building on previous empirical research that demonstrates that amount and complexity of information is negatively related to judgment accuracy, this study used an experimental design to evaluate nutritional information labels of varying complexity. Lens model analysis (Brunswik, 1955; Cooksey, 1996; Hammond, 1955; Stewart, 1976) was used to quantitatively compare individuals' judgment accuracy to a gold standard nutritional quality criterion in three conditions that implemented front-of package (FOP) labels. The conditions were: no highlighted information, information highly related to nutritional quality highlighted, and information marginally related to nutritional quality highlighted. Findings indicate that different FOP labels had different effects on accuracy, but there were no effects of FOP labeling on judgment consistency, model agreement, or nutritional choice. Implications for understanding efforts to improve American food choices and reducing obesity are discussed.

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INTRODUCTION

In the last five decades the prevalence of obesity has dramatically increased. For example, in 1962, only 13% of American adults were obese; yet, as of 2012, 35% of adults and 17% of children in the United States were obese (Flegal, Carroll, Kuxzmarski, & Johnson, 1998; Ogden, Carroll, Kit & Flegal, 2014). Obesity is associated with increased mortality and morbidity as well as steep economic costs for individuals and society. In particular, researchers estimate that obesity-related medical expenses account for 20.6% of U.S. national health expenditures; this corresponded to approximately $209.7 billion dollars in 2008 (Cawley & Meyerhoefer, 2012). One important presumed contributor to obesity is the increased consumption of highly processed, energy-dense foods (e.g., Institute of Medicine, 2005; McGinnis, Gootman, & Kraak, 2006).

In an effort to address the issue of obesity, the US Nutritional Labeling and Education Act (NLEA) of 1990 mandated the use of a standardized nutrition label on food products but the effect of this label unclear (Food and Drug Administration, 1994). Early studies examining the impact of the new Nutrition Fact Panel (NFP) labels showed that it had a beneficial impact on consumer decision-making. For instance, a study examining salad dressing sales found that following the implementation of the NFP, dressings high in fat lost about 5% in market share, and low fat dressings experienced corresponding increases (Mathios, 2000). However, most of the studies addressing the usage of NFP by consumers rely on self-reports of routine behavior and NFP usage when shopping. Such studies fail to take into consideration psychological research indicating that humans are often unaware of the underlying judgment processes that affect their decisions (e.g., Moorman, 1996; e.g., Shafir & LeBoeuf, 2002). Furthermore, national self-report surveys as well as point of purchase studies, in which consumers are interviewed about their food choices in grocery stores, indicate that consumer understanding and use of NFP information varies according to individual demographic and motivation characteristics (International Food Information Council Foundation, 2012, e.g., Burton, Garretson, & Velliquette, 1999). Additionally, analyses of market sales and self-reported consumption over time indicate that aggregate improvement of American nutrient consumption since the implementation of the NFP is small or nonexistent (Variyam, 2008; Weil, Fung, Graham, and Fagotto, 2006). In short, studies showing the NFP to be highly effective were performed early after the label's enactment or rely entirely on self-report. Subsequent studies have shown little to no effect indicating that the label has limited, if any, effect on actual behavior.

One possible explanation for the limited effect of the NFP may be the nature of the information provided in the labels. Specifically, research indicates that judgment accuracy is often negatively related to the amount of information available, particularly when that information is difficult to interpret or to consolidate (e.g., Eppler & Mengis, 2004; Karelia & Hogarth, 2008). In the last decade, several U.S. food corporations have implemented Front-of-Package (FOP) labels that highlight select nutrients from the NFP (Brownell & Koplan, 2011). Psychological research indicates that reduced, pointed information often results in better decision-making than a surplus of information (e.g., Karelia & Hogarth, 2008), yet further investigation of FOP labels is necessary to determine whether they would have this positive effect on nutritional understanding and decision-making (Hamburg, 2010).

The current study analyzed how label information affects what specific nutrient information people use to judge nutritional quality. Lens model analysis, a quantitative method of analyzing the information considered in making a judgment (Cooksey, 1996), was used to provide a statistical estimate of how product nutrients impact individual nutritional judgments. Additionally, this study examined whether highlighting specific nutrient information affects judgment of nutritional quality. I compared the accuracy of participants' nutritional judgment in three conditions: 1) using the current NFP labeling system; 2) using both the NFP and a FOP nutrition label that highlighted only a few, specific nutrients highly related to overall product nutritional quality; and 3) using a FOP nutrition label that highlighted a few, specific nutrients only marginally related to overall nutritional quality.

Nutritional Labelling: Utilization and Effects

The US Nutritional Labeling and Education Act of 1990 (NLEA, 1990) mandated that packaged food products display a standardized nutrition label providing information on the product such as serving size, servings per container, the amount of calories per serving as well as total fat, cholesterol, sodium, carbohydrates, sugar, total protein, and dietary fiber. The legislation of a standardized nutrition label—the NFP—greatly increased the amount of information available to consumers regarding the nutrients in packaged foods, allowing consumers the opportunity to make better-informed decisions regarding the food products they buy and eat. However, studies examining the degree that consumers use the NFP in making food choices have had mixed findings.

Findings on the Effects of NFP Labels

Some early research indicated implementation of the NFP had positive effects on the comprehension and use of nutrient information, but later studies indicated these effects are limited. A telephone survey study found that label use following the NFP implementation increased an average of ten percentage points (Kristal, Levy, Patterson, Li, & White, 1998). Fewer people reported confusion or difficulty reading the label compared to prior to the NFP implementation when label inclusion was largely voluntary (Institute of Medicine, 2010; Kristal, Levy, Patterson, Li, & White, 1998). In a field study, Moorman found that the NFP improved consumer information acquisition—measured as time taken to choose food category brands—and comprehension, operationalized as the recall accuracy of the product total fat level (Moorman, 1996). In this quasi-experimental, naturalistic study, Moorman found that information acquisition and comprehension increased after the implementation of NFPs compared to information acquisition and comparison prior to the NLEA (Moorman, 1996). A later study's in-store observations and follow-up shopping simulations in a laboratory setting found no evidence of improved information acquisition, or information comprehension after the introduction of NFP labels compared to before the NLEA (Balasubramanian & Cole, 2002).

More recent studies indicate that American dietary decisions as a whole have not been positively impacted by the NFP implementation. Weil, Fung, Graham, and Fagotto (2006) concluded that despite some groups having high comprehension and response to the NFP implementation, overall positive effects of the NFP on public health are unclear. Initial decreases in American per capita fat consumption following the implementation of the NFP were short-lived, increasing to previous levels by the year 2000. In the same time period, sugar and calorie consumption increased (Weil, Fung, Graham, & Fagotto, 2006). Based on an analysis of self-report consumption data gathered by the USDA, Variyam (2008) concluded that the NFP implementation had a modest beneficial impact on public consumption habits by increasing dietary intake of fiber and iron, although no other positive effects were found.

Individual Differences in NFP Use

The lack of a robust effect may be due in part to the variability in use and comprehension of the NFP by consumers. One common finding of nutrition label studies is a great degree of variability in consumer consideration of nutrient information and its ultimate impact on their product choices. A telephone survey report found that changes in label use were not consistent across demographics: elderly and less-educated individuals were more likely than others to find the NFP labels too difficult to understand (Kristal, et al., 1998). Moorman (1996) found that motivation and skepticism among consumers moderated the amount of information acquisition in which they engaged, with more motivated and less skeptical consumers being more likely to acquire nutrient information. A 2016 article found that individual variables were predictive of consistency in use of nutrient information and accuracy of nutritional judgment (González-Vallejo, Lavins, Carter, 2016). The authors found that jointly, gender, race, age, education, annual income, employment status, BMI, healthy attitudes, health issues, and dietary behaviors significantly predicted information use consistency, with higher education and erroneous dietary beliefs having significant positive and negative relationship, respectively, with nutrient use consistency after controlling for the other variables. Individual differences in gender, age, education, annual income, dietary behaviors, and reported use of the NFP throughout the study were jointly predictive of participant judgment accuracy. However, on average both the accuracy of participants' judgments and the consistency of their use of NFP nutrient information was modest.

Lin, Lee, and Yen (2004) found that people who believe these is no relationship between diet and disease consume more negative nutrients such as total fat and cholesterol and are less likely to search for information on food labels and those who agree that diet affects risk of disease. In line with this finding, González-Vallejo, Lavins, and Carter (2016) found that reporting having a health issue that affected food choice showed less nutrient use consistency in making food judgments. It may be that lack of nutrient information use and poor food choices may share a causal factor in understanding of nutrition; recent research indicated that obesity knowledge was positively related to nutrition judgment accuracy (González-Vallejo & Lavins, 2015). These findings, as well as those demonstrating the effects of nutrition motivation on label use and comprehension, indicate that the lack of aggregate consumer nutrient improvement may be because the NFP implementation has failed to have an effect on individuals with the least healthy dietary intake (e.g., Moorman, 1996; Burton, Garretson, & Velliquette, 1999).

Lack of a robust effect of the NFP may also be related to variability in NFP use across products. From consumer focus groups on food choices, Balasubramanian and Cole (2002) observed that consumers' search for nutrition information varied according to their perception of the food category in question. For instance, the authors found that shoppers were more likely to consider nutritional quality in a category such as breakfast cereals compared to foods they consider inherently unhealthy, or nutritionally irrelevant, such as snacks or desserts. Differences in product category judgments examined by González-Vallejo, Lavins, and Carter (2016) found that although participants had more consistency in their use of nutrition information for cold cereals than snacks, their accuracy compared to a gold standard was higher for snacks than cereals. Nonetheless, even these higher accuracies were at best moderate.

In part in response to the lack of a consistent positive effect of NFP on nutritional understanding and consumer choice, the FDA (Philipson, 2005) called for an increase in more controlled studies examining the relationship between food labelling and product demand. The FDA expressed the need for more experimental designs with higher control, noting that the majority of studies on this topic “focus on correlations of labelling use and diet choice” (p. 263S) and thus could be finding relationships that are due to alternative factors such as previously existing consumer food knowledge and motivation. Although acknowledging that further measures beyond the current labelling method are required to address the obesity epidemic, the FDA cautioned that new proposals for such labels must be based on solid scientific evidence (Philipson, 2005). Experimental designs are necessary to produce such evidence. Previous research has clearly indicated that individuals differ in their label use and eating habits, but whether this relationship is causal cannot be determined without an experimental design. Without a design that controls for individuals who may have preexisting conditions that make them less likely to use the NFP and less likely to eat healthily, we cannot determine the existence of a causal relationship between NFP use and healthy eating.

Front-of-Package Labelling

Recent FDA commissioner, Dr. Margaret Hamburg (2010) wrote that improving the scientific accuracy and overall utility of food labeling was a priority, naming the development of a front-of-package labelling system as a specific focus. In early 2011, two major American food-industry associations announced voluntary nutrition labelling that would give consumers succinct nutrition quality information on the front of food products (Brownell & Koplan, 2011). Front-of-package (FOP) labels, although not necessarily on the front of food packages and varying in the information they convey, appear in visible areas of the package. FOP labels currently come in three system types: (a) food groups information systems use symbols assigned to a product due to the presence of a food group or ingredient in that product; (b) nutrient-specific FOP systems display the amount per serving of specific nutrients from the NFP or use symbols claiming health or nutritional benefits; and (c) summary indicator systems use a single symbol or score that provides a summarization of the nutritional quality or content of a product (Institute of Medicine, 2010). Figure 1 shows examples of each FOP system type.

Figure 1. Front-of-package systems.

A 2012 systematic review of 111 articles identified 38 empirical studies examining consumer response to front of package labelling (Hersey, Wohlgenant, Arsenault, Kosa, & Muth, 2013). The review determined that FOP labels lead consumers to pay more attention to nutrition information and can help them make better food choices (Hersey et al., 2013). Specific differences between FOP labeling systems were also found. FOP summary systems were found to attract consumer's attention, but consumers more easily identified healthier foods using nutrient-specific than summary systems. For selection, consumers had more facility selecting healthier products when they offered textual or symbolic direction (i.e. the multi-colored nutrient-specific FOP system in Figure 1) rather than only numeric information (Hersey et al., 2013). Studies examining the impact of FOP labeling on purchase behavior and dietary behavior are limited and show mixed results, some finding FOP labels lead to healthier purchases and others finding no effect (Hersey et al., 2013).

There is a particular caveat to this review. The majority of studies reviewed were conducted outside of the United States, in European countries where nutrition information inclusion has historically been voluntary (Hersey et al., 2013; European Food Information Council, 2015). Legislation mandating nutritional information inclusion in the EU only took effect in December 2016 and format requirements for companies voluntarily providing nutrition information are as recent as December 2014 (European Food Information Council, 2015). Thus, it is possible that the demonstrated utilization of FOP systems in European studies are due to the novelty of the nutrition information being supplied, particularly in studies that compare FOP labels to conditions where no nutrition information is included (e.g., Borgmeier & Westenhoefer, 2009 & Synovate, 2005). An additional consequence of nation-level differences in labeling requirements is that many of the existing studies on FOP labels do not provide sufficient insight into the interrelationship between the NFP and FOP labels (Hersey et al., 2013).

Thus far, the implementation and success of FOP systems in the United States has varied. Several researchers have raised concerns that due to the industry-initiated nature of current FOP systems and the lack of an official or regulatory FDA policy, FOP labelling systems may be manipulated by the industry to increase profit margins, rather than healthy consumer choices (e.g., Brownell & Koplan, 2011; Hawley et al., 2012). “Smart Choices” a FOP labeling program implemented in 2009 and voluntarily used by industry leaders such as General Mills, Kraft, Kellogg, and Unilever, was heavily criticized and eventually suspended after its green checkmark meant to indicate high nutritional quality was found on sugary cereals, mayonnaise, and chocolate popsicles (Connecticut Attorney General's Office, 2009; Manning, 2010). Smart Choices was developed by the nonprofit organization Keystone Center who brought together scientists, food industry experts, and consumers to develop the nutritional guidelines underlying the program (Manning, 2010). Although boasting science-based nutrition criteria consistent with authorities such as the Dietary Guidelines of America, Smart Choice's development meetings, totaling over $680,000, were funded by food companies. Following the meetings, fourteen corporations contributed $1.47 million to sponsoring Smart Choices creation (Lupton et al. 2010; Manning, 2010).

Critics see industry funded and developed FOP labels as an attempt to preempt the FDA and other regulatory agencies to avoid the implementation of a FOP system based on actual relevant science (Brownell & Koplan, 2011). Brownell and Koplan (2011) note that the FOP label program Nutrition Keys, developed by major food-industry trade associations the Grocery Manufacturers of America (GMA) and the Food Marketing Institute (FMI), was launched in early 2011 after the CDC and the FDA had commissioned the Institute of Medicine (IOM) to establish an expert committee to issue recommendations for FOP labelling. The initiative of GMA and FMI in launching Nutrition Keys is seen by some as an effort to avoid further federal regulation and maintain content control over new labels. The implication is that the food industry seeks to establish labelling techniques that would delay any new labelling regulations and serve to promote products rather than improve consumers' judgment of product quality and ultimate product selection.

If the purpose of the food industry was indeed to preempt FDA regulation or standardization of FOP labels, it seems to have succeeded, at least temporarily. In late 2011, the IOM concluded that it was time to “move away from systems that mostly provide nutrition information without clear guidance about its healthfulness, and towards one that encourages healthier food choices through simplicity, visual clarity, and the ability to convey meaning without written information” (IOM, 2011, p. 1). Furthermore, the IOM recommended a single, standardized FOP system that would be present on every product in a consistent location across products to allow easy comparison within and across food categories (IOM, 2011). Despite the Nutrition Keys program not satisfying the standards recommended by the IOM in late 2011 the FDA accepted the GMA and FMI request for the FDA to exercise enforcement discretion of certain aspects of the program (Taylor, 2011). In an open letter to the associations, the FDA notes that it will not be exercising enforcement discretion on companies that use the Nutrition Keys system in a misleading manner but rather will assess over time whether the system in fact contributes to public health (Taylor, 2011).

The presumed utility of food labels such as the NFP and FOP labels lies in their ability to communicate information to consumers. The assumption behind label legislation and regulation is that labels are able to communicate information that impacts consumers’ purchasing behavior and can be used to aid consumers in making good decision. Although some contend that the motivations of the food industry will always be in direct conflict with the interests of public health, there is empirical evidence that a nutrient-specific system, such as the Nutrition Keys FOP, may improve consumer judgments compared to the traditional NFP label (Andrews, Burton, & Kees, 2011). The extent that NFP and FOP labels jointly impact individual judgment and subsequent behavior is not well understood (Hersey et al., 2013). Yet, understanding this relationship is imperative to improving communication of nutrient information (Hamburg, 2010). Previous empirical research examining the relationship between information and judgment and behavior can contribute towards a greater understanding of nutrient labels and their impact on consumer product judgment.

Lens Model Analyses of Nutrition Judgments

A primary resource the current study drew upon to understand nutrition judgments was a theory and methodology from judgment and decision making psychology called the lens model. This theoretical and methodological model, the lens model, has been applied to examine judgment accuracy and consistency in many other domains such as clinical, medical, and meteorological judgments (e.g., Hammond, 1955; González-Vallejo, Stewart, Sorum, Chessare, & Mumpower, 1998; Stewart, 1990). It has also recently been applied to examining nutritional judgments, and found to be helpful in clarifying the relationship between food judgments and label information (González-Vallejo, Lavins, & Carter, 2016; González-Vallejo & Lavins, 2015).

Brunswik's (1955) probabilistic functionalism describes the statistical relationship between a judgment and a criterion variable with the lens model. The lens model envisions the judgment process as a statistical function that relates cues in the environment, proximal to the judge, to both the judgments and to a distal criterion in the environment. The model thus provides a methodology for analyzing the relationship of an individual's judgment to the cues existing in the environment as well as assessing the ecological validity of those cues (Cooksey, 1996). This model can also be used to understand judgment accuracy by examining how an individual's judgment relates to the value of the criterion variable (e.g. Hammond, 1955; Stewart, Roebber, & Bosart, 1997). The application of the lens model to psychological research has led to a greater understanding of the situational factors that influence judgment. In particular, studies focusing on the conditions under which judgment formation occurs have found that the number and complexity of cues impact the accuracy of judgments made, with higher cue complexity and number leading to less accuracy in judgment (e.g., Bernieri, Davis, Gillis, & Grahe, 1996; Reynolds & Gifford, 2001). The following sections first describe the origins of probabilistic functionalism and the lens model analysis. As will be shown, research with the lens model methodology has advanced great insights as to conditions that make judgment accuracy low, thus increasing understanding of information complexity.

Lens Model Analysis

The modern analysis of human judgment originated with the criticism of behaviorism by the Austrian psychologist Egon Brunswik (Cooksey, 1996). In Brunswik's view, the psychology of his time was overly nomothetic, focused entirely on controlling subject sampling to the exclusion of context sampling (Brunswik, 1955). The lack of attention to environmental considerations makes it impossible to fully understand the contexts and conditions that accompany discovered phenomena. Without an understanding of the environment that a phenomenon occurs in, the findings of laboratory conditions cannot be expected to lead to actual prediction and control of phenomena. From this perspective, the entire status of psychology as a science was woefully in jeopardy due to establishing its discoveries on behavior observed under artificial conditions (Cooksey, 1996). Accordingly, Brunswik (1955) argued that the role of psychology should be to analyze an organism in terms of its interaction with its environment and recommended a probabilistic methodology that would allow for examining this relationship in terms of the uncertainty that exists in the natural world (Goldstein, 2004). Brunswik developed a psychological approach based on this perspective and named it probabilistic functionalism.

Probabilistic functionalism emphasizes the goal of psychology as “a functionally oriented objective psychology” that is concerned with the relationship between the organism and its environment (Brunswik, 1955, p. 193). As the term emphasizes, a functional psychology examining the relationship between organism and environment is “inherently probabilistic” due to the elements of randomness present in the environment that organisms exist in (Brunswik, 1955, p. 193). Brunswik’s approach is essentially idiothetic, focused on systematically investigating various individuals and examining not only the individual behavior but also the environment that the individual was reacting to (Cooksey, 1996, p. 7).

Brunswik developed the lens model as a method for representing the environment-organism relationship. The application of the lens model design allows for examination of not only the phenomenon in question but also of the relationship of that phenomenon to the environment that it occurs in. Kenneth Hammond (1955) was the first psychologist to apply probabilistic functionalism to an area other than perception (Cooksey, 1996). In applying Brunswik’s ideas and methodological design to examine the judgments of clinical psychologists in patient diagnosis, Hammond provided a practical application of Brunswik’s ideas that led to the spread of probabilistic functionalism to many other domains (Hammond, 1955; Karelaia & Hogarth, 2008). Since Hammond's work, Brunswik's lens model has been applied to various different topics including: medical and psychological diagnosis, weather forecasting, educational learning, policy-making, and business evaluations (e.g. Cooksey, 1996; González-Vallejo, et al., 1998; Hammond & Adelman, 1976; Karelaia & Hogarth, 2008). As the lens model is interested in modeling the environmental factors, its construction varies according to the environment of the domain being explored. For example, in an area such as nutrition, lens model analysis may linearly model the relationship between the environmental cues related to a food product and available to the consumer (e.g., nutrients on an NFP label) and the nutritional value the consumer believes a product to have (e.g., González-Vallejo, Lavins, & Carter, 2016).

In the area of judgment analysis, there are several variations of the lens model. The simplest methodological design is the "single-system design," which describes the relationship between the organism and the environment by modeling the relationship between an individual's judgment and the environmental cues that judgment is based on (Cooksey, 1996). This approach is useful because it takes context into account and allows for comparison between the effects on judgment of one context versus another. The single-system design lens model is particularly useful because it allows for a systematic understanding of the judgment process even when criterion variables are unknown. This allows experimenters to develop a more detailed portrayal of the underlying influences on a judgment rather than simply observing judgment in a contextual void (e.g., Hammond & Adelman, 1976). A graphical representation of the single-system lens model design can be seen in Figure 2.

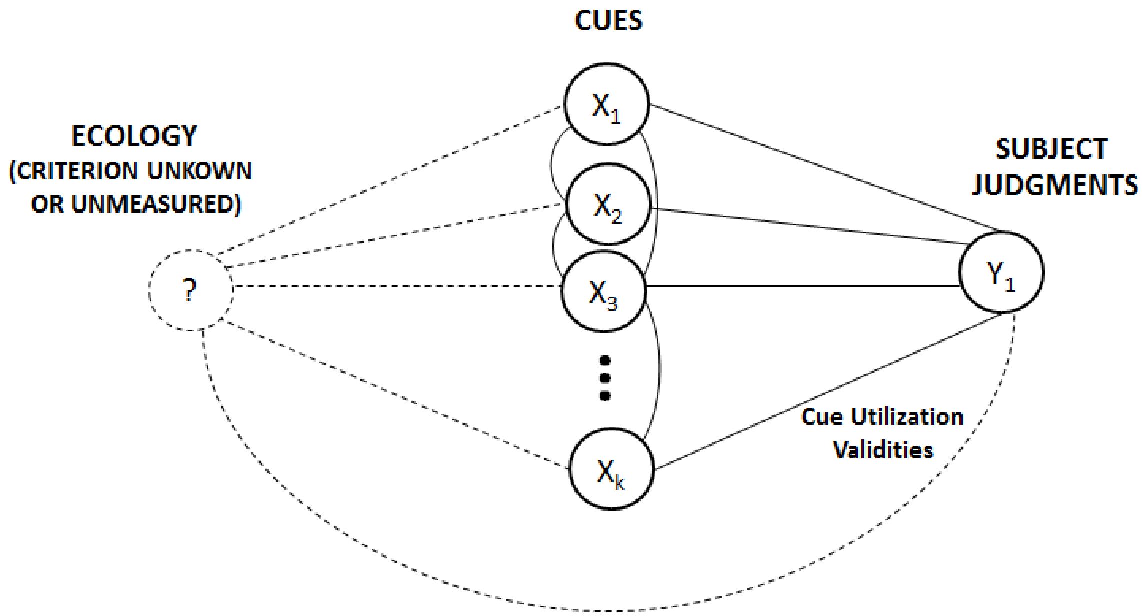

Figure 2. Lens model single-system design (Cooksey, 1996, p. 56). Dotted lines show what ecological relationships are expected to exist but no actual comparison is possible.

In a nutritional environment, a single-system design lens model could be used for instance, to depict the relationship between nutrients in a product and experts' judgment of the healthiness of the product. In that situation, a "correct judgment" can be derived from the policies of several experts and the design would allow us to understand how experts define nutritional quality.

The original lens model proposed by Brunswik, called the "double-system design" consists of the relationship of an individual's judgment to the cues existing in the environment as well as the ecological validity of those cues to the criterion variable being estimated by the individual (Cooksey, 1996). This format (see Figure 3) can be used to understand an individual's use of cues in judging a variable that can be objectively measured in which case the criterion variable is the known reality that the judge is attempting to determine. For instance, in the case of meteorological forecasts, atmospheric cues are used to determine whether rain will or will not occur. The prediction of the meteorologist can be related to the various atmospheric cues to understand how the judgment process occurred. Additionally, the atmospheric cues can also be related to the criterion and assess their validity in predicting the event, e.g., rain or no rain. The accuracy of the meteorologist's forecast can also be determined by comparing the forecast to the actual meteorological event.

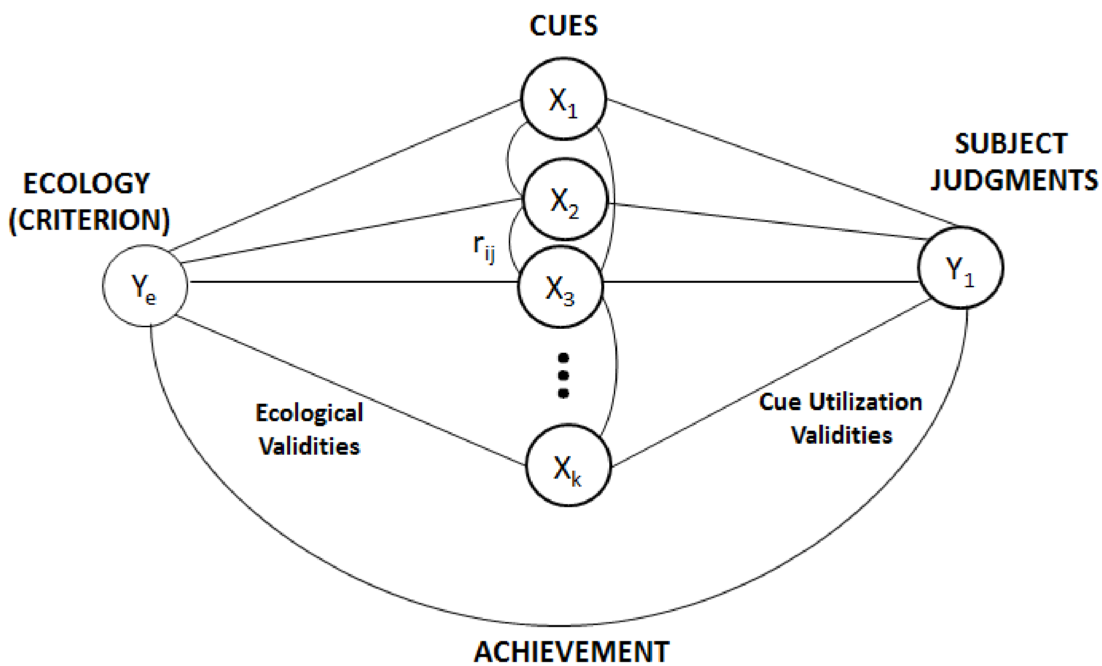

Figure 3. Lens model classic double-system design (Cooksey, 1996, p. 61).

The double-system design can also be used to model an individual's judgment compared to criterion variables whose ecological values are approximated by tests and taken to be the best possible estimate of the true criterion. For example, most people would agree that nutrition scientists and medical physicians have a better understanding of the nutritional quality of foods than most laypeople. In this case, the exact accuracy of a nutritionist's judgment of the nutritional quality of a product is not known, but can be expected to be a better estimation of the true nutritional quality than the judgment of a layperson. Thus, this expert judgment can be used as the criterion value, against which a layperson's judgment is compared, despite the true ecological value being unknown. Thus, regardless of whether the true value of the criterion is known, the double-system lens model design allows for accounting of the influences of the environment on judgment and facilitates comparison of how an individual's judgment relates to the criterion or an approximation of the criterion (e.g. Hammond, 1955; Stewart, Roebber, & Bosart, 1997).

Additional systems, the "triple-system" and "n-system" designs, compare individuals' judgments and cue utilization to each other and to a known or unknown criterion respectively. These designs can be used to depict two different judges' accuracies in relation to a known or expertly estimated criterion, or to compare the differences or similarities in cue utilization of individuals' judgments when the ecological validity of the cues is uncertain or simply not of interest (Cooksey, 1996; e.g., Batchelor, Badenbaugh, Leonard & Williams, 1987; González-Vallejo et al., 1998).

The conceptualization of the lens model gave rise to statistical indices to quantitatively describe the relationships between the various components of the lens model (Cooksey, 1996). The lens model equation (LME) decomposes the variance achievement—that is, the correlation between the subject's judgment and the criterion—into several components. Statistical models of the relationships of the criterion (O) and the judgment (Y) are first developed:

Equation 1:

$$O = M_{O.X}(X_1, X_2, \ldots, X_n) + E_{O.X}$$

$$Y = M_{Y.X}(X_1, X_2, \ldots, X_n) + E_{Y.X}$$

where O is a *n* x 1 vector of observations of the criterion, Y is an *n* x 1 vector of observations of subject judgments, X_i are the cues ($i = 1$ to n), $M_{O.X}$ and $M_{Y.X}$ represent the weights that describe the relations between the cues and the criterion and the cues and the judgment respectively; and the E's, that represent the residuals of the models and are not linearly related to the weights. The partitioning of the judgment and the criterion is used to derive a two-component formulation (Stewart, 1976):

Equation 2:

$$r_{YO} = R_{O.X}\, G\, R_{Y.X} + C\sqrt{1 - R^2_{O.X}}\,\sqrt{1 - R^2_{Y.X}}$$

$R_{O.X}$ is the correlation between O and $M_{O.X}$, a measure of environmental predictability. G is the correlation between $M_{O.X}$ and $M_{Y.X}$, a measure of the agreement between the criterion weights of the cues and the judgment weights of the cues. $R_{Y.X}$ is the correlation between Y and $M_{Y.X}$, a measure of the consistency of the weighting of the cues by the judge. C is the correlation between $E_{Y.X}$ and $E_{O.X}$, a measure of the correlation between the variation of the target and the judge that is unaccounted for by the weighted cues. If the weighted cues capture the systematic variance, then C should be near zero. That is, the errors of Y and O should not be linearly related to each other if the weighted cues capture the systematic variation in Y and O. Significant C's indicate that there is shared linear variance that is not account for by the cues, meaning there is systematic variation in Y and O that is not accounted for by the weighted cues.

One important contribution of lens model analysis has been to identify the many sources that lead to judgment errors. The following section first details the challenges judges face when identifying and using information to make judgments. A brief review of the economic rationality argument is presented to set the framework for analyzing the psychological evidence regarding judgment consistency and accuracy.

Effects of Information

The traditional "rational man" view of humans as rational decision-makers has been shown to be a limited representation of human decision-making (e.g., Simon, 1955; Shafir & LeBoeuf, 2002). One characteristic of the rational decision-maker is an ability to integrate and consider all relevant information available. For such a decision-maker, more is better (i.e., more information available leads to the better decisions). In contradiction to the rational view, psychological research has demonstrated that the storing capacity of human working memory is limited (e.g., Miller, 1956; see Mathy & Feldman, 2012, for a review of relevant studies). As limited information processors, a surplus of information can have debilitating consequences on human ability to accurately judge, fully comprehend, and appropriately act in certain scenarios.

Three areas of research have shown that various forms of increased information debilitate, rather than enhance, the judgment and decision-making process: information overload, too-much-choice-effect, and lens model judgment and task analyses. These areas demonstrate that amount of information, whether practical information, choice options, or number of cues, can have negative effects on judgment and decision-making. Information overload outlines the contributing factors of processor capacity and processing needs that lead to failures in information processing (Eppler & Mengis, 2004).

Too-much-choice-effect provides empirical evidence of the non-monotonic relationship of option number and decision satisfaction, with small and large numbers of options resulting in decreased satisfaction (Schwartz, 2004; Reutskaja & Hogarth, 2009). Finally, lens model analysis research shows how quantitative methods can be used to describe the relationship between the amounts of information used, the nature of the task, and judgment accuracy, as well as the effects of the two former on the latter. Research in this tradition has found that difficult environments that present many cues for consideration may result in less optimal judgments (Karalaia & Hogarth, 2008).

Information Overload

The concept of "information overload" has been defined as the point that information processing requirements exceed information processing capacities (Galbraith, 1974; Tushman & Nadler, 1978). The phenomenon of information overload has been observed in three main information processing areas: information retrieval, organization, and analysis processes, decision processes, and communication processes (Eppler & Mengis, 2004). Information overload has been investigated in many diverse professional fields such as business, finance, marketing, medical diagnosis, strategy development, library management, and aviation (see Eppler & Mengis, 2004 for a complete list). Researchers have noted when information processing requirements that surpass information processing capacity, the overload causes individuals to use less available information, or to experience dysfunctional effects such as stress and confusion (e.g., Swain & Haka, 2000; Meyer, 1998).

Across the wide range of contexts under which information overload has been examined, the primary causes and effects of information overload are fairly consistent.

Eppler and Mengis (2004) developed a conceptual framework to structure the research on information overload that emphasizes information overload as “a system of circular, interdependent relationships” (p. 329). This framework includes four factors that presumably contribute to information overload: the person interacting with the information, the information technology used, the information itself, and the task or processes required. These four factors, explained in detail below, determine whether information overload occurs. That is, information overload is rarely a result of only one of these constructs, but instead results from the interaction among constructs. Given that information overload occurs due to a lack of information processing capacity compared to the information processing requirements, the relationship between the capacity characteristics and the requirement characteristics is what determines whether information overload occurs (Eppler & Mengis, 2004).

The characteristics of the person processing information is the first factor impacting information overload. Consistent with previous research demonstrating individual differences in NFP use and comprehension, individual characteristics such as level of knowledge, experience, and personal skills can influence one’s ability to interact with information (Owen, 1992; Swain & Haka, 2000). Motivation, for instance, may decrease the likelihood of information overload by increasing the individual’s information processing capacity, allowing them to rise to the high demands of a complex task (Muller, 1984). Skill and familiarity is also relevant. For instance, a nutritionist or medical expert will have greater knowledge of, and experience with, nutritional information. Thus, the processing requirements of information that appear incomprehensible and inconsistent to the average consumer will be reduced for experts because their abilities reduce the complexity of the task. This can be explained by information "chunking," that is, when various pieces of information can be grouped together as a single unit, they can more easily be processed in working memory (Mathy & Feldman, 2012). One researcher has defined chunks as "a collection of concepts that have strong associations to one another and much weaker associations with other chunks concurrently in use" (Cowan, 2001, p. 89). Those intimately familiar with the information at hand are more likely to be able to associate relevant concepts to each other in a "chunk," thus facilitating their ability to cognitively interact with that information in an efficient manner.

Aspects of an individual's interaction with information can affect processing capacity. Information technology has been shown to increase an individual's information processing capability as well as inhibit it (Edmunds & Morris, 2000). For instance, an individual's access to nutrition information on products or to nutritional blogs can improve one's ability to distinguish healthy from unhealthy foods; however, information technology can also increase information processing requirements (Speier, Valachich, & Vessey, 1999). For example, individuals who follow multiple healthy eating blogs and receive constant unsolicited input from friends and family on what dietary habits are optimal may be unable to effectively draw conclusions from this information due to the amount of time necessary to consider and verify it. Consumer information technology use has been associated with nutritional concerns that are not evidence-based. Such misconceptions affect behavior, leading consumers to extensively avoid food ingredients and products (Bearth, Cousin, & Siegrist, 2014; Hagemann & Scholderer, 2009). Individuals investigating specific food fears can use the Internet to easily find support for their or others' concerns, moreover, as the Internet provides easy accessibility to biased information determining whether the source of information is reputable can be challenging (Wansink, Tal, & Brumberg, 2014).

The nature of the information itself is an important factor in information overload. Information overload may occur as a result of the sheer amount of information (i.e., the quantitative aspect) that must be considered, or as a result of the characteristics of the information (i.e. qualitative aspects) such as the ambiguity, novelty, or complexity of the information (e.g. Iselin, 1993; Keller & Staelin, 1987). The level of ambiguity, novelty, complexity, and intensity of the information can have a powerful impact on the extent that information becomes too taxing to be processed effectively or efficiently (Schneider, 1987). Moreover, in the realm of healthy eating, information is often inconsistent and contradictory (Davis & Saltos, 1999). When information is inconsistent, incomprehensible, or ill-structured the capacity required to process it increases, increasing the likelihood that the processing requirements will surpass processing capacity (Simpson & Prusak, 1995).

Lastly, the characteristics of the task that the information is being used for is an important factor. If a task itself is complex in terms of how, or to what degree it incorporates information, then information processing requirements are increased (Bawden, 2001). Likewise, if the task is novel or the time to complete it is limited, processing requirements will be increased (Tushman & Nadler, 1978). For example, the task of shopping in a supermarket involves varied degrees of information availability, amount, and novelty. The fruit and veggie section of a market includes limited specific nutrient information, but similar food products in the frozen aisles contain packaging with extensive nutrient information. An individual may be accustomed to purchasing particular products and brands, and thus selecting a new brand or a new product will demand additional time if the selection is to be based on nutritional factors. Time constraints are of particular relevance in naturally-occurring events given that daily tasks rarely have the luxury of unlimited time. Even tasks, such as grocery shopping, that have become mundane in their reoccurrence can be frustrating and overwhelming when one has insufficient time to complete them.

Too-Much-Choice-Effect

Research from social psychology has demonstrated the adverse effects of information amount in the form of choice options, finding that a larger number of options has negative behavioral and affective consequences. For example, using a jam booth in a supermarket, Iyengar and Lepper (2000) studied the effect of a large number of options on consumer purchasing, comparing the number of people who purchased jams after being exposed to a 24-jam sample booth or a 6-jam sample booth. The researchers found that people who were exposed to a smaller selection of jams were more likely to stop at the booth. Additionally, participants who stopped and tried a jam from the 6-jam sample booth were nearly 30% more likely to purchase a jam than those who had encountered the larger selection.

Iyengar and Lepper (2000) described several follow-up studies that replicated the "too-much-choice-effect" across different contexts. Generally, they found that a higher number of options reduced decision-making facility and satisfaction with one's choice. In a naturalistic experiment, 197 students were given a list of either 6 or 30 essay topics from which to choose from for a non-graded, extra-credit assignment (Iyengar & Lepper, 2000). The impact of the number of options on motivation and performance was measured according to the percentage of participants in each condition who chose to write an essay and the quality of the essay. The essay quality was determined by grades assigned by graduate students blind to the choice condition of the essays and the study's hypotheses. Consistent with the too-much-choice-effect, the percentage of participants in the 6-topic condition who chose to complete the assignment (74%) was significantly higher than that of the 30-topic condition (60%). The performance of students in the 6-topic condition was also significantly higher. A third study examining the effect of options on chocolate sampling found that while participants reported higher enjoyment after selecting a chocolate from 30 compared to 6 alternatives, those participants with the wider selection reported less satisfaction with their choice and were subsequently less likely to choose a box of chocolates over money as compensation (Iyengar & Lepper, 2000). Similarly, other studies examining choice behavior have found that maximizers – people who seek to make the best choice by examining all possible options, have more regret, depression, and decision difficulty and less happiness, optimism, life and decision outcome satisfaction compared to satisficers – those who simply seek to make a "good enough" choice (Schwartz, et al., 2002; Iyengar, Wells, & Schwartz, 2006, however, see Scheibehenne, Greifendeder, & Todd, 2010, for failures to replicate this phenomenon).

The too-much-choice effect has been taken to indicate that a consistent negative relationship exists between number of options and choice behavior (Chernev, Böckenholt, & Goodman, 2010). Despite this, having the power to make decisions and additional options from which to choose has also been associated with beneficial increases in motivation, perceived control, performance, and satisfaction (e.g. Zuckerman et al., 1978; Ryan & Deci, 2001). Additionally, having too few options, or none at all, has been shown to negatively affect the satisfaction of consumers and the likelihood that they will make a purchase (e.g., Oppewal & Koelemeijer, 2005).

An examination of findings on both sides of the too-much-choice debate indicates that it is unlikely that the effect of options on choice is linear. For example, a study that examined participant satisfaction in choosing between gift boxes found that participants reported less satisfaction with their choice and choosing process when they had very few (5) or very many (30) options, but higher satisfaction with both choice and choice process when they had a between 10 and 15 options (Reutskaja & Hogarth, 2009). This study also found differences in satisfaction according to the choice task facing the participants. Participants who chose between 30 options of different colored boxes reported higher process and outcome satisfaction than those who chose between 30 options of differently shaped boxes, indicating that the more complex processing of shapes (see Spring & Jennings, 1993) led to the too-much-choice effect (Reutskaja & Hogarth, 2009). The authors concluded that satisfaction is an inverted U-shaped function of alternative number due to the increase in alternatives resulting in a slower increase in benefits relative to costs (Reutskaja & Hogarth, 2009).

Complexity of Information within Lens Model Research

The application of the lens model and LME to psychological research has led to a greater understanding of the situational factors that influence judgment. Several studies focusing on the conditions that judgment formation occurs have found that the number of cues impact the accuracy of judgments with more cues leading to less accuracy in judgment. In a meta-analysis of 248 studies using lens model analysis, Karelaia and

Hogarth (2008) found that the number of cues available impacted the accuracy of judgment. Participants in studies that used fewer cues had significantly higher accuracy in their judgments than those in studies with higher numbers of cues regardless of domain (Karelaia & Hogarth, 2008, p. 413).

The negative relationship between cue number and judgment accuracy could be due to individuals unduly weighting cues with minimal relevancy to the actual variable. In studying judgments of forecasters, Stewart (1990) notes that the degree that forecasters emphasize some cues over more ecologically valid ones can decrease forecasting accuracy (p. 665). Just as a judge's focus on cues with low ecological validity could result in less accurate judgment, a large set of available cues that includes cues of low ecological validity offers greater opportunity for the judge to focus on cues of minimal or no relevancy. For instance, a lens model analysis examining judgments of rapport between paired males and females, found that out of a total of 17 cues, judges focused exclusively on one cue, expressivity. Although expressivity was an ecologically valid cue in predicting inter-couple rapport, it was not the only valid cue or even the most predictive one and the exclusive focus on this single cue resulted in overall low accuracy among judges than could have been reached if the judgments also attended to female gestures, posture shifts, and proximity (Bernieri, Davis, Gillis, & Grahe, 1996). In this case, the predetermined exclusion of marginally relevant cues may not have resulted in the most relevant cues being focused on, but it would have reduced the likelihood that a singly-selected cue would be one of marginal relevance.

An additional example of how high numbers of cues might decrease judgment accuracy comes from a 2001 study examining judgments of intelligence (Reynolds &

Gifford). Judges in three conditions—auditory-visual, visual-only, and auditory-only—rated the intelligence of high school students in one-minute videos of the students outlining their opinions on specific issues. Although auditory cues accounted for a higher proportion of the explained variance in intelligence, both auditory and visual cues were ecologically valid and together accounted for a significantly higher proportion of variance than either set explained individually (Reynolds & Gifford, 2001, p. 194). Nonetheless, judges in the auditory-only condition had higher accuracy in judgment of intelligence than judges who watched the video with the audio. The decrease in accuracy in the visual-auditory condition was attributed to judges' failure to relate ecologically valid visual cues to intelligence and their tendency to focus on cues that had no ecological validity (Reynolds & Gifford, 2001).

Another finding of lens model analysis is that the degree to which individuals can achieve high judgment accuracy depends on the domain (Karalaia & Hogarth, 2008; Kaufmann, Reips, & Wittmann, 2013; Kida, 1980; Stewart, 1990). A psychometric meta-analysis of lens model studies found that judgment performance was moderated by the domain of the task: clinical psychology had the lowest judgment achievement, whereas education and medicine had higher judgment achievements, but were surpassed by judgment accuracy in professional domains such as meteorology, sports, and business (Kaufmann, Reips, & Wittmann, 2013). One possible difference that could be contributing to disparities in accuracy of judgments among domains is the consistency and saliency of cues. A comparison of domains with high judgment accuracy to ones of low judgment accuracy demonstrates important differences in cues. Meteorologists, for instance, have tremendously high judgment achievement and consistently predict weather conditions with astounding accuracy (Stewart, 1990). Meteorological cues (e.g., humidity) are better defined, and the tools for measuring them more precise than tools for measuring cues in a domain such as mental health and antisocial behavior where judgment accuracy as well as environmental predictability is particularly low (Cooper & Werner, 1990). In these cases, inaccuracy may be due to inconsistent or inconspicuous cues as opposed to the inadequacies of the judges.

In the realm of nutritional judgment, the nutrient content of a food may not be saliently displayed due to inadequate packaging, or there may be inconsistencies in how nutrients interrelate with food products. For example, saturated fats are generally considered to be a detrimental nutrient that consumers are instructed to avoid but nutritional research has indicated the effect of saturated fats vary according to product, with some foods high in saturated fats being neutral or even beneficial (Astrup et al., 2011). In this case, the cue of "saturated fat" being in a product can be negatively or positively related to nutritional health depending not on any information in the cue itself but on the food product being judged.

A lens model analysis of lie detection found that although people have very poor judgment accuracy in detecting deception, the inaccuracy is not due to reliance on invalid cues (Hartwig & Bond, 2011). This study found that people associate deception with ecologically valid cues, but that these cues are weak predictors. In other words, the cues people look for are indicative of lying, but there is not a dramatic difference between the exhibition of these cues among liars and non-liars (Hartwig & Bond, 2011). As the ecologically valid cues are not sufficiently salient, accurate judgment of lying has great challenges despite correct cues being used. Similarly, in a nutritional setting, the healthy choice may be unclear not because consumers are not looking at the relevant cues, but because those cues are not sufficiently salient. For instance, a knowledgeable consumer may focus on purchasing products low in sodium. Such a strategy would facilitate nutritional choices among some products but would not help the consumer choose the healthier option between two types of products low in sodium, such as plain frozen vegetables. In such a case, the fault is not with the validity of the cue involved—sodium is in fact related to nutritional quality—but rather with the saliency of the cue in the given situation.

A related aspect that might account for domain differences is training in cue utilization, and the precision with which the criterion itself is measured. Due in part to the existence of standardized detection and interpretation methods, meteorologists receive training in cues that are largely consistent in producing specific results (Stewart, 1990; Stewart, Roebber, & Bosart, 1997). Similar to meteorology, lens model studies in business areas have found judgments of business firm difficulties to be highly accurate, in some cases even more accurate than a mathematical model (Kida, 1980). In these studies, high accuracy has been suggested to be due to the previous training and expertise of the judges as well as a more reliably measured, well-defined, and predictable criterion compared to those of other domains (Kida, 1980; Libby, 1976; Stewart, Roebber, & Bosart, 1997). If precision, reliability, and predictability of the criterion are necessary factors in accurate judgment, this could be one of the shortcomings that limits expert judges from performing adequately in domains with low judgment accuracy as has been demonstrated in clinical psychology and lie detection (Hammond, 1955; Hartwig & Bond, 2011).

The impact of cue number and saliency on judgment is important because it provides insight into what influences judgment in a real-world environment, such as food quality judgment. The finding that the number of cues affects accuracy seems counterintuitive, when making a complex judgment it seems natural to assume that the more information the better. Findings from lens model studies however, like many of those examining information overload and too-much-choice effect, indicate the opposite. Using the lens model analysis as a framework to understand nutrition judgments, it is likely that imperfect examination of nutrient information may debilitate judgment to a greater degree than incomplete information would even if all relevant nutrient information about a product is available. Despite the availability of complete nutrient information, deficits in comprehension may be contributing factors to continued misjudgment of food products. For instance, lack of ability to interpret the meaning of nutrients (which are healthy and which are not) would reduce or eliminate the utility of nutrient information on judgment. Likewise, a lack of training in determining a comprehensive view of a food product based on the various individual nutrients would impede accurate judgments.

Information Effects' Relationship to Nutritional Judgments

Use of FOP label systems have not been without criticism. The lack of experimental research on the utility of such labels to consumers, as well as controversies involving FOP labels have resulted in skepticism towards industry-initiated labelling, including the nutrient highlighting Nutrition Keys program (e.g., Brownell and Koplan, 2011). Previous research has also indicated that comprehensive information, such as that included on the required NFP labels, can debilitate, rather than facilitate optimal judgment and decision-making (e.g., Iselin, 1993; Karelaia & Hogarth, 2008; Keller & Staelin, 1987). Studies in information overload indicate that effective information processing is affected by characteristics of: the person, such as individual familiarity; the interaction with the information, such as the level of attention invested; the information, its complexity and amount; and the task, such as the time available. Social psychology research had indicated that considering too much information, in the form of options available, results in greater decision-making difficulty and diminished choice satisfaction. Studies using lens model analysis have found that the amount, and complexity of information is negatively related to judgment accuracy. These studies indicate the density of information on the NFP label may be a limitation rather than an asset. If information amount and complexity adversely affects consumer processing, FOP labels may improve consumer judgments and decisions by implicitly directing consumers to process a smaller, more manageable, amounts of information.

Current Study

This study compared judgment accuracy when participants used the NFP compared to when participants were provided with both the NFP and a FOP label highlighting specific nutrients from the NFP. The effect of nutrient information on nutritional judgment was investigated using an experimental design informed by previous judgment and decision-making research. Previous research on the effectiveness of FOP labelling has found that such labels can increase consumer attentiveness to nutrition information and healthy food choice (Hersey et al., 2013). This research, however, predominantly included European samples, many of whom may not be accustomed to the inclusion of nutritional information. In particular, the impact of FOP labels *in addition* to the current NFP labels needs further clarification (Hersey et al., 2013). By examining the use of nutritional information using an experimental design that includes FOP and NFP labels as well as measures of choice rather than retrospective self-reports, the current study fills gaps in nutrition research and will be useful for informing future FDA regulations.

The lens model provides a unique opportunity to study nutritional judgment and its relationship to nutrient information at the individual person level. This study used the double-system lens model (see Figure 2) to model the relationship between nutritional judgment and cues in the form of nutrients on the NFP and FOP labels to provide an in-depth portrayal of the relationship between individual nutritional judgments and actual nutritional quality. Although previous studies have used the lens model to examine nutritional information (e.g., González-Vallejo & Lavins, 2015; González-Vallejo, Lavins, & Carter, 2016), it has not been used to investigate the effect of FOP labels on judgment.

To determine whether judgments of nutritional quality are accurate, it is necessary to establish some standard by which to compare individual participant judgments. For this reason this study used the NuVal® score (referred to simply as NuVal hereafter) as the criterion value. NuVal is a Nutrition Scoring System developed by medical and nutritional experts that summarizes the overall nutrition of a food on a scale from 1 to 100. Higher scores indicate higher nutritional quality (NuVal LLC, 2015). NuVal scores are determined by an Overall Nutritional Quality Index (ONQI) algorithm that converts complex nutritional information from the NFP into a single score by computing the ratio of weighted healthy nutrients in a product and weighted unhealthy nutrients (NuVal LLC, 2015). NuVal scores will be used as the “gold standard,” or criterion, in this study, an expert measure of nutritional quality. Previous studies investigating nutritional judgment accuracy have used NuVal as the gold standard (González-Vallejo & Lavins, 2015; González-Vallejo, Lavins, & Carter 2016). The validity of the NuVal ONQI algorithm in predicting lower risk of chronic disease and total mortality for individuals who consumed higher scored products has demonstrated its practical utility as an expert standard (Chiuve, Sampson, & Willett, 2011; Reedy & Kirkpatrick, 2011).

To determine whether the highlighted information of a nutrient-specific FOP label affects judgment accuracy, three conditions were compared. In every condition participants were presented with a cereal name, an image of the front of the cereal box, along with the cereal’s Nutrition Fact Panel, and a list of ingredients. The first condition (hereafter referred to as “NFP-only condition”) included only the standard NFP information. The second condition (hereafter referred to as “FOP1 condition”) included the NFP information as well as an adapted General Mills “Facts Up Front” front-of-package label highlighting the number of calories and product amounts of nutrients highly relevant to the NuVal rating of nutritional quality. The third condition (hereafter referred to as “FOP2 condition”) included the NFP information and an adapted version of the General Mills “Facts Up Front” front-of-package label highlighting the number of calories and product amounts of nutrients only marginally relevant to nutritional quality (see Appendix A for examples of the three conditions). Participants provided nutrition evaluations of each cereal along with a choice (whether or not they would include the item in their “shopping cart” – see Appendix B and the Methods section for further details about the elicited responses).

Nutrients for the FOP labels were determined based, in part, upon the current nutritional literature's designation of particularly relevant nutrients to modern Americans. The 2015 Dietary Guidelines Advisory Committee (DGAC) identifies two levels of "Nutrients of Concern" in the adequacy of American's nutrient intake; nutrients that are overconsumed and under-consumed according to nationally recognized standards. Nutrients of concern were determined by accounting for nutrient intake levels, biochemical markers of nutritional status, and associations with health outcomes (DGAC, 2015). This analysis determined that the nutrients of concern for a substantial proportion of the total population were: vitamin D, calcium, potassium, and fiber due to under-consumption and, sodium and saturated fats due to overconsumption (DGAC, 2015). Although sugar consumption standards are not established by the guidelines used by the DGAC, the overconsumption of sugar combined with the strong association of sugar with health conditions such as obesity and diabetes resulted in added sugars being included with sodium as dietary variables to decrease (DGAC, 2015).

In addition to current dietary guidelines, previous judgment and decision-making studies that have examined the nutrients consumers find most relevant to nutritional quality were considered. A previous study found that participants' mean judgments of nutrition were positively correlated with calories, protein, fiber, and potassium and negatively correlated with sugar and sodium (González-Vallejo & Lavins, 2015). The NuVal score showed a similar relationship to nutrients, with higher scores going to cereals high in protein, fiber, and potassium, and low in total sugars and sodium (González-Vallejo & Lavins, 2015). A follow-up study using additional cereals found negative relationships between NuVal and sodium and sugar, and positive relationships between NuVal and calories, dietary fiber, and polyunsaturated fat (González-Vallejo, Lavins, & Carter, 2016). As the current study analyzed judgments ratings of a new database of cereals, nutritional values displayed on the FOP labels will also be based on correlational analyses of the nutrient composition and NuVal scores of the particular cereals used in the current study.

Hypotheses

H1: Judgment accuracy, determined by the achievement index r_{YO} (Equation 2), is higher, on average, in the FOP1 condition than in the NFP-only and FOP2 conditions.

If participants are more likely to comprehend nutrient information when a small number of nutrients are displayed in the simpler FOP label, then participant ratings of nutritional quality should vary across conditions. As the nutrients on the FOP1 label were highly related to nutritional quality, if participants paid closer attention to these nutrients and weighted them more strongly, their judgment accuracy would be greater than participants who saw no FOP label. Additionally, participants in the FOP1 condition were expected to have higher judgment accuracy than those in the FOP2 condition, where the FOP contained nutrients that are only marginally related to overall nutritional quality.

H2: Average judgment accuracy (r_{YO}) is lower in the FOP2 condition than in the NFP-only condition.

As the FOP2 label highlights nutrients that are only marginally related to overall nutritional quality, participants in this condition are expected to strongly weight nutrients that are only marginally related to overall nutritional quality. If this is in fact the case, participants in the FOP2 condition should have lower judgment accuracy than those in the NFP-only condition as they will be strongly weighting nutrients that are only weakly related to overall nutritional quality. This second hypothesis is necessary to unconfound the effect of information from that of attention. If the information in the FOP label is affecting judgment, then participants who view the FOP2 label should have judgments that are erroneously skewed due to their consideration of irrelevant information. In contrast, if there is no negative effect of the FOP2 label on accuracy, this may indicate that simply including FOP labels increase the attention of consumers to nutritional information. In essence, hypothesis 2 verifies that the use of FOP information is indeed a key factor impacting judgment accuracy.

H3: Consistency, defined as $R_{Y.X}$, (Equation 2) of the judge is higher, on average, in judgments made in the FOP1 and FOP2 conditions than in the NFP-only condition.

Participants in the second and third conditions were given FOP labels that clearly highlighted specific nutrients from the NFP. Given that these labels provided clear direction of which nutrients were important to consider, it was expected that participants in the FOP label conditions would strongly weight the nutrient information on the FOP label when evaluating the products. That is, participants were expected to consistently use the FOP nutrient information across cereals.

H4: Average agreement of the criterion and judgment cue weights, G (Equation 2), is higher in the FOP1 condition than in the NFP-only and FOP2 label conditions.

Participants were expected to more strongly weight nutrients when they were highlighted in the FOP labels than when they were simply presented in the NFP label. Given that the FOP1 label highlighted nutrients that were strongly weighted by the NuVal, participants' weights of nutrients were expected to be more congruent with the NuVal nutrient weights in this condition:

H5: Average agreement of the criterion and judgment cue weights, G, is lower in the FOP2 condition than in the NFP-only condition.

Additionally, as the FOP2 label highlights nutrients that are weighted weakly by the NuVal, participants in the FOP2 condition should have nutrient weights that are less congruent with the NuVal nutrient weights than participants in the NFP-only condition who are not expected to consistently give strong weight to nutrients only weakly related to overall nutritional quality.

H6: Participants in the FOP1 condition add items with higher NuVal scores to their cart than those in the FOP2 and NFP-only condition.

Ultimately, facilitated processing of product nutrient information is of interest because of its assumed impact on the quality of consumer choice. Participants in the FOP1 condition are expected to add products with higher nutritional value than those in the FOP2 and NFP-only conditions. Although increased nutritional accuracy and high consistency are useful measures in terms of their impact on judgment, this hypothesis will test the potential of FOP labels to impact the true variable of interest, consumer behavior.

H7: Judgment measures of accuracy, consistency, and agreement vary as a function of individual differences in nutrition and obesity knowledge, mentalities toward food, and demographic differences. Specifically, individuals who score higher in nutrition and obesity knowledge, health behaviors, annual income, and education and those who score lower in eating pathologies and BMI were expected to have greater judgment consistency, accuracy, and model agreement.

As discussed early in this review, previous research has indicated that NFP use and understanding varies according to such demographic variables as age, education, and health status, as well as cognitive and behavioral characteristics such as motivation, skepticism, nutrition knowledge, and beliefs and habits related to health. Understanding what demographic, cognitive, and behavioral variables affect judgment processes is imperative to creating effective interventions. As well as identifying the groups most in need of interventions, understanding individual difference variables' effect on judgment processing will enable interventions to address factors that will have the greatest impact.

METHODS

Participants

SamplePower was used to compute the required sample size for this study. Due to the practical constraints of the study, and mindful that the costs of regulatory and packaging changes would likely not be worthwhile for small effects, sample size for a medium effect was computed. To obtain .80 power to detect a Cohen's f medium effect size of .25 using Holm adjustment to control for Type I error rate at .05, the total sample size necessary to compare means of three conditions in a one-way between samples analysis of variance is 288 participants; or 96 per condition. Participants of at least 18 years of age were recruited through the psychology participant pool at Ohio University and received course credit for their participation. Per the power analysis, the study was run until approximately 300 were indicated by the survey program to have completed the study. Subsequently, 3 participants were found to have not consented to the study and thus had no data despite their surveys being marked as "complete" by the program. In total, 409 began the survey and 297 completed the study in its entirety. Due to the anonymous nature of the study, it is not possible to determine whether some individuals erroneously exited the study and subsequently recommenced and completed it.

Of the 297 participants for whom demographic data was collected, the majority were female (56.9%), white (88.2%), and in their first year of college (64.3%). The majority of participants also reported that they were not currently dieting (76.1%). Participants' ages ranged from 18 to 25 ($M = 19$, $SD = 1.23$) years. Most participants (69%) completed the study online, without coming to the lab.

Stimuli

Current dietary guidelines along with the findings of previous studies using the NuVal were used to determine which nutrients to include on the FOP labels for this study. Considering the renewed emphasis of the DGAC in recommending decreases in the consumption of sodium, sugar, and saturated fat, these nutrients were selected for display on the FOP labels. Additionally, potassium, dietary fiber, calcium, and vitamin D were considered due to their designation as nutrients of concern due to under-consumption. Considering the prominence of these nutrients among the American public and their association with increased risk of health issues, these nutrients are likely candidates for industry initiated FOP labels as well as possible future FDA mandated ones, however determining these nutrients impact on a particular set of products is necessary for a final decision. As previous studies have indicated, the nutrients relevant to overall nutrition as measured by the NuVal can differ according to the particular products being used (González-Vallejo & Lavins, 2015; González-Vallejo, Lavins, & Carter, 2015).

The correlations in Table 1 show the relationships between nutritional values among all NFP nutrients, but it is important to note that not all NFP nutrients are used in the algorithm that determines the NuVal. A list of NuVal-included nutrients was determined based on previous publications and consultation with an expert nutritionist from the Yale-Griffin Prevention Research Center (Katz, et al., 2010; Rhee, personal communication, January 12th, 2016). Correlations between the NuVal and these nutrients appear in Table 1. Specifically, calories from fat, insoluble fiber, soluble fiber, and other carbohydrates are cereal NFP nutrient values that are not included in determining NuVal.

The number of vitamins and minerals also varies from that reported in Table 1, as not all vitamins and minerals included on the NFP label are accounted for by the NuVal score. The NuVal score includes the following vitamins and minerals: folate, vitamins A, C, D, E, B6, and B12, as well as potassium, calcium, zinc, magnesium, and iron. NFP labels may list additional vitamins and minerals included in the product that are not deemed important by the NuVal algorithm.

Correlational analyses of the NuVal and nutrients of the cereals to be used in this study (N = 74 cereals) were conducted to provide further insight into the relationships between nutrients and nutritional quality for this set of cereals (see Table 1). Consistent with the dietary guidelines and sets of cereals used in previous studies, Pearson correlations showed NuVal negatively related to sodium (-.54) and sugar (-.47) and positively related to fiber (.37), all *p*s ≤. 0.01. Total, saturated, and monounsaturated fat were not related to NuVal score, although polyunsaturated fat was positively related to NuVal score $r = .29$, $p \leq. 0.01$; as was protein (.32), $p \leq. 0.05$. Calories, total carbohydrates, and potassium were not related to NuVal score, nor was the number of NuVal-included vitamins and minerals in the cereal, all $ps \geq .05$. There was a significant negative correlation (-.25) between NuVal score and the number of vitamins and minerals in the cereal, $p < .05$, but the relationship between NuVal and number of vitamins and minerals was not a significant predictor of NuVal score after controlling for the other nutrients (see Table 2).

Table 1

Pearson Correlations and Descriptive Statistics of Cereal Nutrient Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 NuVal																		
2 Calories	.04																	
3 Calories (Fat)	.11	.42*																
4 Total Fat (g)	.12	.45*	.98*															
5 Saturated Fat (g)	.01	.18	.56*	.54*														
6 Polyunsaturated Fat (g)	.29*	.40*	.79*	.82*	.41*													
7 Monounsaturated Fat (g)	-.03	.44*	.84*	.83*	.38*	.60*												
8 Sodium (mg)	-.54*	.03	-.09	-.07	-.04	-.15	.002											
9 Potassium (mg)	.20	.65*	.30*	.33*	.02	.40*	.22	-.03										
10 Total Carbs (g)	.02	.94*	.16	.18	.03	.15	.21	-.01	.60*									
11 Dietary Fiber (g)	.37*	.50*	.23*	.23	.02	.23*	.13	-.24*	.65*	.56*								
12 Soluble Fiber (g)	.13	.23*	.25*	.25*	.01	.20	.28*	-.21	.35*	.23*	.59*							
13 Insoluble Fiber (g)	.24*	.34*	.00	-.00	-.04	.12	-.08	-.43*	.51*	.44*	.63*	.44*						
14 Sugar (g)	-.47*	.51*	.21	.24*	.14	.12	.23*	.28*	.38*	.51*	.13	.07	.00					
15 Other Carbs (g)	-.15	.31*	.27*	.29*	.08	.22	.45*	.23*	.07	.25*	-.03	-.08	-.11	.11				
16 Protein (g)	.32*	.59*	.25*	.27*	-.002	.36*	.19	-.15	.74*	.51*	.64*	.49*	.53*	.05	-.04			
17 Vitamins & Minerals (#)	-.25*	.11	.09	.12	-.02	.06	.22	.40*	.01	.07	-.23	-.21	-.27*	.34*	.50*	-.19		
18 NuVal Vitamins & Minerals (#)	-.21	.01	.08	.10	-.04	.004	.15	.41*	-.06	-.04	-.27*	-.25*	-.37*	.27*	.40*	-.25*	.92*	
Mean	29	145	15	1.62	0.12	0.46	0.43	140	116	31	3.62	0.36	1.09	8.97	6.51	3.55	8.99	7.18
Median	26	120	10	1.00	0.00	0.50	0.00	140	82.5	26	3.00	0.00	0.00	9.00	0.00	2.50	11.0	8.00
S.D.	16	44	11	1.28	0.30	0.67	0.68	73.3	94.4	10	2.66	0.96	2.27	4.00	10.0	2.40	4.95	3.03

*Correlation is significant at the 0.05 level (2-tailed).

To develop FOP labels, relationships among individual nutrients and the overall nutritional quality of products operationalized as the NuVal score were explored using linear regression. Given the dietary recommendations regarding sugar, sodium, and dietary fiber, as well as their correlational relationships with the NuVal, regression models using these three nutrients were run to estimate their utility in predicting the NuVal in the current study's cereal database. Due to historical and current public attention given to calories as well as previous findings indicating that they are significantly related to consumer judgment (González-Vallejo & Lavins, 2015), calories per serving was also included in the model. These nutrients were compared to a full model containing the 16 nutrients included on the NFP. As mentioned previously, a list of NuVal-included nutrients was determined based on previous publications and consultation with an expert nutritionist from the Yale-Griffin Prevention Research Center (Katz, et al., 2010; Rhee, personal communication, January 12th, 2016). Nonetheless, as information that is not included in the NuVal is available to participants, understanding how all NFP nutrients are related to NuVal is useful in determining nutrients for a FOP label. The reduced model of calories, sugar, sodium, and dietary fiber was compared to a full model including all 16 NFP nutrients using a one-step F test[1]. The full model (see Table 2 for regression statistics) was significantly more predictive than the reduced model of calories, sugar, sodium, and dietary fiber, $F(12, 57) = 2.206$, $p < .05$. The full model consisting of the 16 nutrient variables significantly predicted NuVal, $F(16, 57) = 7.552$, $p < .001$, $R^2 = .679$, with an adjusted $R^2 = .589$. With the exception of insoluble

[1] That is, $F(df_r\text{-}df_{f,}\ df_f) = [(SSE_r - SSE_f)/(dfr\text{-}dff)]/MSE_f$, where SSE is the sums of square error (residual), MSE is the mean square error, and df is degrees of freedom, with subscripts f and r to denote full and reduced models, respectively.

fiber ($p < .05$), the nutrient quantities that are not used in computing NuVal (calories from fat, soluble fiber, insoluble fiber, and other carbohydrates) did not have significant coefficients. The reduced model with only four nutrients (see Table 3 for regression statistics) significantly predicted NuVal score as well, $F(4, 69) = 19.499$, $p < .001$, $R^2 = .531$, with an adjusted $R^2 = .503$.

Table 2

Summary of Regression Analysis for Predicting NuVal from All NFP Nutrients (N=74)

		β	R^2	Adj. R^2
Full Model:			.679*	.589
	Calories	-.042		
	Calories from Fat	-.395		
	Total Fat (g)	.336		
	Saturated Fat (g)	.015		
	Monounsaturated Fat (g)	-.097		
	Polyunsaturated Fat (g)	.298		
	Dietary Fiber (g)	.404*		
	Soluble Fiber (g)	-.104		
	Insoluble Fiber (g)	-.327*		
	Potassium	.202		
	Protein	-.028		
	Sodium (mg)	-.432*		
	Sugars (g)	-.606*		
	Total Carbohydrates (g)	.199		
	Other Carbohydrates (g)	-.164		
	Vitamins & Minerals (#)	.172		

*$p \leq 0.05$, two-tailed.

Table 3

Summary of Regression Analysis for Predicting NuVal from FOP1 Nutrients (N=74)

		β	R^2	Adj. R^2
Model Statistics:			.531*	.503
	Calories	.168		
	Dietary Fiber (g)	.272*		
	Sodium (mg)	-.344*		
	Sugars (g)	-.498*		

*$p \leq 0.05$, two-tailed.

In addition to a FOP label with nutrients that are highly related to NuVal, it was necessary to develop a label with nutrients that were only marginally related to NuVal. As discussed in hypothesis two, a poor model of NuVal is required to clarify the effect of the FOP label on accuracy. That is, if FOP labels cause participants to pay greater attention to the specific nutrients they highlight then a label with highly relevant nutrients would be expected to improve accuracy. If, in contrast, FOP labels cause participants to pay greater attention to the NFP label, improved judgment accuracy would still be expected. Thus, a label with nutrients that are a poor model for the NuVal is necessary to unconfound increased attentiveness to nutritional information from use of highlighted information. If FOP labels motivate consumers to pay closer attention to nutritional information as a whole, then judgment accuracy should be improved for those exposed to FOP labels regardless of the content of those labels. Alternately, if the highlighting information increases attention to the specific information highlighted, then the content of FOP labels, as well as their mere presence, is important.

To determine a group of nutrients for a comparison label of nutrients only marginally related to nutritional quality, an additional model was run. Saturated fats and potassium, both high profile nutrient variables due to their designation as nutrients of concern, yet unrelated to nutritional quality among these products, were selected as variables to be run in the model. Carbohydrates, as neither a nutrient of concern nor a variable related to the NuVal, was chosen as carbohydrates are often associated by the public with unhealthy sources of carbohydrates such as refined grains and are more likely to be a recognizable, though ill-understood, nutrient (DGAC, 2015). However, as the nutrient variable "total carbohydrates" is a composite variable including dietary fiber and sugar, the variable "other carbohydrates" which consists of carbohydrates other than sugar and fiber, was used as a measure of carbohydrates alone. "Other carbohydrates" are not included in the NuVal algorithm, thus it was expected not to have relationship with the NuVal score. Calories was included in this model as well, as current attention to calories makes it unlikely that it would be excluded from an actual FOP label. As calories was not related to NuVal in this group of cereals ($r = .04$, $p = .736$) it did not confound the effect of a marginally-relevant FOP label.

As anticipated, this model was found to not be significantly predictive of NuVal score, $F(4, 69) = 1.277$, $p = .288$, $R^2 = .069$, with an adjusted $R^2 = .015$ and it varied significantly from the full model consisting of all 16 nutrients included on the NFP label, $F(12, 67) = 9.048$, $p < .05$ (see Table 2). Model statistics and coefficients for the FOP2 nutrients can be seen in Table 4.

Table 4

Summary of Regression Analysis for Predicting NuVal from FOP2 Nutrients (N=74)

		β	R^2	Adj. R^2
Model Statistics:			.069	.015
	Calories	-.098		
	Saturated Fat (g)	.027		
	Potassium (mg)	.268		
	Other Carbohydrates (g)	-.138		

*$p \leq 0.05$, two-tailed.

Design

Participants were recruited through online sign-up where two versions of the study were advertised. One option was to complete the study online, the other to come to the lab to complete the study. Among the students who completed the study, 205 (69%) did so online, while 92 (31%) did so in the lab (out of a total of 93 participants who began the study in the lab). In either case, the entirety of the study was conducted online through survey tool Qualtrics. The only difference between the two was in the laboratory setting participants interacted briefly with the experimenter who gave them instructions to open a link to the survey. On beginning the study, participants were randomly assigned to one of three conditions. In every condition, after being presented with information on the study and consenting to participate, participants were presented with a cereal name, an image of the front of the cereal box, along with the cereal's Nutrition Fact Panel, and list of ingredients. The first condition included only this base information. The second condition included all the above information as well as an adapted General Mills "Facts Up Front" front-of-package label, highlighting the number of calories and product amounts of nutrients highly relevant to nutritional quality: dietary fiber, sodium, and sugars as the percent recommended daily value they consist of. The third condition included an adapted version of the General Mills "Facts Up Front" front-of-package label, highlighting the number of calories and product amounts of nutrients only marginally relevant to nutritional quality: saturated fats, carbs, and protein as well as the percent recommended daily value they consist of. Figure 4 depicts a figure participants were presented within the second condition (see Appendix A for an example of all three conditions). Participants in each of the three conditions were presented with 74 cereals, and after viewing each cereal they were asked several questions regarding the product. Following this, participants in each condition completed health behavior, nutrition knowledge, numeracy, and demographic measures.

Figure 4. Example of second condition stimuli. An image of a cereal box is accompanied by its ingredients, NFP label, and a FOP label with highly relevant nutrients.

Measures

This study included two categories of measures: judgment variable measures and individual measures. The judgment variable measures consisted of questions that asked the participant to rate various cereals as well as their familiarity with the cereal, impressions of it as a food product, and decision to add or not add the product to the cart. Knowledge scales were used as a measure of participants' knowledge of nutrition, obesity, and numerical information. Individual measures will be used to report the characteristics of the study's sample such as gender, ethnicity, socioeconomic status, and health-related variables such as concern with health and dieting behavior.

Nutrition Rating Cereal Questions

For each cereal, responded to a set of nine questions regarding their opinion of the health value and nutritional quality of the product, their familiarity and consumption of the product, and the likelihood they would purchase it. Questions were answered on a scale from 1-100, except for three questions: the question requesting frequency of consumption (free response), factors impacting purchase (free response), and the question asking participants whether they would add the item to a shopping cart (yes/no). Of particular interest as the subject judgment variables in the lens model equation were the questions "How healthy is this cereal?" and "How nutritious is this cereal?" which participants were asked to rate on a scale of 1 (not healthy/nutritious at all) to 100 (extremely healthy/nutritious). Across participants, responses to these questions for each item were highly correlated, (*r*'s ranging from .714 to .932). An average of the participants' responses to questions concerning the health and nutrition value of each individual cereal was used as the "nutrition judgment" variable.

General Nutrition Knowledge Questionnaire (GNKQ)

An abbreviated version of the GNKQ (Parmenter & Wardle, 1999) with a true/false format was used to measure nutritional knowledge. A total of twelve questions from three different sections of the GNKQ were included, each containing statements on a different area of nutritional knowledge: dietary recommendations (e.g., “the most important fat for people to cut town on is monounsaturated fat”), sources of nutrients (e.g., “polyunsaturated margarine contains less fat than butter”), choosing everyday foods (e.g., “brown sugar is a healthy alternative to white sugar”). Each item carries one point for a correct answer, with higher scores indicated greater nutritional knowledge. Among this study’s respondents, this abbreviated measure’s internal reliability had a Cronbach α of .123. Subsequent examination of the inter-item correlations of the scale indicated that items did not tend to positively correlate with each other (corrected item-total correlation range from -0.134 to .14) and the low correlations were not due to outliers so the GNKQ was excluded from further analyses.

Obesity Risk Knowledge Questionnaire (ORK)

The ORK (Swift, Glazebrook, & Macdonald, 2006) measures knowledge of obesity risk with ten statements regarding obesity risk factors which participants are asked to judge as true or false (e.g., “obesity increases the risk of getting bowel cancer” and “a person with a ‘beer-belly’ shaped stomach has an increased risk of getting diabetes”). Each item carries one point for a correct answer, with higher scores indicated greater knowledge of obesity risk. The ORK was found to have acceptable reliability ($\alpha > .70$) among a sample of 430 participants (Swift, Glazebrook, & Macdonald, 2006). Among this study’s participants, this measure’s internal reliability had a Cronbach α of .118. Subsequent examination of the inter-item correlations of the scale indicated that items did not tend to positively correlate with each other (corrected item-total correlation range from -0.3 to .21) and the low correlation were not due to outliers so the ORK was excluded from further analyses.

The Health Behaviors Checklist (HBCL)

The HBCL (Vickers, Conway & Hervig, 1990) measures four behavioral factors thought to contribute to a person's health. The checklist contains 40 items, 27 of which are used to create subscales representing four health domains in two general areas: preventative health behaviors and risk taking behaviors. The domains used in this study consist of (a) wellness maintenance behaviors (e.g., "I take vitamins") and (b) the use of potentially harmful substances (e.g., "I do not drink alcohol"). Participants answerer each of the 14 questions by indicating the accuracy with which the specific health behavior describes their typical behavior on a 5-item scale ranging from strongly disagree (1) to strongly agree (5). Items will be reverse coded when necessary so that higher scores indicate greater care to their health. In this study's sample of 297 participants, the HBCL wellness and substance subscales were found to have acceptable (α = .77) and questionable reliability (α = .63) respectively.

Eating Pathology Symptom Inventory (EPSI)

The EPSI (Forbush et al., 2013) measures eight areas of eating disorder to assess eating disorder psychopathology. The measure contains 45 items that make up eight empirically-derived subscales that consist of (a) binge eating (e.g., "I ate until I was uncomfortably full"); (b) purging (e.g., "I made myself vomit in order to lose weight"); (c) restricting (e.g., "I skipped two meals in a row"); (d) excessive exercise (e.g., "I planned my days around exercising"); (e) body dissatisfaction (e.g., I did not like the size of my thighs"); (f) cognitive restraint (e.g., "I tried to exclude 'unhealthy' foods from my diet"), (g) muscle building (e.g., "I used muscle building supplements"); and (h) negative attitudes towards obesity (e.g., "I thought that obese people lack self-control"). Participants were asked to report the frequency with which they have undergone the experiences described by the statements over the previous 4 weeks on a 5-point scale, ranging from never to very often. According to previous research, this measure showed a robust factor structure across various samples (i.e., eating disorder patients, general psychiatric outpatients, students), excellent internal consistency (mean *α's* = .84-.89) and test-retest reliability over a 2 to 4-week period (mean r = .73) across five samples with a mean size of 306 participants (Forbush et al., 2013).

Objective Numeracy Scale (ONS)

The ONS (Weller, et al., 2013) is an 8-item measure that assesses numerical literacy. Each item has a correct answer and scores are determined by the total number of items answered correctly. The scale was designed to have items distributed across difficulty levels from easy to hard. Over six studies, the mean published alpha for the scale was found to approach acceptability, α = 0.69 (range α = 0.64-0.71) (Peters & Bjalkebring, 2015). In this study, this measure showed questionable reliability of α = .63.

Subjective Numeracy Scale (SNS)

The SNS (Fagerlin, et al., 2007) is an 8-item measure of self-reported ability with and preference for numbers. Individuals respond to questions such as "How good are you at working with fractions?" and "When reading the newspaper, how helpful do you find tables and graphs that are parts of a story?" on a 6-point scale, where higher ratings indicate greater preference for and overall ease with using numbers. Cronbach's alpha in a study of 130 participants was found to be good, $\alpha = 0.83$ (Peters & Bjalkebring, 2015). In this study, this measure had a good reliability of $\alpha = .89$.

Demographic Questions

Participants will be asked a comprehensive set of questions concerning their height, weight, age, gender, income, level of education, and employment status. Information on their eating habits, medical history, and use of packaging/NFP when making purchases will also be requested. Participants will also rate the importance of the various nutrients in the NFP in general, and in relation to their use in this study. Finally, they will be asked qualitative questions concerning their participation in the study, and the factors they believed will influence their choice of healthy vs. unhealthy foods. See Appendix B for the full survey.

Body Mass Index (BMI)

BMI will be calculated as the individuals' weight divided by height squared (lbs/in^2) multiplied by a conversion factor of 703. The Center for Disease Control and Prevention's standard weight categories for men and women 20 and older are as follows: Below 18.5, Underweight; 18.5 – 24.9, Normal; 25.0 – 29.9, Overweight; and 30.0 and above, Obese (Center for Disease Control, 2011). Higher scores indicate an unhealthier BMI. Following the exclusion of one outlier who reported a height of two feet and weight of 220 pounds, BMI's ranged from 15.59 to 45.61 ($M = 24.36$, $SD = 4.37$).

Procedure

Individuals received two credits toward their psychology course for participating and median time to complete the study was one hour and 34 minutes. Out of all participants, 67.8% took two hours or less to complete the survey. Within each condition, participants viewed 74 cereals (see Appendix A) and answered questions concerning each item. Following the 74 cereal tasks, participants completed a questionnaire battery consisting of the Obesity Risk Knowledge Questionnaire (Swift, Glazebrook, & Macdonald, 2006), an adapted version of the General Nutrition Knowledge Questionnaire (Parmenter & Wardle, 1999), the Eating Pathology Symptoms Inventory (Forbush, et. al., 2013), an Objective and Subjective Numeracy scale (Weller, et al., 2013; Fagerlin, et al., 2007), and two sections of The Health Behaviors Checklist (Vickers, Conway & Hervig, 1990). This was followed by demographic section and then participants were debriefed.

ANALYSIS AND RESULTS

The LME was used to decompose the variance achievement—the correlation between participants' ratings of nutritional quality and the gold standard of nutritional quality—into several components (see Equation1). These LME statistics served as dependent variables in subsequent analyses. In the current application of the lens model, NuVal is a vector of 74 cereals' NuVal scores, judgment is a vector of an individual participant's nutritional quality ratings of 74 cereals, cues are the values of product nutrients (calories, calories from fat, total fat, saturated fat, polyunsaturated fat, monounsaturated fat, sodium, potassium, total carbohydrates, dietary fiber, soluble fiber, insoluble fiber, sugars, other carbohydrates, protein, and number of vitamins and minerals). As participants rated 74 cereals, this study has an adequate number of items to conduct standard multiple regression for each individual using all the above nutrients. In the current application, the total number of nutrients was equal to 16 based on the nutrients available to participants on the NFP label.

$M_{O.X}$ and $M_{Y.X}$ represent the linear regression models that describe the relations between the nutrients and nutritional quality and the nutrients and participant's judgment respectively; and the E's, which represent the residuals of the models and are not linearly related to the weights. The partitioning of the judgment and the criterion is used to derive a two-component formulation (Stewart, 1976) as seen in Equation 2, where $R_{Y.X}$ is the correlation between nutritional quality and $M_{O.X}$, a measure of environmental predictability, this consists of the R^2 of the regression model for the NuVal score that equals .679 for the model containing all NFP nutrients. G is the correlation between $M_{O.X}$ and $M_{Y.X}$, a measure of the agreement between the regression model of the nutritional environment and the regression model of judgment. $R_{Y.X}$ is the correlation between judgment and $M_{Y.X}$, a measure of the consistency of the weighting of the nutrients by the participant. In addition to the LME measures, the point biserial correlation between participant cereal choice and the NuVal score was used as a measure of nutritional choice.

To test each of the hypotheses, ANCOVA was used to compare the various components of the LME, (r_{YO}, $R_{Y.X}$, and G) and the choice correlation across conditions with planned contrasts used to determine differences between the conditions. Individual levels variables used as covariates included scale variables: objective numeracy score, subjective numeracy score, health behaviors related to substance use, health behaviors related to wellness, and scores on the eating pathology symptom subscales binge eating, body dissatisfaction, cognitive restraint, excessive eating, muscle building, negative attitudes toward obesity, restricting, and purging. Individual variables BMI, education, annual income, current dieting behavior, hours taken to complete the study, and setting[2] in which the study was completed were also included. Individual variables' distributions were examined and time taken, BMI, and the EPSI subscales negative attitudes toward obesity, purging, and restricting were log transformed to reduce positive skewness. See Tables 5-7 for correlations of the variables with untransformed judgment measures. Except when noted, lens model indices (correlations) as dependent variables were transformed using Fisher z transformation to meet assumptions for ANCOVA testing.

[2] Judgment accuracy (r_{YO}) and cue use consistency (R_{XY}) were found to vary as a function of whether the participant completed the study in the lab or online. This relationship still existed after time taken in the study was accounted for, but it did not make a difference in findings related to experimental condition.

Table 5

Pearson Correlations of Individual Level Variables with Lens Model Indices Computed Within NFP-Only Experimental Condition

	Judgment Accuracy r_{YO} (N = 89)	Cue Use Consistency R_{XY} (N = 89)	Model Agreement G (N = 71)	Choice Correlation r_{pb} (N = 83)
Objective Numeracy	0.073	0.216*	-0.074	-0.241*
Subjective Numeracy	-0.018	0.151	-0.122	-0.035
HBCL Substance	0.116	0.122	0.127	-0.045
HBCL Wellness	0.077	0.008	0.226	0.166
EPSI Body Dissatisfaction	0.241*	0.123	0.188	0.141
EPSI Binge Eating	0.127	0.014	0.136	0.103
EPSI Cognitive Restraint	0.250*	0.162	0.231	0.245*
EPSI Purging[a]	0.080	-0.109	0.118	0.194
EPSI Restricting[a]	0.018	-0.121	-0.102	0.127
EPSI Excessive Exercising	0.162	-0.149	0.274*	0.144
EPSI Negative Attitudes re. Obesity[a]	0.156	0.086	0.091	0.245*
EPSI Muscle Building[a]	-0.058	-0.233*	0.108	0.096
Body Mass Index[a]	-0.169	-0.187	-0.089	-0.162
Year in School	0.036	0.024	-0.003	-0.099
Dieting Behavior	0.119	0.079	0.224	0.163
Annual Income	-0.308*	-0.292*	--[b]	-0.230
Hours to Complete Study[a]	0.045	-0.068	-.070	-0.042
Setting of Study	-0.074	-0.105	-.047	0.096

* Correlation is significant at the 0.05 level (2-tailed). [a]Log transformed variables. [b]All cases in same income level.

Table 6

Pearson Correlations of Individual Level Variables with Lens Model Indices Computed Within FOP1 Experimental Condition

	Judgment Accuracy r_{YO} ($N = 99$)	Cue Use Consistency R_{XY} ($N = 99$)	Model Agreement G ($N = 82$)	Choice Correlation r_{pb} ($N = 91$)
Objective Numeracy	0.178	0.194	0.096	-0.024
Subjective Numeracy	-0.071	-0.140	-0.013	-0.045
HBCL Substance	0.039	0.012	0.066	0.103
HBCL Wellness	0.092	0.116	0.128	0.144
EPSI Body Dissatisfaction	-0.041	-0.061	-0.009	0.239*
EPSI Binge Eating	-0.125	-0.023	-0.198	0.187
EPSI Cognitive Restraint	0.014	0.106	0.094	0.494*
EPSI Purging[a]	-0.386*	-0.311*	-0.317*	0.015
EPSI Restricting[a]	-0.276*	-0.272*	-0.113	-0.020
EPSI Excessive Exercising	-0.027	0.036	-0.036	0.132
EPSI Negative Attitudes re. Obesity[a]	-0.236*	-0.183	-0.071	0.021
EPSI Muscle Building[a]	-0.364*	-0.315*	-0.231*	-0.092
Body Mass Index[a] ($N = 88$)	0.069	-0.057	-0.070	-0.086
Year in School	-0.188	-0.225*	-0.063	-0.101
Dieting Behavior	-0.118	-0.013	-0.087	0.130
Annual Income	0.061	0.032	0.062	0.100
Hours to Complete Study[a]	0.076	0.128	-0.006	0.022
Setting of Study	-0.164	-0.129	0.001	0.014

* Correlation is significant at the 0.05 level (2-tailed). [a]Log transformed variables.

Table 7

Pearson Correlations of Individual Level Variables with Lens Model Indices Computed Within FOP2 Experimental Condition

	Judgment Accuracy r_{YO} (N = 109)	Cue Use Consistency R_{XY} (N = 109)	Model Agreement G (N = 71)	Choice Correlation r_{pb} (N = 104)
Objective Numeracy	-0.176	-0.031	-0.160	-0.148
Subjective Numeracy	-0.166	-0.030	-0.131	-0.164
HBCL Substance	0.133	-0.017	0.225*	0.091
HBCL Wellness	-0.018	-0.038	0.065	0.250*
EPSI Body Dissatisfaction	0.177	-0.100	0.240*	0.182
EPSI Binge Eating	-0.174	-0.226*	-0.098	0.095
EPSI Cognitive Restraint	0.087	0.001	0.141	0.320*
EPSI Purging[a]	-0.103	-0.252*	0.017	0.267*
EPSI Restricting[a]	-0.100	-0.183	-0.030	0.186
EPSI Excessive Exercising	-0.089	-0.074	-0.140	0.157
EPSI Negative Attitudes re. Obesity[a]	-0.277*	-0.181	-0.194	-0.010
EPSI Muscle Building[a]	-0.276*	-0.192*	-0.253*	0.096
Body Mass Index[a]	-0.012	-0.021	-0.113	-0.165
Year in School	-0.117	-0.047	-0.081	0.128
Dieting Behavior	-0.031	-0.115	-0.047	0.171
Annual Income	0.031	-0.009	0.035	-0.031
Hours to Complete Study[a]	-0.056	0.061	0.038	-0.052
Setting of Study	-0.283*	-0.249*	-0.121	-0.204*

* Correlation is significant at the 0.05 level (2-tailed). [a]Log transformed variables.

Judgment Accuracy Results

To test the first hypothesis, that H1: Average judgment accuracy is higher in the FOP1 condition than in the NFP-only and FOP2 conditions and second hypothesis, that H2: Average judgment accuracy is lower in the FOP2 condition than in the NFP-only condition, an ANCOVA was conducted with r_{YO} as the dependent variable after being Fisher-z-transformed, condition as the independent variable, and the individual level variables as covariates (see Tables 5-7). Preliminary analyses were conducted to determine the suitability of individual level variables as covariates. No individual level variables violated the assumption of independence from the condition, so none were excluded as potential covariates. Correlational analyses were performed between potential covariates and the transformed accuracy measure to establish the presence of linear relationships. Variables that were significantly correlated ($p < .05$) with accuracy were selected as candidate covariates.

A one-way ANCOVA was conducted to examine the effect of condition on the accuracy variable with setting and the cognitive restraint, and log transformed purging, restricting, muscled building, and negative attitudes toward obesity subscales of the EPSI scale included as covariates. All two-way interactions between condition and the covariates were also to ensure not covariates violated the homogeneity of regression slopes assumption. The effect of condition was significant, $F(2, 276) = 4.406$, $p = .013$, $\eta_p^2 = .031$, in the presence of the covariates. A difference contrast indicated that, on average, the judgment accuracy of participants in the FOP2 condition ($M = .245$, $SD = .17$) was significantly lower than that of participants in the NFP-only condition ($M = .265$, $SD = .16$), $p = .026$, 95% CI [-1.087, -.070]. The judgment accuracy of those in the

FOP1 condition (*M* = .271, *SD* = .19) was significantly larger compared to the combined average judgment accuracy of those in the FOP2 and NFP-only conditions, $p = .039$, 95% CI [.021, .836]. Full descriptive statistics for judgment accuracy can be found in Table 8.

The first hypothesis, that judgment accuracy would be higher on average in the FOP1 condition than in the NFP-only and FOP2 conditions was supported by the overall effect of condition on judgment and the subsequent difference test. The second, that average judgment accuracy would be lower in the FOP2 condition than in the NFP-only condition was also supported.

Table 8

Accuracy Descriptive Statistics by Experimental Condition

	FOP 2 (N = 109)	NFP Only (N = 89)	FOP 1 (N = 99)
Mean (St. Deviation)	.245 (.174)	.265 (.175)	.271 (.192)
Median	.255	.280	.292
Minimum	-.198	-.309	-.217
Maximum	.753	.585	.670

Judgment Consistency Results

The third hypothesis stated that the average consistency of the judge will be higher in judgments made in the FOP1 and FOP2 conditions than in the NFP-only condition. This hypothesis assumed that the FOP labels would make participants focus attention on the highlighted cues, showing more consistency in their use of cues and thus making their nutritional judgments better predicted by the NFP nutrients.

Linear regression models containing all NFP nutrients (calories, calories from fat, total fat, saturated fat, polyunsaturated fat, monounsaturated fat, sodium, potassium, total carbohydrates, dietary fiber, soluble fiber, insoluble fiber, sugars, other carbohydrates, protein, and number of vitamins and minerals) were used to predict individual participant judgments. Once all individual regression models were determined, transformed *multiple R* values were compared to determine whether differences existed across conditions. Out of all participants, 80% ($N = 240$) had judgments that could be predicted from a full model containing all nutrients on the NFP label, $p < .055$, indicating that the analysis of model consistency was valid. A chi-square test comparing the frequency of valid participants' models across conditions indicated that the proportion of significant models did not vary across them, $X^2(2, N = 297) = .391, p = .82$.

Average consistency of full models (containing all NFP nutrients) regardless of significance was expected to be higher in the FOP1 and FOP2 condition than in the NFP-only. FOP1 participants were expected to have full models with higher average consistency than participants in the other two conditions. FOP1 participants were expected to attend to the nutrients in the FOP1 label and more heavily weight these nutrient values in their nutritional judgments. This FOP1 strategy was expected to yield higher consistency than participants' strategy when faced with all the NFP nutrients without guidance (i.e., participants in the NFP-only condition). Similarly, full models of those in the FOP2 condition were expected to show higher average consistency than those in the NFP-only full models. The highlighted FOP2 label was expected to cause participants to use NFP nutrients (particularly those in the FOP2) label more consistently, and thus the nutrients were expected to be more predictive of their judgments than of the judgments of the NFP-only participants. This last hypothesis, however, is extreme as it assumes participants' will highlighted information will greatly effect consumers—to the point that they suspend previously existing knowledge and rely solely on highlighted information even when it is not useful for the task.

A one-way ANCOVA was conducted to examine the effect of condition on the transformed multiple R_{XY} values of all individual models. Individual variables setting and the log transformed purging, restricting, and muscle building subscales of the EPSI scale were included as covariates, as were all condition and covariate two-way interactions. Judgment consistency did not vary as a function of condition, $F(2, 282) = 1.608$, $p = .20$, $\eta_p^2 = .011$, in the presence of the covariate variables. This indicates that participants in the FOP label conditions were no more consistent in their use of nutrient cues than those in the NFP-only condition. The mean consistency values for the models were in the expected direction, with multiple R values in the FOP1 ($M = .678$, $SD = .11$) and the FOP2 ($M = .666$, $SD = .10$) higher than those in the NFP-only conditions ($M = .662$, $SD = .09$). Additional descriptive statistics for full model consistency by condition can be found in Table 9. Direction notwithstanding, the differences are very small so the lack of statistical significance is not surprising. Thus, the third hypothesis, that cue use consistency would be higher on average in the FOP conditions than in the NFP-only condition was not supported.

Table 9

Full Model (All NFP Nutrients) Consistency (R_{XY}) Descriptive Statistics by Experimental Condition

	FOP 2 (*N* = 109)	NFP Only (*N* = 89)	FOP 1 (*N* = 99)
Mean (St. Deviation)	.666 (.101)	.662 (.091)	.678 (.112)
Median	.692	.659	.704
Minimum	.420	.450	.358
Maximum	.865	.905	.885

Cue use consistency findings indicated that there were no differences in cue consistency between conditions, but did not establish whether conditions had differing cue patterns. To explore possible relationships between cue patterns and experimental condition, the standardized nutrient coefficients of significant models were examined. Table 10 shows the proportion of significant individual models in which each nutrient was significantly related to judgment in the presence of all other nutrients. With the exception of two nutrients, sugar and number of vitamins/minerals, the proportion of models in which nutrients had significant coefficients was significantly lower than 50% regardless of condition. Multicollinearity may have played a role in the non-significance of nutrient coefficients, yet these findings further emphasize the lack of a clear impact of FOP labels on nutritional judgment. Had the FOP labels had their expected effect on participants' judgments, the proportion of models in which the FOP nutrient coefficients were significant would be expected to vary across condition. Specifically, FOP1 participant models would be expected to contain a higher proportion of significant sodium, sugar, and fiber coefficients. Similarly, FOP2 participant models would be expected to contain a higher proportion of significant potassium, saturated fat, and other carbohydrate coefficients. Chi-square tests of independence confirmed that this was not the case, all *p's* > .05. Of all FOP nutrients, the only nutrient whose coefficient significance varied across conditions was calories, $X^2(2, N = 240) = 7.15, p = .028$. Calories did not have a significant coefficient in any of the FOP2 participant models even though calorie amount was highlighted.

Table 10

*Proportion of Predictive Models in which Nutrient Coefficients were Significant*and Median Standardized Beta Coefficients of All Predictive Models (N = 240)*

	NFP Only (*N* = 71)		FOP 1[a] (*N* = 82)		FOP 2[a] (*N* = 87)	
	N (%)	*Mdn β*	*N* (%)	*Mdn β*	*N* (%)	*Mdn β*
Calories	6 (8%)	0.34	4 (5%)	0.45	0 (0%)	0.22
Calories (Fat)	10 (14%)	-0.54	14 (17%)	-0.49	18 (21%)	-0.62
Total Fat	10 (14%)	0.64	18 (22%)	0.60	20 (23%)	0.81
Saturated Fat	10 14%	-0.08	15 (18%)	-0.10	17 (20%)	-0.11
Polyunsaturated Fat	10 (14%)	-0.18	20 (24%)	-0.18	11 (13%)	-0.15
Monounsaturated Fat	4 (6%)	0.01	5 (6%)	0.02	2 (2%)	-0.04
Sodium	4 (6%)	-0.04	14 (17%)	-0.07	15 (17%)	-0.05
Potassium	8 (11%)	0.14	9 (11%)	0.18	11 (13%)	0.14
Total Carbs	4 (6%)	-0.17	6 (7%)	-0.33	1 (1%)	-0.02
Dietary Fiber	8 (11%)	0.17	17 (21%)	0.23	12 (14%)	0.22
Soluble Fiber	2 (3%)	-0.07	3 (4%)	-0.06	5 (6%)	0.01
Insoluble Fiber	12 (17%)	-0.18	15 (18%)	-0.18	28 (32%)	-0.21
Sugars	41 (58%)	-0.33	41 (50%)	-0.29	49 (56%)	-0.34
Other Carbs	6 (8%)	-0.04	7 (9%)	-0.02	7 (8%)	-0.04
Protein	9 (13%)	0.13	8 (10%)	0.13	8 (9%)	0.12
# of Vitamins & Minerals	34 (48%)	-0.22	41 (50%)	-0.21	41 (47%)	-0.17
Model Mean R^2	.4893		.5197		.5029	
Model Median R^2	.4797		.5189		.5041	

*$p < .055$. [a] Underlined coefficients indicate nutrients highlighted in the FOP condition.

Model Agreement Results

The fourth hypothesis, that average agreement will be higher in the FOP1 condition than in the NFP-only and FOP2 label conditions, and the fifth hypothesis, that average agreement will be lower in the FOP2 condition than in the NFP-only condition, were examined next. Out of all participants, 80% (N = 204) had judgments that could be predicted from the NFP nutrient values. For each of these individuals, model agreement, the extent to which their models matched the expert, NuVal model, was computed. Model agreement (G) was determined for each individual participant by computing the correlation between the predicted judgment values of each individual's regression model, ($M_{Y.X}$) and the predicted scores of the NuVal's regression model including all NFP variables ($M_{O.X}$) (see Table 2). Predicted nutritional judgments were computed for every participant using the 16 nutrient coefficients from their regression models. Once model values were determined, predicted values for each product for both participants and the environment (i.e. NuVal) were computed and these two values were then correlated. Descriptive statistics for G can be found in Table 11.

Table 11

Model Agreement (G) Descriptive Statistics by Experimental Condition (N = 204)

	FOP 2 (*N* = 87)	NFP Only (*N* = 71)	FOP 1 (*N* = 82)
Mean (St. Deviation)	.493 (.224)	.487 (.192)	.510 (.182)
Median	.556	.518	.504
Minimum	-.142	-.133	.073
Maximum	.926	.807	.878

Preliminary analyses were conducted to determine the suitability of individual level variables as covariates. Correlational analyses performed between potential covariates and the accuracy measure to establish the presence of linear relationships ($p < .05$) resulted in an ANCOVA test that included setting, and the EPSI body dissatisfaction, cognitive restraint, and the log transformed purging and muscle building subscales as covariates. The resulting model using the Fisher-z transformed *G*s indicated that, controlling for the covariate variables, condition was not related to model agreement, $F(2, 222) = 2.647$, $p = .073$, $\eta_p^2 = .023$.

Hypothesis four, that average agreement of the criterion and judgment cue weights (*G*) would be higher in the FOP1 label condition than in the NFP-only and FOP2 condition and hypothesis five, that *G* would be lower in the FOP2 condition than in the NFP-only condition, were not supported.

Choice Results

To test H6: Participants in the FOP1 condition will add more items with higher NuVal scores to their cart than those in the FOP2 and NFP-only condition, participants' choices to add an item to their cart were correlated with the NuVal scores of the items. The resulting point biserial correlation, a measure for nutritional choice, was used as a dependent variable in a between-subjects ANCOVA with the experimental condition (whether the participant was exposed to the FOP1, NFP-only, or FOP2 condition) as the independent variable, and the individual level variables as covariates.

Among the participants who rated all cereals, 93.6% ($N = 278$) had some variation in their choices to add cereals to their cart, so correlations between the NuVal scores and their choices were computed, within person, for the subsequent analysis. Correlations between NuVal and choices were low in all conditions: NFP-only: M = .046, Mdn = .015; FOP1: M =.025 Mdn = -.007; FOP2: M = -.01 Mdn =-.045. Full descriptive statistics of the choice correlation can be found in Table 12. Fisher z transformations of the correlations failed to put them on a normal distribution so nonparametric options were explored. A nonparametric Kruskal-Wallis test indicated that choice correlations did not vary across conditions, $H(2) = 4.767$, $p = .092$. The hypothesis that participants in the FOP1 condition will add items with higher NuVal scores to their cart than those in the FOP2 and NFP-only condition was not supported.

Table 12

Choice Correlation Descriptive Statistics by Experimental Condition

	FOP 2 (N = 104)	NFP Only (N = 83)	FOP 1 (N = 91)
Mean (St. Deviation)	-.010 (.161)	.046 (.177)	.025 (.177)
Median	-.045	.015	-.007
Minimum	-.399	-.297	-.282
Maximum	.399	.608	.632

Individual Level Predictors of Judgment LME Indices

Multiple linear regression was used to test the seventh hypothesis. This hypothesis stated that judgment measures of accuracy, consistency, and agreement will vary as a function of individual differences in nutrition and obesity knowledge, mentalities toward food, and demographic differences. In the initial regression models, transformed judgment measures: accuracy, full model consistency (consistency for the model containing all 16 NFP nutrients), model agreement, and choice correlation, were the dependent variables and individual level variables were predictor variables (see Table 5-7) and condition. Annual income was excluded as a predictor variable due to have a substantial number (N = 58) of missing values.

To determine which individual variables would be in a model predicting the transformed judgment accuracy measure, a full model containing all individual predictor variables was compared to a reduced model containing only the predictors that were significant ($p < .055$) in the full model using a one-step F test[3]. The reduced model, containing setting and the EPSI body dissatisfaction, and log transformed muscle building and purging subscale scores was no less predictive than the full model containing all variables[4], $F(15, 276) = 1.39$, $p > .05$, so the reduced model was utilized (see Table 13).

Jointly, the four variables in the reduced model predicted judgment accuracy, r_{YO}, $F(4, 295$[5]$) = 12.45$, $p < .001$, $R^2 = .097$. After controlling for the other variables in the model, muscle building ($\beta = -.149$, $p = .016$) and purging ($\beta = -.202$, $p = .006$) were negatively related to judgment accuracy, indicating that higher muscle building and purging tendencies were associated with lower judgment accuracy. Setting was also related to judgment accuracy with those who completed the study in the lab having higher

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[3] That is, $F(df_r\text{-}df_{f,}\ df_f) = [(SSE_r - SSE_f)/(dfr\text{-}dff)]/MSE_f$, where SSE is the sums of square error (residual), MSE is the mean square error, and df is degrees of freedom, with subscripts f and r to denote full and reduced models, respectively.

[4] There was no effect of condition in the full model with all individual variables but when linear regression models that mirrored the ANCOVA models were conducted, the condition effect on accuracy was consistent with the ANCOVA results.

[5] Due to missing values in the predictor variables, the total sample number available for the full model consisted of 296. This same sample was used in the reduced models as well to avoid statistical inconsistencies.

accuracy than those who completed the study online ($\beta = .142$, $p = .011$) after controlling for all other variables in the model. The EPSI body dissatisfaction coefficient ($\beta = .215$, $p = .001$) was positively related to judgment accuracy indicating that participants with higher body dissatisfaction had higher judgment accuracy.

To determine which individual variables would be in a model predicting the transformed consistency measure, a full model containing all individual predictor variables was compared to a reduced model containing only the predictors that were significant in the full model using a one-step F test. The reduced model, containing setting, log transformed BMI, and the EPSI cognitive restraint, and log transformed muscle building, purging, and restricting subscales was found to be no less predictive than the full model containing all individual level variables, $F(13, 276) = 0.66$, $p > .05$, so the reduced model is reported.

The model predicting transformed cue use consistency contained setting, the EPSI cognitive restraint, log transformed muscle building, purging, and restricting, and log transformed BMI (see Table 13). Jointly, the variables predicted the transformed full model judgment consistency, R_{XY}, $F(6, 289) = 9.17$, $p < .001$, $R^2 = .16$. Controlling for all other variables, BMI ($\beta = -.114$ $p = .044$), muscle building ($\beta = -.153$, $p = .01$), purging ($\beta = -.195$, $p = .003$), and restricting ($\beta = -.156$, $p = .011$) were negatively related to full model cue use consistency, indicating those with higher BMI and higher muscle building, purging, and restricting tendencies had less consistency in their use of nutrient cues. In contrast, cognitive restraint ($\beta = .219$, $p < .001$) was positively related to full model cue use consistency in the presence of the other variables. Similar to judgment accuracy, setting was marginally related to full model cue use consistency with those who completed the study in the lab having higher consistency than those who completed the study online ($\beta = .106$, $p = .051$) after controlling for all other variables in the model.

To determine which individual variables would be included in a model predicting the transformed model agreement measure, a linear regression model containing all individual predictor variables was conducted. Model agreement could only be computed for participants whose judgments could be predicted from nutrient information, so the Fisher z transformed model agreements of this subpopulation ($N = 240$) were regressed on the individual level variables. The reduced model, containing the EPSI body dissatisfaction subscale and log transformed BMI, was found to be no less predictive than the full model containing all individual level variables, $F(17, 220) = 1.35$, $p > .05$, so the reduced model is reported.

Jointly, the reduced model containing the EPSI body dissatisfaction subscale and log transformed BMI, significantly predicted model agreement, *G*, $F(2, 239) = 9.17$, $p < .001$, $R^2 = .16$. Controlling log transformed BMI, body dissatisfaction was positively related to model agreement ($\beta = .167$ $p = .011$), indicating that participants who expressed greater body dissatisfaction were more likely to have judgment models for cereals that were positively correlated with the NuVal's model. Controlling for body dissatisfaction, BMI was negatively related to model agreement, ($\beta = -.145$, $p = .027$), indicating that participants with higher BMI were less likely to have judgement models that matched that of the NuVal. Standardized coefficients for the model agreement's reduced model are reported in Table 13.

To determine which individual variables would be included in predicting the point biserial choice correlation, a full model containing all individual predictor variables was compared to a reduced model containing only the predictors that were significant in the full model. The reduced model included the HBCL wellness subscale, BMI, and the EPSI cognitive restraint and binge eating subscales. This reduced model was no less predictive than the full model with all predictor variables, $F(17, 257) = 0.83$, $p > .05$. Due to this result, the reduced model statistics are reported. The reduced regression model, containing EPSI cognitive restraint and log transformed BMI (see Table 13) significantly predicted the point biserial choice correlation, $F(2, 274^{6}) = 22.54$, $p < .001$, $R^2 = .14$. In the presence of all other variables in the model, the cognitive restraint ($\beta = .353$, $p < .001$) EPSI subscales was positively related to nutritional choice, indicating that higher reported frequency of behaviors such as excessive and unconscious eating, as well as avoiding high calorie food, counting calories, and excluding unhealthy foods were associated with cereal choices more highly correlated with NuVal scores. In contrast, BMI ($\beta = -.143$, $p = .011$) was negatively related to nutritional choice, indicating that participants with higher BMIs had cereal choices that had low correlations with NuVal after controlling for all other variables in the model.

[6] A missing value in BMI resulted in a smaller number of cases ($N = 277$) than the total number 278 for whom point biserial correlations could be computed.

Table 13

Standardized Beta Coefficients for the Individual Variable Models Predicting Lens Model Indices

	Judgment Accuracy[a] *N* = 296	Cue Use Consistency[a] *N* = 296	Model Agreement[a] *N* = 240	Choice Correlation *N* = 277
Objective Numeracy	--	--	--	--
Subjective Numeracy	--	--	--	--
HBCL Substance	--	--	--	--
HBCL Wellness	--	--	--	--
EPSI Body Dissatisfaction	.215*	--	.167*	--
EPSI Binge Eating	--	--	--	--
EPSI Cognitive Restraint	--	.219*	--	.353*
EPSI Purging[b]	-.202*	-.195	--	--
EPSI Restricting[b]	--	-.156*	--	--
EPSI Excessive Exercising	--	--	--	--
EPSI Negative Attitudes re. Obesity[b]	--	--	--	--
EPSI Muscle Building[b]	-.149*	-.153*	--	--
Body Mass Index[b]	--	-.114*	-.145*	-.143*
Year in School	--	--	--	--
Dieting Behavior	--	--	--	--
Hours to Complete Study	--	--	--	--
Setting of Study	-.142*	-.106	--	--
Condition FOP1[c]	--	--	--	--
Condition FOP2[c]	--	--	--	--
R^2	.113*	.160*	.039*	.141*

Table 13 continued

Adjusted R^2	.100	.142	.031	.135

* Correlation is significant at $p \leq 0.05$ (2-tailed).
[a]Fisher-z transformed judgment measures used. [b]Log transformed variables used.
[c]Dummy coded variables were used to measure condition. In predicting choice, the FOP1 condition was used as the refence group; the NFP-Only condition was used as the reference group in predicting all other indices.

DISCUSSION

National rates of obesity remain at all-time highs, increasing likelihoods of chronic illness and early death. Mandated nutritional information has had little impact on improving nutritional habits of the overall population and reducing unhealthy eating. One reason for the lack of informational impact may be the complexity of the NFP label. The label often includes many nutrients and several metrics that need to be considered when determining the nutritional quality of the product (e.g., serving size, recommended daily value, amount per servicing size). In addition, the value of the nutrients themselves (whether they are healthy or not) may not be clearly understood by consumers, and the importance of specific nutrients within varying products and in the presence of other nutrients might not be straightforward.

A possible improvement to the current labelling system is the use of simple, prominent FOP labels that draw consumers' attention to specific content regarding the products nutritional attributes. This study investigated the effect of a specific FOP label, the nutrient-specific label, currently in use on many products. Determining whether these labels improve nutritional judgment accuracy and food choice, as well as how they do so, is imperative to the development of FOP label systems that will have a beneficial impact on public health.

In this study, judgment accuracy was found to vary according to the nutrition labels participants were exposed to. Importantly, participant judgment accuracy did not improve merely as a function of having a FOP label to use. Rather, results indicate that the benefits of a FOP label were not independent from content. That is, labels that included FOP information that was accurate nutritional information, but was not very relevant to the overall nutritional quality of the product, did not result in greater nutritional accuracy or nutritional model agreement compared to when participants were not provided with FOP labels. On the contrary, these labels had a detrimental effect on judgment accuracy compared to no FOP label. These findings indicate that nutrient-specific, FOP labels can impact nutritional judgment, but a beneficial effect is dependent not on their mere presence on a product but on the relationship of the nutrients they include to the overall nutritional quality of the product.

This finding might appear unremarkable if the utility of FOP labels a whole were not in question. The finding that the utility of FOP labeling is dependent on content indicates that FOP labels should be changed across food domains to include the nutritional information most relevant to the product. For instance, although saturated fat was not particularly important to the nutritional environment of the 74 cereals used in this study, it might be highly relevant to products that have a large variation in saturated fat, such as dairy products. Thus, this study's findings indicate that highlighted labels should not be used to prompt consumers to pay closer attention to the comprehensive nutrition information available in the NFP, because they do not have that effect. Having nutritionally accurate FOP labels is not sufficient; if FOP labels are to aid rather than harm consumer judgment accuracy their content must also be relevant to the nutritionally quality of the specific product on which they appear.

Facts Up Front, the General Mills nutrient-specific FOP label on which this study's FOP label was based, consistently includes calories, saturated fat, sodium, and sugar and sometimes adds one or two additional nutrients (Patton, 2014; Facts about facts up front, 2017). The label is based upon national Dietary Guidelines, but does not account for variation across food products. As examination of the environment in this study indicated, among cereals, neither calories, nor saturated fat are associated with nutritional quality (see Tables 1 & 2), which brings into question the utility of including them on an FOP label. Indeed, the current findings indicate that highlighting nutrients that are not associated with nutritional quality can have a detrimental, rather than simply neutral effect. Calorie amount is given particular prominence on FOP labels; when products are too small to include a full FOP label, calorie amount is the sole quantity highlighted (Facts up front FAQ, 2017).

Examination of the median standardized coefficients among participants whose judgments could be predicted from the nutrients indicates that participants did not seem to weight nutrients differently when they were highlighted. Calories, for instance, had a median β of 0.34 in the NFP-only condition, which was expectedly smaller than the FOP1 median β for calories of 0.45 but unexpectedly larger than the FOP2 median calories β of 0.22. Contrary to expectations, there were no differences in the proportion of significant coefficients among the highlighted nutrients (excepting calories as noted above). That is, the content of the FOP labels was not associated with greater weighting of the variables highlighted. Notably, sugars were highly used by participants, with 50% or more of significant models having a significant sugar coefficient. Use of sugar, however, did not vary across condition and in all conditions, median betas were negative which is consistent with the NuVal’s modeling of sugar in cereals. The similarity in accurate sugar weighting across conditions may explain the lack of variation in judgment measures between conditions. Further research is necessary to determine the direct cause of the differential effects of the FOP1 and FOP2 models as this study did not find connecting differences in nutrient weightings.

Despite the findings that judgment accuracy varied according to the content of FOP labels, the practical utility of such labels for improving nutritional judgment is questionable. Notably, differences in accuracy between conditions were very small, never in the first decimal place. All judgment variables were moderate at best, with medians and means for accuracy, consistency, and model agreement never higher than .51 regardless of condition. In addition, evidence of benefits for choice behavior, and thus health outcomes, remains poor. Products that were selected by participants to "add to cart" did not vary by condition, indicating that participants who observed FOP labels were no more or less likely to choose healthy items than those who observed the conventional NFP labels. One possibility for this finding is that participants may not have been sufficiently motivated to select healthy products due to personal preference or the hypothetical nature of the task. Future studies should examine whether increasing participant motivation increases the effect of FOP labels, or whether such motivation eliminates any beneficial or detrimental effect of relevant and irrelevant FOP content respectively.

This study did find several individual level variables that related to lens model indices. Setting, as well as the EPSI body dissatisfaction, purging, and muscle building subscale scores were found to be jointly related to judgment accuracy. Purging and muscle building, along with cognitive restraint, restricting, BMI, and setting were found to be jointly related to cue use consistency and body dissatisfaction and BMI were found to be related to model agreement. Cognitive restraint and BMI were also related to nutritional choice.

Body dissatisfaction score was determined by the sum of seven items related to dissatisfaction with one's body, for instance "I did not like how clothes fit the shape of my body," "I thought my butt was too big," and "I wished the shape of my body was different." In models predicting judgment accuracy and model agreement, body dissatisfaction was found to be positively related to the judgment measure, after controlling for the other variables in the models. Cognitive restraint, which was the sum of three items: "I tried to exclude "unhealthy" foods from my diet;" "I counted the calories of food I ate;" and "I tried to avoid foods with high calorie content," was positively related to both judgment consistency and nutritional choice. That is after controlling for all other variables in the respective models, higher reported frequency of such behavior was associated with higher judgment consistency and more nutritious cereal selections.

The positive relationships between body dissatisfaction and judgment accuracy and model agreement respectively may be due to participants who are dissatisfied with their bodies increasing their understanding of negative and positive consequences of product nutrients. Notably, there was no relationship between body dissatisfaction and consistency or choice. This indicates that although individuals who are dissatisfied with their bodies may be more likely to accurately judge the nutritional quality of food products and even correctly perceive the relationship between various nutrients and the product's overall quality, being dissatisfied with their bodies does not necessarily increase their cue use consistency or help them make better product selections. Similarly, cognitive restraint was positively related to cue use consistency and nutritional choice but not to judgment accuracy or model agreement. The positive relationship between cognitive restraint and cue use consistency and nutritional choice respectively indicates that individuals who are explicitly trying to avoid certain nutrients and make heathy choices are more likely to develop consistent practices in their use of nutrient information and select healthier items. Such individuals may not, however, be accurate in their explicit judgments of overall product nutritional quality or in their understanding of how a products' nutrients interact to create a healthy whole, as evidenced by the lack of relationship between cognitive restraint and judgment accuracy and model agreement respectively.

The purging score was determined by the sum of six items related to induced food elimination, such as "I used diet teas or cleansing teas to lose weight," "I used diet pills," and "I made myself vomit in order to lose weight." For all EPSI subscales, higher scores were indicative of higher frequency of the items occurrence in the most recent four weeks. Similarly, muscle building was determined by summing responses to five items related to muscle building such as "I used muscle building supplements," "I thought about taking steroids as a way to get more muscular," and "I thought my muscles were too small" (see Eating Pathology Symptoms in Appendix B for all purging and muscle building items). Both purging and muscle building subscales were negatively related to multiple judgment measures, as was BMI.

Purging and muscle building were negatively related to both judgment accuracy and cue use consistency, after controlling for other variables in each respective model. BMI was negatively related to cue use consistency, model agreement, and nutritional choice. Restricting score, which was determined by the sum of six items related to restriction of food intake, such as “people told me that I do not eat very much,” “people would be surprised if they know how little I ate” and “I got full more easily than most people” was also negatively related to cue use consistency. The negative relationships between these variables and various judgment measures may be indicative of populations which would greatly benefit from interventions aimed at improving nutrient label use and nutritional judgment and choice. The negative relationship of purging and muscle building to judgment accuracy and cue use consistency indicates that individual interest and investment in physical appearance is not necessarily related to nutritional understanding or even consistent perception of product nutrients. Indeed, as further evidenced by the negative relationship between restricting and cue use consistency, individuals who are willing to engage in extreme behavior to modify their physical appearance lack judgment capacities that may much more simply and safely assist them in their goals for self-improvement. Similarly, the negative relationships between BMI and cue use consistency, model agreement, and nutritional choice further indicate opportunities for positively affecting health outcomes. As those high in BMI are low in judgment and decision-making capacities, improving these processes amongst consumers would likely have a positive effect on overall consumer health.

An individual level variable that was not utilized in this study was knowledge of nutrition and nutritional health. Two scales included in the survey, the General Nutritional Knowledge Questionnaire and the Obesity Risk Knowledge Questionnaire were intended to measure knowledge of nutrition and health risks associated with obesity, but the scales had poor psychometric properties in this study’s sample, despite the same formats having been successfully used to predict nutritional judgment and choice in previous studies (Gonzalez & Lavins, 2015). One possible cause of the low reliability of these scales in the current study is low levels of knowledge among the participants in this study. Across the entire sample, average general knowledge (computed as the sum of correct answers across the ten items) was equal to 5.56 (SD = 1.70), with 51.2% (N = 152) of participants scoring 5 or lower. As the question format was true/false, a score of 5 is no more than would be expected by chance. Scores on the obesity risk knowledge questionnaire were slightly higher, with a mean equal to 6.58 (SD = 1.39) and 19.9% (N = 59) of participants correctly answer 5 questions or fewer. In the previous study relating these scale formats to nutritional judgment and choice, González-Vallejo and Lavins (2015) used a sample recruited from MTurk that was more diverse in terms of age, race, income, and occupation. It is possible that the restricted range of scales in the current sample dampened any possible relations between them and nutritional judgment.

One limitation of this study is that the design did not allow the differences in accuracy between the two different settings to be clearly understood. Differences in duration between the two settings were significant, but were not associated with accuracy once setting was controlled for. This indicates that some other difference between participants in the laboratory and online may have caused their judgment accuracies to have varied. One possibility is that those in the laboratory setting were more motivated to pay attention to the task than those in the online condition. Such a possibility raises two concerns: first, that the true ability of consumers to evaluate nutritional value, as well as the strength of the effect of highlighted information, can only be accurately determined in a laboratory setting. Second, if the effect of highlighted information is dependent on a motivational factor that is not reliably obtainable in a non-laboratory environment, the effect of FOP labels on the judgment and decision-making of the average consumer in a natural environment are questionable.

Nonetheless, current NFP labelling does expect consumers to manifest some motivation to understand the nutritional content of their food, and motivation has previously been found to be a key factor in label use (Burton, Garretson, & Velliquette, 1999; Moorman 1996). The current study found that body dissatisfaction was positively related to model agreement between participants and experts. In contrast, BMI was negatively related to model agreement as well as cue use consistency and healthy choice. These findings may perhaps indicate some relationship between pre-existing motivations for healthy eating and judgment and decision behaviors. Future research should investigate the role of motivation for healthy behaviors and the effect of FOP labeling to determine whether FOP labeling improves the judgments and decisions of those most invested in making healthy food choices.

Future research should also examine whether different FOP labels might have a stronger effect on nutritional judgment and choice. As depicted in Figure 1, multiple different FOP systems exist and their effects may vary (Institute of Medicine, 2010). Currently, the General Mills nutrient highlighting labels is common in the United States, but other nutrient highlighting label formats such as the traffic light label and indicator label formats such as the Chile stop sign (Ramirez, 2015) may have different effects on judgment and choice. As FOP labeling has not yet become a requirement in the United States, and FDA specification and regulation of FOP labels has not been fully determined, now is the time for further research to determine whether FOP labels influence product behavior, and whether that effect is sufficient to merit the regulatory expense widespread labeling will require. The current study indicates that the effect of FOP labeling is so small that it may have no overall influence on dietary habits, however, further investigation into the effect of motivation on FOP effectiveness is necessary. Format differences in highlighting may also make all the difference.

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APPENDIX A: STIMULI

List of Cereals and Corresponding NuVal Scores

Item Number	Product Name	NuVal Score
1	Kellogg's Special K Original Lightly Toasted Rice Cereal	20
2	Post Fruity Pebbles Sweetened Rice Cereal	20
3	Nature's Path Envirokidz Organic Gorilla Munch Cereal Gluten Free	23
4	Post Original Shredded Wheat Biscuits Made From 100% Natural Whole Grain Wheat	91
5	Kellogg's Unfrosted Bite Size Mini-Wheats Unfrosted Whole Grain Wheat Cereal.No Added Sugar.	91
6	Nature's Path Organic Corn Puffs Cereal No Additives Or Preservatives Fat Free Sugar Free Sodium Free 100% Whole Grain Goodness Organic Corn Puffs Usda Organic This Product Is Third-Party Certified Organic By Quality Assurance International (Qai)	87
7	Nature's Path 3 Generations Organic Qia Superfood Chia, Buckwheat & Hemp Cereal Apple Cinnamon Excellent Source Of Ala Omega-3 Certified Gluten-Free Usda Organic This Product Is Third-Party Certified Organic By Quality Assurance International (Qai)	87
8	Kashi Go Lean Protein & High Fiber Cereal Crunchy Fiber Twigs, Soy Protein Grahams And Honey Puffs	47
9	General Mills Total Raisin Bran Crunchy Whole Grain Wheat & Bran Flakes With Plump, Juicy Raisins 160 Calories Per Serving 100% Daily Value Of 11 Vitamins & Minerals	30
10	General Mills Berry Berry Kix Lightly Sweetened Corn Cereal With Whole Grain Guaranteed Made With All Natural Corn	27
11	General Mills Cheerios Honey Nut Sweetened Whole Grain Oat Cereal With Real Honey And Natural Almond Flavor	27
12	General Mills Golden Grahams Cereal With Whole Grain	26
13	General Mills Cocoa Puffs Combos Chocolate & Vanilla Naturally And Artificially Flavored With Whole Grain	25
14	General Mills Cookie Crisp The Great Taste Of Chocolate Chip Cookies & Milk Whit Whole Grain Guaranteed	25
15	General Mills Lucky Charms Frosted Toasted Oat Cereal With Marshmallows New Swirled Marshmallow Charms With Whole Grain Guaranteed	24
16	General Mills Count Chocula Cereal Chocolatey Cereal With Spooky-Fun Marshmallows With Whole Grain	25

17	General Mills Frosted Corn Flakes Sweetened Flakes Of Corn With 11 Vitamins And Minerals	24
18	Kellogg's Special K Low Fat Granola Touch Of Honey 50% Less Fat Than Leading Granola	30
19	Kellogg's Krave Good Source Of Fiber & Made With Whole Grain Made With Real Chocolate! Double Chocolate Crispy Multi-Grain Cereal Outside, Smooth Chocolate Inside Cereal With Chocolate Flavored Center	31
20	General Mills Cinnamon Toast Crunch Real Cinnamon & Sugar In Every Bite Crispy, Sweetened Whole Wheat And Rice Cereal	24
21	Kellogg's Special K Protein Plus Lightly Sweetened Wheat, Soy & Rice Flakes	27
22	Kellogg's Raisin Bran Two Scoops! Delicious Raisins Perfectly Balanced With Crisp, Toasted Bran Flakes Cereal Excellent Source Of Fiber & Made With Whole Grain	27
23	Kellogg's Corn Pops Cereal	26
24	Kellogg's The Original & Best Corn Flakes	25
25	Kellogg's Froot Loops Sweetened Multi-Grain Cereal Natural Fruit Flavors Now Provides Fiber	24
26	Kellogg's Apple Jacks Reduced Sugar	24
27	Kashi Good Friends High Fiber Cereal Trio Of Flakes, Twigs & Granola	33
28	Kashi 7 Whole Grain Honey Puffs 23G Whole Grains	32
29	Kashi Golean Crisp! Naturally Sweetened Multigrain Cluster Cereal Toasted Berry Crumble With Cranberries & Wild Blueberries No High Fructose Corn Syrup	30
30	Kashi Go Lean Crunch! Protein & High Fiber Cereal Naturally Sweetened Multigrain Clusters	28
31	Post Raisin & Almond Trial Mix Crunch Cereal Lightly Crunchy Nuggets, Granola, Raisins, Almonds And A Touch Of Honey	29
32	Post Honey Bunches Of Oats Cereal Honey Roasted Crispy Flakes, Crunchy Oat Clusters & A Touch Of Honey!	27
33	Cascadian Farms Organic Honey Nut O'S Organic Whole Grain Oat Cereal Touched With Golden Honey & Organic Almond Flavor	27
34	Quaker Life Cereal Made With Whole Grain	26
35	Quaker Life Cereal Cinnamon	25
36	Malt-O-Meal Raisin Bran Whole Grain Wheat & Bran Cereal With Raisins	24
37	Kashi Strawberry Fields Cereal	10
38	Kellogg's Rice Krispies Treats Cereal	3
39	Cinnabon Cereal, 10 oz. box	6
40	Waffle Crisp Cereal	6

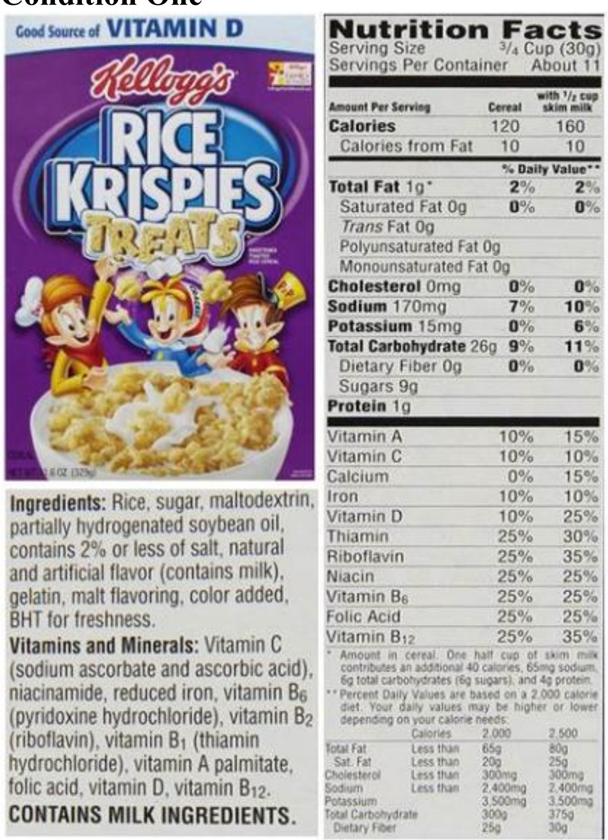
41	Organic Promise Raisin Vineyard Cereal, 13.7 Ounce	11
42	Crispy Rice	15
43	Envirokidz Organic Leapin' Lemurs Peanut Butter & Chocolate Cereal	20
44	Honey & Oat Blenders	23
45	Reese's Puffs - 13 oz	23
46	Indigo Morning Organic Corn Cereal	23
47	Simply Maize Cereal, 10.5-Ounce	23
48	Basic 4 Cereal, 16-Ounce Boxes	23
49	Smart Start Antioxidants Cereal, Original, 17.5-Ounce Boxes	23
50	Blueberry Morning Cereal	23
51	Honey Kix	24
52	Honey & Oat & Almond Blenders	24
53	Kellogg's Special K Cereal, Fruit and Yogurt, 16.6 Ounce	24
54	Oatmeal Crisp Cereal, Hearty Raisin, 18-Ounce Box	24
55	Path Organic Whole O's, Gluten Free Cereal	24
56	Honey Sunshine Squares Cereal, 10.5 Ounce	25
57	Organic Granola Cereal Ancient Grains, 12.5 Ounce	25
58	Kix	26
59	Multigrain Cheerios	26
60	Honey Bunches of Oats Vanilla Bunches	26
61	Honey Bunches of Oats Almond	26
62	Special K Cereal, Chocolate Almond, 12.7 Ounce	26
63	Mueslix, 15.3-Ounce Boxes	27
64	Grape Nuts	28
65	Great Grains Raisin, Date & Pecan Cereal	29
66	Frosted Mini Wheats	30
67	Path Organic Flax Plus Red Berry Crunch Cereal	32
68	Cheerios	33
69	Banana Nut Crunch	33
70	Frosted Mini Spooners	34
71	Frosted Strawberry Cream Mini Spooners	34
72	Blueberry Mini Spooners	36
73	Organic Promise Cereal, Cinnamon Harvest Whole Wheat Biscuits, 16.3 Ounce Boxes	38
74	Path Organic Smart Bran, Psyllium & Oatbran Cereal	40

Food Evaluation Instructions and Example:

In this part of the study we want you to evaluate some common packaged foods. For each food item you will see a screen with a picture that shows its front packaging information. You will also have its Nutrition Facts Panel and the list of its ingredients. This information should be helpful as you evaluate the foods with regards to their nutrition. Please view each item and then answer the questions that follow as best as you can so that they represent your opinions.

In addition to evaluating each food item, we will ask you to hypothetically purchase the item by placing it in a shopping cart if you think it is desirable (a yes/no answer). For this part, assume cost is not an obstacle to possessing the item. However, also consider that you wouldn't want to add something to your cart that you wouldn't consume.

Condition One



Condition Two

Condition Three

APPENDIX B: MEASURES

Questions Concerning the Food Items

1. How healthy is this cereal?
   Please rate the healthiness of this item on a scale from 1(not healthy at all) to 100 (extremely healthy)

2. How nutritious is this cereal?
   Please rate the nutrition of this item on a scale from: 1 (not nutritious at all) to 100 (extremely nutritious)

3. How well do you know this cereal? Please rate how well you know this cereal on a scale from 1(not at all) to 100 (extremely well)

4. How many times a week do you consume this item?

5. How tasty do you think this cereal is?
   Please rate how tasty you know this cereal is on a scale from 1(not at all) to 100 (extremely tasty)

6. How much do you like this cereal?
   Please rate how much you like this cereal on a scale from 1(not at all) to 100 (a lot)

7. If price were not a factor, how likely would you be purchase this cereal?
   Please rate the likelihood on a scale from 1 (I would definitely not purchase this cereal) to 100 (I would definitely purchase this cereal)

8. Please list the factors that determined your nutrition evaluation for this cereal (enter "unknown" if you do not know).

9. Add to My shopping cart?
   Yes/No

General Nutrition Knowledge Questionnaire

Please indicate, to the best of your knowledge, whether each of the following statements are true or false.

1. Experts advise that people eat three servings of fruit and vegetables a day (one serving could be, for example, an apple or a handful of chopped carrots). (F)

2. The most important fat for people to cut down on is monounsaturated fat. (F)

3. Some foods contain a lot of fat but no cholesterol. (T)

4. A glass of unsweetened fruit juice counts as a helping of fruit. (T)

5. Saturated fats are mainly found in dairy products. (T)

6. Brown sugar is a healthy alternative to white sugar. (F)

7. There is more protein in a glass of whole milk than in a glass of skimmed milk. (F)

8. Polyunsaturated margarine contains less fat than butter. (F)

9. White bread contains more vitamins and minerals than brown or whole grain bread. (F)

10. Butter is higher in calories than regular margarine. (F)

11. Coconut oil contains mostly monounsaturated fat. (F)

12. Polyunsaturated fats are mainly found in vegetable oils. (F)

Obesity Risk Knowledge Questionnaire

Please indicate, to the best of your knowledge, whether each of the following statements are true or false.

1. A person with a 'beer-belly' shaped stomach has an increased risk of getting diabetes. (T)
2. Obesity increases the risk of getting bowel cancer. (T)
3. An obese person who gets diabetes needs to lose at least 40% of their body weight for clear health benefits. (F)
4. Obese people can expect to live as long as non-obese people. (F)
5. Obesity increases the risk of getting breast cancer after the menopause. (T)
6. Obesity is more of a risk to health for people from South Asia (e.g. India and Pakistan) than it is for White Europeans. (T)
7. There is no major health benefit if an obese person who gets diabetes, loses weight. (F)
8. Obesity does not increase the risk of developing high blood pressure. (F)
9. It is better for a person's health to have fat around the hips and thighs than around the stomach and waist. (T)
10. Obesity increases the risk of getting a food allergy. (F)

Health Behaviors Checklist (HBCL)

Please indicate how well the specific health behaviors describe your typical behavior. In each case, you will be asked to indicate *how much you agree or disagree* with each statement by choosing the corresponding number.

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

1. I see a doctor for regular checkups **1 2 3 4 5**
2. I watch my weight..**1 2 3 4 5**
3. I exercise to stay healthy...**1 2 3 4 5**
4. I don't smoke **1 2 3 4 5**
5. I don't take chemical substances which might injure my health (e.g., food additives, drugs, stimulants)..**1 2 3 4 5**
6. I see a dentist for regular checkups..**1 2 3 4 5**
7. I limit my intake of foods like coffee, sugar, fats, etc. **1 2 3 4 5**
8. I take vitamins..**1 2 3 4 5**
9. I do not drink alcohol..**1 2 3 4 5**
10. I avoid areas with high pollution **1 2 3 4 5**
11. I discuss health with friends, neighbors, and relatives...................**1 2 3 4 5**
12. I gather information on things that affect my health by watching television and reading books, newspapers, or magazine articles...**1 2 3 4 5**
13. I use dental floss regularly **1 2 3 4 5**
14. I take health food supplements (e.g., protein additives, wheat germ, bran, lecithin) **1 2 3 4 5**

Wellness subscale includes items: 1, 2, 3, 6, 7, 8, 11, 12, 13, 14

Substance subscale includes items: 4, 5, 9, 10

Eating Pathology Symptoms Inventory (EPSI)

Below is a list of experiences and problems that people sometimes have. Read each item to determine how well it describes your recent experiences. Then select the option that best describes how frequently each statement applied to you during the past four weeks, including today.

Never	Rarely	Sometimes	Often	Very Often
○	○	○	○	○

1. I did not like how clothes fit the shape of my body. *(Body Dissatisfaction)*
2. I tried to exclude "unhealthy" foods from my diet *(Cognitive Restraint)*
3. I ate when I was not hungry *(Binge Eating)*
4. People told me that I do not eat very much *(Restricting)*
5. I felt that I needed to exercise nearly every day *(Excessive Exercise)*
6. People would be surprised if they knew how little I ate *(Restricting)*
7. I used muscle building supplements *(Muscle Building)*
8. I pushed myself extremely hard when I exercised *(Excessive Exercise)*
9. I snacked throughout the evening without realizing it *(Binge Eating)*
10. I got full more easily than most people *(Restricting)*
11. I considered taking diuretics to lose weight *(Purging)*
12. I tried on different outfits, because I did not like how I looked *(Body Dissatisfaction)*
13. I thought laxatives are a good way to lose weight *(Purging)*
14. I thought that obese people lack self-control *(Negative Attitudes toward Obesity)*
15. I thought about taking steroids as a way to get more muscular *(Muscle Building)*
16. I used diet teas or cleansing teas to lose weight *(Purging)*
17. I used diet pills *(Purging)*
18. I did not like how my body looked *(Body Dissatisfaction)*
19. I ate until I was uncomfortably full *(Binge Eating)*
20. I felt that overweight people are lazy *(Negative Attitudes toward Obesity)*
21. I counted the calories of foods I ate *(Cognitive Restraint)*
22. I planned my days around exercising *(Excessive Exercise)*
23. I thought my butt was too big *(Body Dissatisfaction)*
24. I did not like the size of my thighs *(Body Dissatisfaction)*
25. I wished the shape of my body was different *(Body Dissatisfaction)*
26. I was disgusted by the sight of an overweight person wearing tight clothes *(Negative Attitudes toward Obesity)*
27. I made myself vomit in order to lose weight *(Purging)*
28. I did not notice how much I ate until after I had finished eating *(Binge Eating)*
29. I considered taking a muscle building supplement *(Muscle Building)*
30. I felt that overweight people are unattractive *(Negative Attitudes toward Obesity)*
31. I engaged in strenuous exercise at least five days per week *(Excessive Exercise)*

32. I thought my muscles were too small *(Muscle Building)*
33. I got full after eating what most people would consider a small amount *(Restricting)*
34. I was not satisfied with the size of my hips *(Body Dissatisfaction)*
35. I used protein supplements *(Muscle Building)*
36. People encouraged me to eat more *(Restricting)*
37. If someone offered me food, I felt that I could not resist eating it *(Binge Eating)*
38. I was disgusted by the sight of obese people *(Negative Attitudes toward Obesity)*
39. I stuffed myself with food to the point of feeling sick *(Binge Eating)*
40. I tried to avoid foods with high calorie content *(Cognitive Restraint)*
41. I exercised to the point of exhaustion *(Excessive Exercise)*
42. I used diuretics in order to lose weight *(Purging)*
43. I skipped two meals in a row *(Restricting)*
44. I ate as if I was on auto-pilot *(Binge Eating)*
45. I ate a very large amount of food in a short period of time (e.g., within 2 hours) *(Binge Eating)*

Rasch Based Numeracy Scale

Numbers - Please do not use a calculator or look up answers for any of these questions. We are interested in what you think.

1. Imagine that we roll a fair, six-sided die 1,000 times. (That would mean that we roll one die from a pair of dice.) Out of 1,000 rolls, how many times do you think the die would come up as an even number?

Answer:_____________________

2. In the BIG BUCKS LOTTERY, the chances of winning a $10.00 prize are 1%. What is your best guess about how many people would win a $10.00 prize if 1,000 people each buy a single ticket from BIG BUCKS?

Answer:_____________________ people

3. In the ACME PUBLISHING SWEEPSTAKES, the chance of winning a car is 1 in 1,000. What percent of tickets of ACME PUBLISHING SWEEPSTAKES win a car?

Answer:_____________________%

4. If the chance of getting a disease is 10%, how many people would be expected to get the disease:

B: Out of 1000? Answer:________________ people

5. If the chance of getting a disease is 20 out of 100, this would be the same as having a _____% chance of getting the disease.

6. Suppose you have a close friend who has a lump in her breast and must have a mammogram. Of 100 women like her, 10 of them actually have a malignant tumor and 90 of them do not. Of the 10 women who actually have a tumor, the mammogram indicates correctly that 9 of them have a tumor and indicates incorrectly that 1 of them does not have a tumor. Of the 90 women who do not have a tumor, the mammogram indicates correctly that 80 of them do not have a tumor and indicates incorrectly that 10 of them do have a tumor. The table below summarizes all of this information. Imagine that your friend tests positive (as if she had a tumor), what is the likelihood that she actually has a tumor?

	Tested positive	Tested negative	Totals
Actually has a tumor	9	1	10
Does not have a tumor	10	80	90
Totals	19	81	100

Answer: _______out of ________

7. A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?

______ cents

8. In a lake, there is a patch of lilypads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?

______ days

Subjective Numeracy Scale Fagerlin Zikmund Fisher Ubel

1. How good are you at working with fractions?

Not at all good					Extremely good
1	2	3	4	5	6

2. How good are you at working with percentages?

Not at all good					Extremely good
1	2	3	4	5	6

3. How good are you at calculating a 15% tip?

Not at all good					Extremely good
1	2	3	4	5	6

4. How good are you at figuring out how much a shirt will cost if it's 25% off?

Not at all good					Extremely good
1	2	3	4	5	6

5. When reading the newspaper, how helpful do you find tables and graphs that are parts of a story?

Not at all helpful					Extremely helpful
1	2	3	4	5	6

6. When people tell you the chance of something happening, do you prefer that they use words ("it rarely happens") or numbers ("there's a 1% chance")?

Always prefer words					Always prefer numbers
1	2	3	4	5	6

7. When you hear a weather forecast, do you prefer predictions using percentages (e.g., "there will be a 20% chance of rain today") or predictions using only words (e.g., "there is a small chance of rain today")?

Always prefer words					Always prefer percentages
1	2	3	4	5	6

8. How often do you find numerical information to be useful?

Never					Very often
1	2	3	4	5	6

Demographics Questionnaire

This is the last and most important part of the survey. In order to accurately understand the relationship between beliefs, cognition and health, we need a little bit of background information about you. Please answer each question as accurately and truthfully as possible. ALL responses are ANONYMOUS and confidential - there will be no way to link your responses to these questions back to you.
Thank you again so much for your time and help!!

1. What is your height in feet and inches?

2. What is your weight in pounds?

3. What is your age?

4. What is your gender?

    a. Female
    b. Male
    c. Prefer not to respond

5. What year of school are you (freshman, sophomore, junior, senior, other, N/A)? If you are not currently in school, please select N/A.

6. What is your employment status (student, employed, not employed, disability, homemaker, retired, other)?

7. Are you currently dieting?

8. What it your annual income range?
    a. Below $20,000
    b. $20,000 - $29,999
    c. $30,000 - $39,999
    d. $40,000 - $49,999
    e. $50,000 - $59,999
    f. $60,000 - $69,999
    g. $70,000 - $79,999
    h. $80,000 - $89,999
    i. $90,000 or more

9. What is your race?
    a. White/Caucasian
    b. African American
    c. Hispanic/Latino
    d. Asian
    e. Native American

f. Pacific Islander
g. Other
h. Prefer not to respond

10. Do you snack?

0	50	100
Never= 0% of the time	Half the time = 50%	Always = 100% of the time

11. Do you eat healthy foods?

0	50	100
Never= 0% of the time	Half the time = 50%	Always = 100% of the time

12. Do you have regular meals (breakfast, lunch, dinner)?

0	50	100
Never= 0% of the time	Half the time = 50%	Always = 100% of the time

13. Are you concerned with eating healthy?

0	50	100
Never= 0% of the time	Half the time = 50%	Always = 100% of the time

14. Do you have health issues that affect your food choices (e.g., diabetes, allergies)?
    Yes _____ (If yes, please describe: ________________________) No ______

15. What information on a food package do you tend to read/look for (choose all that apply)?
    a. Health claims (e.g., 100% whole grains, low sodium, American Heart Association (AHA) approved)
    b. Ingredients
    c. Nutrition Facts Panel
    d. GMO (genetically modified organism)
    e. Gluten Free
    f. Organic
    g. Local
    h. Picture/image of item
    i. Games/entertainment
    j. Expiration data
    k. Instructions for consumption/use
    l. other _____

16. How often do you use the Nutrition Facts Panel when you consider whether to purchase or consume a food item?

0	50	100
Never= 0% of the time	Half the time = 50%	Always = 100% of the time

17. If you use the Nutrition Facts Panel, which nutrient information do you consider to be **<u>the most important</u>** in making your decision? Please rank the following with 1 = most important to 14 = least important. If you don't use the Nutrient Facts Panel, please select the information you think should be the most important in making a decision. Please do not use a number more than once.
    a. calories
    b. calories from fat
    c. total fat
    d. saturated fat
    e. trans fat
    f. poly/monounsaturated fats
    g. carbohydrates
    h. cholesterol
    i. sodium
    j. fiber
    k. sugar
    l. protein
    m. vitamins
    n. additives (e.g., BHT, Carmel color, food coloring, hydrogenated oils)

18. Did you use the Nutrition Facts Panel when evaluating food items in **<u>THIS</u>** study?
    Yes/No

19. If you used the Nutrition Facts Panel in **<u>THIS</u>** study, did you focus on some nutrients more than others? If so, please rank the importance of the nutrients you **<u>focused on for this study</u>** from 1 = most important to 14 = least important. If you did not use the Nutrient Facts Panel, please select the information you think should be the most important in making a decision for the items in THIS study. Please do not use a number more than once.
    a. calories
    b. calories from fat
    c. total fat
    d. saturated fat
    e. trans fat
    f. poly/monounsaturated fats
    g. carbohydrates
    h. cholesterol
    i. sodium
    j. fiber
    k. sugar
    l. protein
    m. vitamins
    n. additives (e.g., BHT, Carmel color, food coloring, hydrogenated oils)

20. If you use the Nutrition Facts Panel, how important do you consider nutrients in making your decision? Please rate the importance of the following nutrients from 1 = not at all important to 10 = very important. If you do not use the Nutrient Facts Panel, please select how important you think each nutrient should be in making a decision.
    a. calories
    b. calories from fat
    c. total fat
    d. saturated fat
    e. trans fat
    f. poly/monounsaturated fats
    g. carbohydrates
    h. cholesterol
    i. sodium
    j. fiber
    k. sugar
    l. protein
    m. vitamins
    n. additives (e.g., BHT, Carmel color, food coloring, hydrogenated oils)