THESIS

IS LOCATION KEY?: AN EYE-TRACKING INVESTIGATION OF ATTENTION TO NUTRITION INFORMATION AMONG YOUNG WOMEN AND MEN

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ABSTRACT

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Attention is a precursor for decision making and has been shown to be influential in the effective use of nutrition labels. Attention to nutrition information varies based on factors related to the individual, such as sex, and to the label, such as nutrient location. Given the previous findings that individuals tend to give more attention to the top portions of nutrition labels, this study used eye-tracking measures to explore whether moving three nutrients (sugar, fiber, and sodium) to higher positions on a label could increase attention and lead to healthier food choices. This study also sought to replicate previous findings of sex differences and over-reporting tendencies in label reading. Results from 112 undergraduate women (55.4%) and men showed that the novel label alteration had no significant effects on the attention to the moved nutrients or the healthfulness of subsequent food selections. No sex differences were found with regard to label reading, however, women had significantly higher rates of restrained eating and dieting behaviors ($p<.015$). Participants significantly over-reported their attention to sugar, but were accurate in predicting their low levels of attention to the other nutrients and to the label as a whole. The finding that sugar as a nutrient had distinct trends in this study highlights the need for future investigations aimed to distinguish potential nutrient-specific effects. Further research is needed to test the effectiveness of a greater variety of label formats using larger and more diverse samples.

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DEDICATION

I dedicate this work to the teachers of my life. For your passion, courage, and inspiration, I am forever grateful.

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CHAPTER 1: INTRODUCTION

Over the past 50 years, the globalization of the food market has led to a decline in the costs associated with harvesting food and manufacturing food products. As a result, there is a greater variety of foods available to shoppers than ever before (Kearney, 2010). This modernization of the food market has also led to the increased production of processed foods and has been linked to a "nutritional transition" internationally; global statistics have shown an association between the changing food context and the growing rates of non-communicable health issues such as obesity, diabetes, heart disease and cancer. The rise in these diet-related diseases has increased attention to the key nutrients responsible for changes in one's health.

Several governments around the world have sought to address the concerns of poor diet by increasing opportunities for informed consumption, as seen in the expansion of available nutrition information (Campos, Doxey, & Hammond 2011; Grunert & Wills, 2007). In the United States (U.S.), the Food and Drug Administration (FDA) has worked to increase consumer awareness through regulations requiring the labeling of food items, and several agencies have released fact sheets and other health education literature to better inform citizens on the recommendations for maintaining a healthful diet. For example, the Institute of Medicine (2002) has suggested that Americans pay more attention to their intake of sugar, sodium, and fiber. In U.S., nutrition labels (NLs) play a large role in the monitoring of nutrient intake. They provide details about both the food's content of a specific nutrient and the percentage of the daily recommended amount it equates to, making the NL a critical tool in promoting healthful eating behaviors.

NLs in the U.S. and other countries have been shown to have significant impacts on numerous consumer behaviors including increased levels of healthy food choices and better weight maintenance. Many complications, however, arise in their application (Drichoutis, Lazaridis, & Nayga, 2006; Variyam & Cawley, 2008). While self-reported NL use is fairly high, often ranging from 60 to 75% in the U.S. and around 50 to 80% in most other countries, there have been critiques from consumers about the ease of their use (Campos et al., 2011; Grunert & Wills, 2007; Ollberding, Wolf & Contento, 2011). More details on the history of NLs and factors related to the use of NLs will be discussed in Chapters 2 and 3 of this document.

General surveys show that the average person views the information presented on NLs as important, however differences in usage, the degree of perceived importance, and understandability have been identified and vary by demographic factors such as age, income, gender, and ethnicity (these findings are discussed in more detail in Chapter 4) (Blitstein & Evans, 2006; Gans, Burkholder, Risica, & Lasater, 2003; Kim, Nayga, & Capps, 2001). It has been shown in national and international studies that women tend to have higher reported use and perceived importance of NLs compared to men (Campos et al., 2011; Grunert & Wills, 2007). Additionally, objective measures of understanding (NL literacy) and attention (eye-tracking data) have shown that when compared to men, women tend to have significantly higher levels of accuracy in their application of NL information and are more likely to attend to certain nutrients like sugar, as well as to NLs in general (Graham & Jeffery, 2012; Rasberry, Chaney, Housman, Misra, & Miller, 2007).

It is clear that attention to NLs is essential for their use in subsequent food selections decisions. However, theories of attention and the empirical work supporting them have suggested that attention is a limited and selective resource. Nutrition information must compete with a wide range of other available stimuli. Further complicating this process, it has been shown that the majority of shoppers are not personally motivated to seek out nutrition information regularly (Bialkova, & van Trijp, 2010). Therefore, it is beneficial to explore strategies to increase NLs' capacities to capture the attention of shoppers as they make food selections. Researchers have identified several factors that influence the attention processes, such as the location or physical characteristics of the target information.

Previous research has shown eye tracking to be a valuable methodological tool in exploring attention to NLs and the effectiveness of different NL formats (see Chapter 7 for more details and Graham, Orquin, & Visschers, 2012 for a review up to that date). One notable finding was that individuals tend to read NLs from top to bottom, regardless of their interest in the nutrients in those areas and the perceived utility of the information (Graham & Jeffery, 2011). Studies such as these show the benefits in our ability to measure attention objectively and offer potential avenues to induce more attention to certain nutrients.

The use of high-speed eye-tracking cameras also allows researchers to address significant limitations prevalent in the empirical study of NLs, namely the dominance of self-report methods. Relying solely on survey methods can lead to several issues such as those that arise from differences in the wording or temporal scale of questions (for example, in assessing how often an individual reads NLs, questions might ask about label use over the past 12 months versus the past week). There are also disparities in the interpretations of scales (for example, what justifies a rating of "sometimes" versus "often"). Additionally, eye tracking provides an unbiased, precise, and reliable measure of attention that avoids the fallibility of participants' perceptions, a critical benefit as previous research has shown individuals tend to overestimate their usage of NLs (Campos et al., 2011; Graham & Jeffery, 2011; Grunert & Wills, 2007).

Despite the notable benefits, the application of eye-tracking methodology is just beginning, leaving gaps in its integration with psychological theory. Given the considerable effects NLs can have on dietary behaviors and the previous research showing that NL formats can greatly influence their use and understanding, it is critical to investigate what NL arrangements lead to increased use and subsequently improved health behaviors.

The present study seeks to expand the literature on NL attention by exploring the influence of a novel NL arrangement on attention to and application of nutrient information among young adults using eye-tracking technology. It also investigates whether women and men differ in eating behaviors and factors related to perception and use of NLs. Lastly, this study assesses the accuracy of self-report NL reading rates through objective (eye-tracking) tasks.

Participants in this study completed a computer-based, simulated grocery shopping experience. They were shown information for 64 unique food items including a picture of the item, price and size information, item description, ingredients list, and a NL. Participants were randomly assigned to one of two NL conditions: in one condition, they were shown an Altered Nutrition Facts Label (ANFL). In another condition, they were shown a Standard Nutrition Facts Label (SNFL) that reflects the current FDA label format. The ANFL changes were inspired by research showing that consumers tend to focus the majority of their attention on nutrients located at the top of NLs (Graham & Jeffery, 2011). Incorporating this trend, the ANFL features information for the nutrients sugar, sodium, and fiber moved closer to the top of the label and caloric information moved to the bottom of the NL. To complete each of the trials, participants considered the information and then stated their purchase intentions for the food item shown. At the conclusion of food selection tasks, participants completed a questionnaire assessing factors involved in their food selection behaviors.

Hypotheses

Given the ANFL format and trends showing that consumers tend to give increased attention to the topmost information on NLs (Graham, & Jeffery, 2011), I predict (H1) that participants will have more focal fixations and will spend significantly greater amounts of time (fixation duration) viewing sugar (H1a, b), sodium (H1c, d), and fiber (H1e, f) when exposed to the Altered Nutrition Facts Label (ANFL) than when exposed to the Standard Nutrition Facts Label (SNFL).

Furthermore, given the link between NL use and healthful food selection (see Chapter 5), it is predicted that (H2) those in the ANFL condition will select foods with significantly lower amounts of sugar (H2a) and sodium (H2b) and significantly higher fiber (H2c) content than those in the SNFL condition.

Previous research has shown that women and men differ in NL use and perceptions (see Chapter 4) (Campos et al., 2011; Graham & Jeffery, 2012; Grunert & Wills, 2007; Orquin & Scholderer, 2011). It is predicted that (H3) women will give greater amounts of attention, both in fixation frequency (H3a) and duration (H3b) to NLs than men. Furthermore, it is predicted that on survey data, women will report higher levels of health literacy (H3c), self-reported NL use (H3d), health consciousness (H3e), perceived importance of NLs (H3f), restrictive eating behaviors (H3g) and dieting behaviors, including current dieting (H3h) and dieting over the past year (H3i).

Lastly, previous research has shown that individuals tend to overestimate their use and understanding of NLs (Cowburn & Stockley, 2005; Graham & Jeffery, 2011; Grunert, Wills, & Fernández-Celemín, 2010). Therefore, a comparative analysis of one's stated use of NLs and their actual use as recorded using our eye-tracking equipment will also be made in this study**.** It is predicted that (H4) individuals will over-report their attention to NLs (H4a), sugar (H4b), sodium (H4c), and fiber (H4d) in comparison to their actual attention to those pieces of information.

CHAPTER 2: THE CREATION OF NUTRITION LABELS

The enforceable labeling of food is a relatively recent phenomenon, and the use of labeling as a consumer tool is still in its infancy. In fact, while the government has set parameters on food suppliers for the past century, the first federal regulations, such as the Pure Food and Drug Act of 1906 and the Federal Food, Drug and Cosmetic Act of 1938, primarily focused on the safety, quality, and truthful advertising of foods (FDA, 2009). These early legislative efforts were chiefly seeking to prevent the manufacture and sale of dangerous foods rather than provide information to consumers about the nutritional quality of their food. This remained the focus for many decades as the FDA lobbied for increased national standards and made significant strides in reducing citizens' exposures to harmful additives and misbranded food products (Frohlich, 2017). However, as the quality of foods became more stable and access to processed foods increased, the focus of government shifted to improving consumer information. At the brink of what is sometimes referred to as the "information age," the U.S. government made a significant push toward informed consumption, requiring for the first time that manufacturers report and display important nutritional information about the products they sold.

In 1990, the Nutrition Labeling and Education Act (NLEA) was passed by the U.S. Congress, creating the Nutrition Facts label and mandating that food producers apply the required changes by 1992. In addition to the already extant requirement to display a list of ingredients, the NLEA made it necessary for manufacturers to display information regarding serving sizes, servings per container, calories, calories from total fat and from saturated fat, total fat, saturated fat, cholesterol, sodium, total carbohydrates, sugars, protein, dietary fiber, vitamins, minerals, and other nutrients (Congress, 1990). The NLEA also allowed certain health claims, such as “light” and “low-fat,” to be made on food packaging for the first time (FDA, 2009). With its implementation, this formative piece of legislation indicated not just a change in regulatory values from safety concerns to information distribution, but a shift in the national responsibility for the health consequences related to dietary choices. Consumers were given information about the nutrient content of food and were therefore accountable for self-regulating their own consumption.

Research in the years following the enactment of the NLEA legislation showed both positive responses from consumers and promising trends for improved health. Following the enforcement of the regulations, one study found that the new law impacted health conceptualizations among college students, most of whom viewed the information as useful (Marietta, 1999). Another study found that while the NLEA regulations did not significantly change information recall among the general public, it showed improvements among consumers who were “highly motivated and less knowledgeable,” (Balasubramanian & Cole, 2002). Additionally, significant decreases in the BMI of NL users were reported, with those with the highest BMIs reporting the largest changes (Jayachandran & Cawley, 2006). The decreased consumption of fat was likely one of the most drastic changes seen after the NLEA. The purchase rates of low-fat foods significantly increased and the level of fat consumption among respondents of lower education levels significantly decreased (Balasubramanian & Cole, 2002; Finke, 2000). It was also shown that, compared to frequent label users in 1989 and non-label users in 1995, those who were frequent label readers in 1995 were significantly more likely to consume a low-fat diet (Finke, 2000).

The Nutrition Facts label created by the NLEA remained unchanged for a decade until national concerns about the harmful effects of trans fats rose enough to warrant the nutrient’s inclusion on the label starting in 2006 (FDA, 2009). After being asked to assess the increasing occurrence of obesity, the FDA published a report emphasizing the importance of calories, the need for additional research, the impact of education and the role of food labels in the effort to fight the rising epidemic (FDA, 2009). This 2009 document led to a surge in scientific research regarding the use and formatting of NLs in the years following. These empirical findings paired with the work exploring key nutrients involved in the occurrence of obesity led to the new Nutrition Facts label released in May of 2016 (FDA, 2017). Several scientifically supported changes were implemented in the new format intending to address concerns regarding ease and accuracy in the reading and interpretation of NL information. The revised NL format also applied updates to nutritional standards (FDA, 2017).

To improve consumer understanding and awareness, the new label adopted larger and bolded type for caloric and serving size information. To address the new recommendation that consumers should not be getting more than 10% of their calories from added sugars, the new label requires the exact grams and % daily values for added sugars. There were also changes in the requirements for vitamin and mineral reporting; vitamins A and C are no longer required on the label due to their sufficient consumption by the general population, however, vitamin D and potassium have been added to the label in response to their underconsumption and abilities to lower the risks for chronic diseases. The new regulations also require that both the actual amount and percentage daily values are shown for vitamins and minerals. This new label, set to be enforced by the year 2020, also reflects changes in serving size information and updated figures for % daily value measures. Serving sizes will be based on the actual amount of food individuals tend to eat, rather than a suggested amount for one to eat. In some cases, like ice cream and soft drinks, the serving sizes will be increased to reflect realistic consumption amounts (0.5 cups to 1 cup and 8 to 12 fluid ounces, respectively). In other cases, like that of yogurt, serving sizes will be lowered (from 8 ounces to 6 ounces) (FDA, 2017).

Many studies nationwide are being conducted to assess the efficacy of this new label format as well as alternative formats that can improve consumer use, understanding, and application of nutrition information. The FDA states that “The Nutrition Facts label is designed to provide information that can help consumers make informed choices about the food they purchase and consume.” FDA also states that “It is up to consumers to decide what is appropriate for them and their families’ needs and preferences,” (FDA, 2017). In the sections that follow, I will discuss the effects Nutrition Facts labels and other labels have on consumer perceptions and behaviors, highlight disparities in these effects, and discuss the theoretical framework for the alternative NL that I will be testing to help improve consumers’ capabilities and intentions in making healthier food choices.

CHAPTER 3: PERCEPTIONS, KNOWLEDGE, AND USE OF NUTRITION LABELS

The preponderance of information regarding the perceptions, knowledge, and use of NLs originates from studies conducted in high-income nations. This review will primarily focus on the empirical studies of Canada, the U.S., the EU-15 countries, Australia and New Zealand, but will reference data from other regions when available to offer a more global view of the subject.

Perceptions of the Importance and Utility of Nutrition Labels

Across U.S. and international samples, individuals have repeatedly reported high levels of interest in NLs (Armstrong, Farley, Gray, & Durkin, 2005; European Commission, 2005; Grunert & Wills, 2007; Loureiro, Gracia, & Nayga, 2006) and have viewed them as important sources of information for their diets (Campos et al., 2011; Krystallis & Ness 2004; Lindhorst, Corby, Roberts, & Zeiler 2007; Reid & Hendricks, 1993; Silayoi & Speece, 2004; Smith, Taylor & Stephen, 2007). However, despite the noted utility of nutrition information, participants have tended to underrate the importance of NLs when compared to the importance of ingredients list and health claims (Reid & Hendricks, 1993). In fact, many European studies found that participants instead favored information referring to food safety, “best before” dates, additives, and pesticide usage, or origin location over nutritional information (Bernués, Olaizola, & Corcoran, 2003; Caulfield, 2003; Grunert & Wills, 2007). Consumer-reported values for nutrition information also varies by food type. Participants often stated that they felt NLs were more important for foods for which it was harder to decipher the actual contents, (such as pre-cooked or ready-made meals) and that the nutrition information was less important for produce or meat products (European Commission, 2005; Food Standards Agency, 2005; Grunert & Wills, 2007). The perceived importance of nutrition information also depended on the consumer’s previous experience with the item. Respondents often noted that NLs were most useful when they were considering buying a product for the very first time (Bussell, 2007; Food Standards Agency, 2005; Grunert & Wills, 2007).

Perceptions and attitudes toward NLs are strong predictors of NL use. National and international studies have found that positive attitudes toward NLs significantly predict use (Byrd-Bredbenner, 2000; Byrd-Bredbenner & Kiefer, 2001; Marietta et al., 1999; Misra, 2007; Reid & Hendricks, 1993). Trust in the information is also an important predictor in NL use, and this trust has been shown to be highest among younger and more educated groups (Drichoutis, Lazaridis, Nayga, Kapsokefalou, & Chryssochoidis, 2008; Worsley, 2003). Both national and international sources emphasize the role of trust. However, trust seems to be on the decline with the high frequency of new and occasionally conflicting nutrition claims for products on the market. In fact, many consumers express doubts about the information they receive from manufacturers, especially those making health claims (Grunert & Wills, 2007; Marietta et al., 1999; Misra, 2007).

Summary. While many consumers perceive NLs as important sources of information, consumers in some regions (e.g., EU) tend to find other food-related information as more consequential (Grunert & Wills, 2007). The perceived need for nutrition information seems to depend on the food type, one’s previous experience with the food, and the values one holds about the foods and food culture. Attitudes toward NLs are an important factor to consider as they relate to label use, however, trust in NLs seems to be on the decline in certain populations as they become more exposed to conflicting claims about the healthfulness of food (Campos et al., 2011; Grunert & Wills, 2007).

Perhaps consequently, this uneasiness is often paired with confusion about the application of nutrition information. In fact, the relationship between misunderstanding NLs and one's perception of them has been shown to be bidirectional, with less understanding predicting less favorable perceptions and vice versa.

Consumer Knowledge and Understanding of Nutrition Labels

While most international and national consumers agree that NLs are useful, there are mixed results regarding perceptions of ease/difficulty in interpreting NLs (Campos et al., 2011; Satia, Galanko, & Neuhouser, 2005; Shine, O'Reilly, & O'Sullivan, 1997; Silayoi & Speece, 2004). These inconsistencies sometimes result in surprising findings in which related measures do not always adequately predict intuitive outcomes. For example, in Canada, it was shown that while awareness of nutrition terms increased from 1984-1994, the level of understanding of NLs did not (Reid, Conrad, & Hendricks, 1996). However, there have been cases in which successful changes to NL structure have increased consumer knowledge. For example, in the U.S. after the application of NLEA regulations and the first standardized label, 95% of respondents said that they saw the change to the label as useful. Furthermore, it was shown that a brief education session on the use of these NLs resulted in significant enhancements in participant knowledge and use (Marietta et al., 1999).

Nevertheless, while this increase in perceived usefulness and accessibility was reported, many national and international surveys still showed that respondents desired modifications to NLs to make them easier to read and understand (BEUC, 2005; Campos et al., 2011). Because difficulty in understanding NLs is often reported as one of the top reasons for their non-use, researchers have spent considerable resources exploring the factors that affect NL comprehension (Mannell et al., 2006; Peters-Texeira & Badrie, 2005; Shine et al., 1997).

Studies show that literacy and numeracy explain some of the variance in the understanding of NLs, as do age, education, and income-level (Rothman et al., 2006). The ability to understand and use the quantitative data present on NLs is repeatedly reported in both national and international studies as the consumer's greatest challenge. The highest levels of difficulty with this numeric formatting have been reported by older adults (Byrd-Bredbenner & Kiefer, 2001; Block & Peracchio, 2006), adolescents (Hawthorne, Moreland, Griffin, & Abrams, 2006), diabetics (Miller, Probart, & Achterberg, 1997), those with kidney disease, those with less education, and those who use labels less often (Campos et al., 2011; Klopp, & MacDonald, 1981). Respondents emphasize that accurate understanding also becomes more difficult as they combine information across multiple items to create total amounts for meals (Grunert & Wills, 2007). Importantly, however, it has been shown that educational interventions, both in person and web-based, are an effective way to raise consumer understanding of NLs, particularly in low-income and low-literacy groups (Campos et al., 2011; Miller et al., 2017).

Studies using objective measures of NL literacy requiring nutrient recall and calculation are an important research tool to tease apart one's perceived knowledge and one's ability to apply this understanding. For example, one U.S. study found that while those of lower income levels report high levels of understanding, the sample performed quite poorly on objective measures of NL literacy (Campos et al., 2011). This was replicated in international (UK and France) samples showing that those of older ages, less education, and lower socioeconomic status performed worse on objective measures and were less likely to be able to accurately sort levels of key nutrients into low, medium, and high categories (Grunert & Wills, 2007).

Objective measures can be helpful in determining which label formats are more effective in presenting dietary information. For example, one U.S. study found that while the majority of individuals wanted percent daily value information, this type of content was often inaccurately applied (Feunekes et al., 2008; The Strategic Counsel, 2010). However, in a later study also conducted in the U.S., it was found that compared to the presentation of daily values alone presenting, adding nutrient information in relative terms (i.e. low, medium, and high) successfully increased participants' accuracy in the application of NL information (Khandpur, Graham, & Roberto, 2017). In this way and others, objective measures help elucidate the types of formats that could be most beneficial in increasing the understanding of nutrition information.

Format. NL format is a strong determinant in how well an individual can read, understand, and apply the information with which they are presented (Campos et al., 2011). Research has shown that simpler labels lead to increased performance on dietary tasks including more accurate appraisals of health information (Finke, 2000; Goldberg et al., 1999). It has been found that participants reading labels that minimize the use of numerical values and incorporate more adjectives, graphics, and symbols in their format show higher levels of performance in applying nutrition information (Campos et al., 2011).

In recent years, the benefits of alternative nutrition labeling have been tested using front of package (FOP) labels, which have been shown to be particularly effective among groups with lower levels of nutrition knowledge (Grunert & Wills, 2007). While results tend to vary slightly from study to study, labels using color-coded guideline daily amounts (GDA) or multiple traffic light figures, which use red, yellow, and green colors to notate whether a food has a high, medium or low amount of a nutrient one should limit, are the most successful in increasing accurate reading and application of nutrition information (Grunert & Wills, 2007). These findings support formatting requests of participants, namely that labels be colored, have larger font sizes, have simpler terms, are presented more in the context of a healthy diet, and are consistent across products (Grunert & Wills, 2007; Mannell et al., 2006; Shine et al., 1997). Similar to the relationship noted for perceptions, the level of understanding can have significant and variable effects on one's overall use of NLs.

Summary. NL knowledge and one's reactions to NL formats do not always follow intuitive predictions (e.g. the Canadian paradox in which increased awareness did not lead to knowledge gains), however some individual factors have been shown to reliably relate to NL understanding (Campos et al., 2011; Reid et al.,1996). Individuals with lower incomes and lower levels of education tend to perform poorly on objective measures of NL knowledge, but promising results from nutrition education interventions have shown that these effects are malleable (Campos et al., 2011; Miller et al., 2017). The use of numbers to display nutrition information has been shown to be a barrier to consumer understanding and labels that incorporate more symbols, graphics, and adjectives seem to improve consumer accuracy in application tasks (Campos et al., 2011; Grunert & Wills, 2007). Label formats can have significant effects on one's understanding and research has supported the use of formats that include color, fewer numbers, and more graphics (e.g. the FOP formats discussed above) to improve consumer abilities to correctly interpret nutrition information (Grunert & Wills, 2007).

Consumer Use of Nutrition Labels

Self-reported use of NLs varies by (and within) country and tends to be fairly high, with most countries showing over 50% use. Some of the highest rates have been reported in New Zealand (85%), while more moderate levels have been reported in both Canada (52%) and the EU (47%) (Campos et al., 2011). Rates of reported use vary in the U.S., generally falling between 60 and 75% depending on the sample examined (Campos et al., 2011; Grunert & Wills, 2007; Ollberding et al., 2011). However, it is important to be cautious when interpreting these results as they 1) are typically cross-sectional, 2) framed differently from study to study, and 3) affected by individual biases or misconceptions (including differences based on sample characteristics). The use of self-report data is of concern because individuals tend to over-report their usage (Graham & Jeffery, 2011). However, given the wealth of data collected on NL usage, several variables emerge as important predictors and correlates of frequent and accurate use. In addition to demographic factors of influence which will be discussed in the succeeding section, the variables influencing NL use can be broadly divided into three core groups: those related to behaviors, those related to knowledge, and those related to contextual or setting factors.

Behaviors. One of the strongest behavioral correlates of NL use is a healthy diet. In the US, those who consume healthier foods are significantly more likely to use NLs than those who eat a less healthful diet (Campos et al., 2011). This gravitation by NL users toward healthier selections has been found to be driven by personal preference (Bender, & Derby, 1992; Elbon, Johnson, Fischer, & Searcy, 2000; Satia et al, 2005) or by prescribed or recommended diets for health reasons (Bender, & Derby, 1992; Gorton, Ni Mhurchu, Chen, & Dixon, 2009; McArthur, Chamberlain, & Howard, 2001). Studies also show that those who are more health-motivated are more likely to use NLs when making food selections compared to those motivated by hedonic factors (Bialkova et al., 2014; Visschers, Hess, & Siegrist, 2010). Other behavioral correlates of high NL use include abstaining from smoking, increased physical activity, and the use of nutritional supplements (Kessler & Wunderlich, 1999; Lin & Yen, 2008; Misra, 2007). Lastly, weight loss goals have been highly correlated with increased NL use in general (Satia et al, 2005; Rasberry et al., 2007), and these goals tend to relate to greater attention certain nutrient information such as calories (Wolfson, Graham, & Bleich, 2017).

Knowledge. Previous research has shown that those who have higher levels of knowledge for nutrition and for NLs have higher levels of NL usage when compared to less knowledgeable individuals. Reporting high levels of nutrition education is also related to elevated levels of NL use, and this effect has been shown to increase after education interventions are implemented with those of lower baseline knowledge, suggesting this is a malleable variable (Campos et al., 2011; Miller et al., 2017). Perhaps unsurprisingly, one's previous practice with reading NLs (Goldberg et al., 1999) and their emphasis on the nutritional quality of their food selections (Campos et al., 2011) are also both positively related to NL use. Additionally, research has shown that those who have higher regard for the nutritional guidelines and a better understanding of the diet-disease relationship are typically more frequent users of NLs (Elbon et al., 2000; Satia et al., 2005).

Context and Setting. The context in which one experiences NLs can significantly influence NL use. For example, in the grocery store setting it has been shown that the time available for decision making can greatly affect the amount of consideration given to NLs; those with more time tend to use labels more often while those with less time tend to avoid referencing this information (Klopp, & MacDonald, 1981; Mannell et al., 2006; Rasberry et al., 2007). In addition to time, the consumer's previous experience with the food type and their perception of the food item can determine whether or not they will read the NL. For instance, when a consumer is purchasing an item for the first time, they are much more likely to read the NL for that product. Similarly, a participant might use information about a certain category of food, based on previous experience, to assume the health of an item (Gomez, 2013; Grunert & Wills, 2007). Perceptions of healthfulness can vary in accuracy and could be prone to certain biases, but they are nonetheless strong predictors of NL use (Campos et al., 2011; Gomez, 2013).

Consumers tend to consider the nutrition information of foods perceived as healthy as less important (Grunert & Wills, 2007), and often note that labels are most needed when the food is highly processed or seem more ambiguous in their degree of healthfulness, such as “meal-type foods,” (compared with foods clearly perceived to be healthy, such as vegetables, or unhealthy, such as cookies). This lack of nutritional transparency often results in higher NL use for these products (Graham & Jeffery, 2012; Mannell et al., 2006). Research has also shown that there is a positive relationship between use and spending habits, showing that the more money one spends on food, the more they tend to use NLs. Conversely, a negative relationship has been observed between emphasis on price and NL use (Drichoutis et al., 2006; Loureiro et al., 2006). This finding that price is of less concern to frequent NL users may relate to participants’ increased value of the nutritional quality of their food, further driving NL use as previously noted (Campos et al., 2011).

Summary. Self-report use of NLs is high among national and international samples, however, these reports can be skewed and are often overestimated (Campos et al., 2011; Grunert & Wills, 2007; Ollberding et al., 2011). Increased NL use is related to several health behaviors including consuming a healthy diet, participating in physical activity, weight loss behaviors and maintaining a health-motivated mindset (Bialkova et al., 2014; Campos et al., 2011; Satia et al, 2005). NL use is also positively associated with increased levels of nutrition knowledge, previous experience with NLs, one’s value of the nutritional quality of food purchases, and one’s belief in the diet-disease relationship. Lastly, contextual factors such as more time to make food purchasing decisions, purchasing a food for the first time, or high levels of ambiguity in the healthfulness of the food item tend to be related to increased levels of NL use (Graham & Jeffery, 2012; Klopp, & MacDonald, 1981; Mannell et al., 2006; Rasberry et al., 2007).

CHAPTER 4: GROUP DIFFERENCES

Several national and international studies have explored NL attitudes and behaviors based on the sex, age, and education of participants (Campos et al., 2011; Grunert, & Wills, 2007). The empirical results from studies using both self-report and objective (health literacy assessments or eye-tracking tasks) measures to explore these effects are discussed in the following sections.

Sex. Women and men differ in NL use across both national and international studies. Women have both higher levels of NL use and higher levels of trust in the information the labels provide (Campos et al., 2011). Women are more likely than men to report that NLs play a large role in their dietary choices. Furthermore, these sex differences in NL use have been shown to be consistent across a diversity of age, ethnicity, income, and education levels (Campos et al., 2011; Grunert, & Wills, 2007). In addition to increased rates of use and perceived importance, women also tend to have higher performance on objective measures of health knowledge and tend to have more favorable attitudes toward NLs in general (Rasberry et al., 2007).

These self-reported trends seem to persist behaviorally as objective eye-tracking measures of NL use have shown that women also give more attention to certain nutrients. One study in the U.S. found that women were more likely than men to view information regarding sugar content and spent longer considering serving information (Graham, & Jeffery, 2012). International studies have suggested that this effect is related to the social expectation for women to maintain a low weight, which is associated with women's higher rates of dieting, relative to men's (Grunert & Wills, 2007). This is perhaps related to alternative explanations noting the greater social pressure for women to look attractive. Finally, one explanation suggests that the culturally assigned role of women as primary food purchasers might encourage more attention to nutrition information due to their increased exposure and the added responsibility to provide healthful food not just for themselves, but for family members as well (Cannoosamy, Pugo-Gunsam, & Jeewon, 2014).

Age. Studies from the U.S. show that the highest users of NLs are young and middle-aged adults (Campos et al., 2011). However, it has been shown in European samples that older adults place higher importance on NLs (Food Standards Agency, 2005). National studies show that children have difficulty interpreting and applying NLs and adolescents have relatively low rates of usage when compared to adult populations (Hawthorne et al., 2006). Additionally, the types of information sought by those of different age groups seem to vary. For example, one study using eye tracking showed that compared to young adults, individuals over 50 years old looked at fat and protein content significantly more and spent more time considering calorie information (Graham, & Jeffery, 2012) while another study found that younger adults tended to look at the vitamins and minerals portion of the labels more than older populations (Campos et al., 2011).

Education and Income. Previous research has not yet explored the association between NL use and general intelligence, however, trends related NL use and education level have been identified. Individuals with lower rates of education tend to have lower levels of nutrition knowledge and health literacy (Wang, Fletcher, & Carley, 1995). These patterns of nutrition knowledge and NL use are also mirrored by those of low-income as well. It has also been shown that those with less education and income tend to use NLs less when compared to their more educated and affluent peers (Blitstein, & Evans, 2006).

Summary. Attitudes and behaviors regarding NLs have been shown to vary based on several intersectional identities including sex, age, income, and education. Research has shown that women tend to have higher levels of NL use as well as greater perceived importance of nutritional information (Campos et al., 2011; Grunert, & Wills, 2007). These sex-based disparities are likely influenced by dysfunctional gender ideologies promoting thinness as beautiful, as noted by their greater engagement in dieting practices (compared to men) (Cannoosamy, 2014; Grunert, & Wills, 2007). Age is a complex demographic variable as many age groups have been shown to give preference in their attention to certain nutrients more than other age groups. However, research has shown that young and middle-aged individuals report the highest rates of use (Campos et al., 2011; Grunert, & Wills, 2007). Studies have also shown that NL use and understanding differs by income and education; individuals with lower income and/or less education tend to also have lower amounts of NL use and knowledge (Campos et al., 2011; Grunert, & Wills, 2007). These group difference no doubt affect the study of NL use and thus are critical to note when interpreting the results of studies investigating NLs and eating behaviors in general.

CHAPTER 5: THE EFFECTS OF NUTRITION LABELS

Since the implementation of the NLEA, researchers have sought to examine the effects NL use has on one's food selection and dietary choices. Early studies in the U.S. showed that NLs did seem to have measurable and significant effects on consumer decisions and these effects were particularly evident when individuals were considering nutrients they ought to limit (Drichoutis et al., 2006). In 1995, a national survey showed that almost 50% of respondents stated that NLs had changed their purchasing decision for an item (Derby, & Levy, 2001). A U.S. survey released the following year showed that this influence on purchasing behavior could work in either direction, for or against a product; a third of respondents stated that NLs had stopped them from buying a regularly purchased food and a quarter of respondents said that, because of NLs, they had begun purchasing a new food item (Derby, & Levy, 2001). Interestingly, participants reported that many of these decisions focused on the fat content of the items being evaluated, reflecting the national trend toward reduced fat intake at that time. In fact, one nationally representative study found that participants using NLs had a 2% decrease in total fat intake following the implementation of the NLEA (Kristal, Hedderson, Patterson, & Neuhauser, 2001).

However, some of these early results seem to be dependent on other factors as well. One U.S. study found that while the introduction of NLs was associated with lower BMI, it was shown that the relationship was only significant for white females (Variyam & Cawley, 2008). Another study in the U.S. showed that income level moderated the effect of NL use on healthful eating; while NL use was associated with more nutritious diets for all income levels, the benefits of reading NLs was much greater for those of higher economic status (Pérez-Escamilla &

Haldeman, 2002). These early studies gave insight into some of the effects seen after the government adopted standardized NLs and led the way for further work in this area.

As researchers have continued to explore the relationships between use and dietary decisions, more evidence has amassed showing the benefits of consumer NL use. One study found that the positive relationship between NL use and healthful food selection remained significant even after accounting for the bi-directional effects and the participant's previous nutrition knowledge (Barreiro-Hurlé, Gracia, & de-Magistris, 2010). Other researchers have explored the effects of NL use on the consumption of certain nutrients. One study in the U.S. found that, on average, label use increased daily fiber intake by over 7.5 grams while significantly reducing one's intake of cholesterol, fat, and sodium (Kim, Nayga, & Capps, 2001). Another study from the U.S. confirmed these findings showing that NL readers had significantly higher consumption rates for both fiber and iron (Variyam, 2008). Studies have explored the effects of NLs for certain types of foods as well; one study found that reading NLs on meat products led consumers to buy options that were lower in fat (Crutchfield, Kuchler, & Variyam, 2001; Schupp, Gillespie, & Reed, 1998) or were healthier varieties (i.e. chicken over beef) (Rimal, & Fletcher, 2003).

Research has shown that nutrition education interventions can be an effective way to improve the perceptions and understanding of NLs (Hawthorne et al., 2006; Miller et al., 2017), increase consumer use, and potentially induce healthier food selection behaviors (Abood, Black, & Coster, D, 2008; Lindhorst et al., 2007). Educational programs have been successful in several settings and have been particularly beneficial among populations that have lower levels of pre-test understanding (Campos et al., 2011). For example, web-based interventions integrated into schools have been shown to increase health knowledge and decrease intentions to eat unhealthy foods among obese adolescents (Abood et al., 2008). Similar results were seen when multimedia, web-based interventions were applied in young adult samples as well (Miller et al., 2017). These computerize interventions are particularly beneficial as they have great potential for scalability; they are low cost and easy to mass distribute. However, comparable results have been seen in traditional interventions, including formats like nutrition workshops and classes (Campos et al., 2011; Hawthorne et al., 2006). Taken together, these studies suggest improving one's knowledge of NLs maybe an effective way to increase the application of this nutritional tool and possibly promote healthier food selections.

While many studies continue to highlight the positive effects that NLs, regardless of label and information formats, can have on healthful eating (Aschemann-Witzel et al., 2013; Kim, Nayga, & Capps, 2001), it is important to consider the methodological limitations of this research. Specifically, previous empirical work relies on survey data, leaving results to vulnerable to self-report biases. Some studies have used more objective measures of NL use, such as eye tracking (more details can be found in Chapter 7 of this document), to explore how these labels can affect food selection. For example, it has been found that attention to NLs can significantly mediate the relationship between nutrient content and subsequent food choices. While these types of studies use a more accurate measure of NL use, adding support to the realism of these effects, it should nevertheless be noted that the food selection tasks were simulated experiences. Greater investigation using alternative methodologies is needed to bolster realism to support the current evidence linking NL use to health behaviors and decision-making tasks.

Summary. NLs have been shown to have significant effects on food selection and dietary behaviors, often influencing individuals to consume higher levels of positive nutrients such as fiber while helping them moderate their consumption of nutrients such as fat (Kristal et al.,2001; Variyam, 2008). Some studies have suggested that these benefits might be related to certain group factors as well (e.g. sex, ethnicity, and income) (Pérez-Escamilla & Haldeman, 2002; Variyam & Cawley, 2008). While self-report surveys and eye-tracking measures suggest that the use of NLs can be beneficial to the maintenance of a healthy diet, there is a need for additional research exploring these relationships in more applied settings.

CHAPTER 6: THEORIES OF ATTENTION

Attention is a necessary precursor to cognitive processing, making it a bottleneck feature of NL use (Bridewell & Bello, 2016). One must attend to a piece of information to incorporate it into their decision-making process. However, this process is not without conflict as empirical evidence suggests that both attention and cognitive processing maintain finite capacities. More specifically, it is theorized that one's ability to attend to and process items of information is limited rather than boundless (Bridewell and Bello, 2016; Van Knippenberg, Dahlander, Haas, & George, 2015). Given the increasing abundance of information bombarding our minds within the modern knowledge-based society, the competition for these limited resources is intensifying. So how does one's brain cope with these rising demands? Theories of attention stipulate that attention is not only selective, leading to the processing of choice information, but biased by our own cognitive processes and personal motivations in a given task (Bridewell and Bello, 2016). These findings that attention is related to personal motivations seem to be consistent with previous findings on NL reading as well, and could be explanatory for some of the group differences identified.

Since the start of the "age of information" just a few decades ago, there has not only been an increase in informational volume, but a shift in the variety of information made available to the general public (Van Knippenberg, et al., 2015). In the case of nutrition, this can be seen most readily with the introduction and advancement of the Nutrition Facts Label over the past three decades (FDA, 2009 and 2017). While, on the surface, this seems an unimpeachable benefit, consumers have more data available to them and consequently have a greater option to attend to such information, this is met with some considerable complications. Of primary concern is the competition of visual cues for attention. In the scope of a typical grocery store shopping experience, one is exposed to a vast amount of potentially distracting information, including branding, advertisements, pricing, and other products. Even considering just a single product package, the amount of available information is substantial (health claims, descriptors, branding information, ingredients list, and NLs). It seems that increasingly our packaging is becoming filled with vast amounts of "visual clutter," effectively surrounding the NL with other competitive cues for attention. This is of concern because consumers have a tendency to attend more to simpler labels and it has been shown that there is an inverse relationship between the number of features on a given label and the attention the NL receives (Visschers et al., 2010).

So how does one increase attention to key nutrients amid the array of other available information? Attention theorists suggest that this objective is moderated by the intentions and motivations of the individuals meant to attend to the information. To this point, distinct trends have been seen based on the reasons for which someone attends to an item, namely whether it is the result of the intentional efforts of the individual, sometimes called "goal-directed attention", or if it is captured attention originating from characteristics of the item itself, sometimes referred to as "stimulus-driven attention" (Bialkova, & van Trijp, 2010). In assessing these theories, research on attention has confirmed the previous findings discussed in the document; those who are independently motivated to attend to information do so with a greater degree of success. Conversely, it has been shown that if it is not one's inherent goal to attend to a piece of information, they are not likely to actively direct their attention to that content (a NL or specific nutrient). This seems to be the case for the mainstream shopper as studies have shown that individuals tend to give focused attention to NLs only when they have reasons to do so, such as for a dietary restriction (Bialkova, & van Trijp, 2010; Rawson, Janes, & Jordan, 2008). This reliance on stimulus-driven attention for most individuals highlights the need to create more engaging *stimuli* that are better able to catch and hold their attention. To this end, several strategies have been identified to improve attention to NLs.

Previous research exploring the factors involved in stimulus-driven attention have shown that location and salience are key. Early eye-tracking work showed that the spatial organization of stimuli can have significant effects on attention (Yantis, 1992), an effect that was later found to be significant in NLs, with items toward the label's top being attended to at significantly higher rates (Graham & Jeffery, 2011; Graham & Roberto, 2016). Eye-tracking visual search tasks have also shown that attention draw is more effective when information is easily accessible (specifically the top left portions of products), display size is increased, and contrasting colors are used (Bialkova, & van Trijp, 2010). Additional factors involved in the capture of attention in NLs are discussed in the succeeding chapter (Chapter 7: Eye-Tracking Methodology).

Summary. Attention is both a selective and limited resource that is influenced by one's motivation toward the target piece of information or outcome. Previous research has shown that most shoppers are not highly motivated to seek out NL information, suggesting that strategies poised to increase stimulus-driven attention would be most effective in promoting NL use. However, capturing the attention of individuals might be becoming progressively difficult given the dramatic rise in the amount and variety of competing information presented in the typical grocery shopping setting. Saliency and location have been shown to be related to the amount of attention a piece of information receives, suggesting that further research investigating a variety of NL formatting options would be beneficial in the effort to improve NL use.

In the context of this study, it is predicted that women will have greater use of NLs when compared to men. Previous research has shown that women tend to be more health motivated and tend to hold higher values on health and health-based behaviors (Campos et al., 2011; Grunert, & Wills, 2007; Rasberry et al., 2007). Following the theories outlined above, it is likely the increased motivation women hold for health behaviors results in more directed attention to nutrition information and for certain nutrients in general. This goal-directed searching, fueled by an internalized motivation to maintain higher health standards, is likely key in explaining the disparate use between women and men when considering NLs.

These theories also provide an explanation for why individuals who are exposed to an ANFL are predicted to fixate more and for longer periods on the manipulated nutrients. It has been shown that the majority of shoppers tend to have stimulus-driven attention to NLs and are therefore more reliant on the characteristics of the stimuli. Evidence suggests that the spatial organization of data can be highly influential in the active capturing of attention (Graham & Jeffery, 2011; Yantis, 1992). Therefore, even if participants are not showing a goal-oriented, directed use of their attentional resources, they will still be more likely to attend to portions made more easily accessible (moved toward the top of the label).

As previously mentioned, the attention theories assert that attention is requisite for cognitive processing. Consequently, attention to an item is influential to future decisions made regarding that item; meaning if one is to consider a piece of information in a decision, they must first have attended to that item. Assuming the accuracy of the prediction of increased fixations and fixation duration to the manipulated nutrients in the ANFL condition compared to the SNFL, it can be inferred that the increased attention leads to the increased likelihood of those items being cognitively processed. It is suggested here that this increased availability for processing will lead to a greater consideration of these nutrients in the participant's purchasing decisions, leading to healthier food selections.

CHAPTER 7: EYE-TRACKING METHODOLOGY

Today's eye-tracking research utilizes high-speed cameras able to track eye movements down to the millisecond. While this methodology often faces the drawback of reduced realism characteristic of many laboratory studies, eye tracking offers several advantages to the study of NLs. As a supplement to frequently used standard self-report measures, eye tracking offers an objective and precise way to accurately measure one's attention to the different components of NLs. This is a critical improvement to traditional methods as research has shown that individuals tend to misreport their use of NLs, often overstating their use or understanding (Cowburn & Stockley, 2005; Graham & Jeffery, 2011; Grunert, et al., 2010). Additionally, this methodology gives researchers greater control in the temporal ordering of their measures, allowing them to gather objective measures before self-report questions potentially make the purpose of the study more salient. This allows researchers to look at habits that are more natural and less subject to the influence of participant's perceived social desirability to appear health conscious or attempt to appease the researcher (Graham et al., 2012).

Viewing is a precursor to the use of NLs, yet some critics note that simply measuring this attention does not lend explanations to the cognition processes underpinning the recorded eye movements (Graham et al., 2012). To address this limitation, recent studies have shown the benefit of pairing eye-tracking measures with scales and questionnaires to elucidate the connection between viewing and other factors such as group differences and cognition (Ares, Mawad, Giménez, & Maiche, 2014; Mawad, Trias, Gimenez, Maiche, & Ares, 2015). In general, two lines of research have stemmed from the application of eye-tracking measures in NL reading: 1) studies that explore the effects of individual-level characteristics on label use and understanding and 2) studies that investigate how populations in general react to and use different label formats.

In researching the effects that individual-level differences have on NL consideration, it has been found that both one's knowledge/ability and motivation have independent and significant positive relationships with effective NL reading (Graham et al., 2012). One study found that practiced readers are better able to accurately assess labels in a shorter amount of time than less practiced readers (Goldberg et al., 1999). Other studies have found that increased attention is also related to one's increased understanding of NLs (van Herpen & van Trijp, 2011; Visschers et al., 2010). Similarly, results indicate that increased motivation is associated with increased levels of attention to NLs (Bialkova et al., 2014; Bialkova, & van Trijp, 2010; Orquin, & Scholderer, 2011; van Herpen & van Trijp, 2011; Visschers et al., 2010). More specifically, researchers have found that the type of motivation can be influential. Health goal-based motivations are significant predictors of NL use; those who are more health-focused tend to give increased consideration to labels (Bialkova et al., 2014; van Herpen & van Trijp, 2011; Visschers et al., 2010).

In addition to the findings on understanding and motivation, researchers have used measures of several cognitive processes to understand how one's personal tendencies might affect their reading and application of nutrition information. Mawad and colleagues (2015) tested how one's field dependence, or the degree to which one relies on the information from the external environment, might influence NL reading. Contrasting with those who are field dependent, field independent individuals have a greater ability to derive meaning and extract important information from complex contexts and a lowered dependence on external information. Eye-tracking tasks have shown that those who are field independent tend to give greater attention and spend longer amounts of time in their evaluation of NLs (Mawad et al., 2015). Similarly, researchers have investigated the degree to which one's tendency to be a rational (analytic) or intuitive (experience based) processor might influence their attention to NLs. Results show that those with rational thinking styles had higher need for cognition (the inclination for one to think deeply on a subject) and performed more in-depth processing of NLs compared to those with more intuitive-experiential thinking styles (Ares et al., 2014). Together these results illustrate how one's cognitive tendencies might explain some of the individual and group differences seen in the attention given to NL reading tasks.

Eye-tracking studies have also investigated the association between different demographic characteristics and NL attention. In terms of the number of fixations, it has been shown that women attend to nutrition information more than men (Orquin, & Scholderer, 2011). Differences between men and women were also seen with regard to nutrients; women tend to give more attention to sugar and serving information compared to men (Graham, & Jeffery, 2012). Differences have also been found relating to one's age; older individuals tend to spend more time viewing caloric information and give more attention to fat and protein than other age groups (Graham, & Jeffery, 2012). These results lend additional support to self-report findings, suggesting a range of personal factors are associated with the differences observed in NL use.

In addition to exploring how one's personal factors might relate to their reading of labels, some studies have used eye-tracking methodology to explore the influences that label format can have on consumer attention and comprehension. This measure has been especially prevalent in studying the effectiveness of front of package (FOP) labeling, with a recent emphasis on the success of traffic light (TL) based labels; these labels use the familiar symbol (a TL) to notate whether a food contains low (green), medium (yellow), or high (red) levels of nutrients one ought to limit in their diet, such as fat, sodium, and sugar (Bialkova & van Trijp, 2010; Borgmeier & Westenhoefer, 2009; Feunekes et al., 2008; Graham, Heidrick, & Hodgin, 2015; Jones & Richardson, 2007; Kelly et al., 2009; Siegrist, Leins-Hess, & Keller, 2015; van Herpen & van Trijp, 2011). For example, one study found that those who view TL labels were more focused on key nutrition information and consequently showed more accurate assessments of the healthfulness of food items shown (Jones, & Richardson, 2007). TL labels have also been shown to help increase attention in situations of time pressure (Borgmeier & Westenhoefer, 2009; van Herpen & van Trijp, 2011). This is an important factor to consider as studies have shown that consumers spend limited amounts of time in making nutrition evaluations (Clement, 2007). In fact, some studies report that participants only attended to NLs for an average of one second (Graham & Jeffery, 2011; Wolfson et al., 2017).

Some researchers believe that the success of TL labeling is likely due to the simplification of the information presented, showing that less complex FOP labels often take less time to comprehend than standard labels (Feunekes et al., 2008). Others note the use of color as one of the key factors driving the success of these labels (Bialkova, & van Trijp, 2010; Borgmeier & Westenhoefer, 2009; Feunekes et al., 2008). Importantly, one study found that FOP TL labels were only successful in N. American populations when signposts emphasizing their meaning were present (Graham et al., 2015). This shows that in areas where this type of label format might be adopted for the first time, education about the use and presence of TL labeling as an informational tool might be an important factor in its application.

Another area of research exploring effective NL formats has focused on increasing the label's visual saliency. The salience of a particular label can be modified by altering the orientation, format, contrast or color. Greater levels of salience have been shown to increase the attention one gives to a label while lowering the amount of time it takes for the individual to make the first fixation on the label (Itti, Koch, & Niebur, 1998; Orquin, Scholderer, & Jeppesen, 2012). In addition to the previously noted positive effects of color on saliency, it has been shown that using thinner anchor lines improves attention to NLs (Goldberg et al., 1999). This is likely related to the perceived or actual surface area given to each section which has also been shown to be consequential; research has indicated that increasing the surface area of a given section leads to a lower time for the first fixation on the enlarged section as well as greater overall attention to the section (Orquin et al., 2012). Eye tracking has been an important tool in this area as it has been used to dispel intuitive attempts to increase salience. For example, one study showed that the FDA-recommended (and implemented) increase in the font size of calories and serving information did not serve to increase attention in a study of young adults (Graham, & Roberto, 2016).

Additional research has also shown the effects that nutrient location and the presence of certain forms of information can have on usage and understanding. Studies have shown that regardless of their pre-stated preferences in nutrient searching, individuals tend to focus most their attention on the top portions of a nutrition level, giving gradually lower amounts of consideration the further down the label they go (Graham & Jeffery, 2011; Graham & Roberto, 2016). It has also been shown that individuals tend to give more attention to nutrition information when it is central to the visual field rather than on the peripheral portions (Graham & Jeffery, 2011). Another study found that when given the option, the majority of participants preferred receiving caloric information as both a numeric value and in terms of its physical activity equivalents (Wolfson et al., 2017). These studies highlight how modest differences in the presentation of information can affect individuals' attention to NL components.

Summary. Eye tracking has emerged as an effective supplement of self-report measures of attention to NLs (Graham et al., 2012). Via eye tracking, it has been shown that knowledge and motivation (specifically health-based motivation) have independent and positive effects on NL use (van Herpen & van Trijp, 2011). Used in concert with other measures, eye tracking has also helped demonstrate some of the cognitive processes related to NL use, showing that both rational thinking styles and field independence are positively related to increased attention to NLs (Ares et al, 2014; Mawad et al., 2015). Additionally, eye-tracking data have confirmed some of the differences by group (e.g. sex and age) seen in self-report measures. Notably, studies have shown that women often attend more to and spend more time viewing NLs than do men (Graham, & Jeffery, 2012; Orquin, & Scholderer, 2011).

Eye tracking has been useful in testing the effectiveness of NL formats, one of the most popular being the TL format. Through the use of this objective measure, researchers have shown that TLs improve the accuracy of consumers' perceptions when considering different food types (Jones & Richardson, 2007). Eye tracking is also shown that improvements in visual saliency can both increase attention to and lower the time of first fixation on NLs (Itti et al., 1998; Orquin et al., 2012). This ability to objectively test the usefulness of additions or alterations to NLs before the changes are made is invaluable and can have significant policy implications with agencies such as the FDA (Graham, & Roberto, 2016).

Given the previous research in this area noting increased attention to the top of the NL, this study predicts that by moving information for nutrients (sugar, sodium, and fiber) to the upper portion of the NL participants will attend more to these areas. Additionally, considering the link between attention and consumer choices, it is suggested that this predicted increase in attention will be related to healthier product choices.

CHAPTER 8: METHODS

Participants

This study took place during the Spring semester (January - May) of 2016. Students from Colorado State University enrolled in Psychology courses were recruited to participate in an eye-tracking food selection study through an online registration portal. Participation was compensated with research credit in courses. Of the 132 participants, 20 were removed from analysis due to eye-tracking calibration failures (n=15), missing survey data (n=1), or inadequate eye-tracking data (n=4). The final sample (N=112) included participants between the ages of 18 and 34, with a mean age of 19.66±2.11 years. The majority of the sample identified as "white" (88.4%) and female (52.7%). The BMI of participants ranged from 17.9 and 38.7 with a mean of 23.6± 3.82. Accurate vision (the ability to read text from a screen placed 55cm distance away) or soft corrective lenses (those with hard contact lenses were excluded due to incompatibility with Eyelink measures) were required to be eligible to participate. Table 1 shows the demographics for the total sample as well as for the ANFL and SNFL conditions.

Materials

Eye-Link Eye-tracking program and stimuli. To measure the frequency and duration of fixations for key areas of interest (AOIs), this study used the Eye-link1000 high-speed eye-tacking camera (SR Research, Mississauga, Canada). This system was calibrated and validated for each participant using a nine-point procedure. Experiment Builder Software (SR Research, Ottawa, Canada) was used to create 64 trials with 21 unique AOIs per trial. AOIs are tracking areas that included sections for price, food description, ingredients, the food picture, and each nutrient included on the food label (such as servings, calories, fats, sugars, proteins, etc.)

Chinrest. A chinrest was used to maintain the integrity of the data collected throughout the eye-tracking trials. This was located 55cm away from the eye-tracking camera lens and ensured the resolution and accuracy of our tracking.

Food Stimuli. Sixty-four different foods were presented in the trials. These foods were chosen to represent a range of products across and within the various categories of foods that are mandated to include Nutrition Facts Labels. The 64 foods included nine varieties of dessert items (cookies and ice cream), sixteen snack foods (including crackers, nuts, chips, rice cakes, and pretzels), twenty-two meal items (including yogurts, soups, cereals, meats, and pizza) and seventeen fruits and vegetables of canned and frozen varieties.

Labels. An alternative version of the SNFP was used to create the ANFP by moving information on sugar, sodium, and fiber higher and caloric information lower on the label. These nutrients were selected due to their emphasis in the recommendations set out by the Institute of Medicine (2002). Examples of the SNFP and ANFP can be found in Figures 1 and 2 respectively.

Non-label Food Information. In addition to NLs, participants were shown a picture of the products removed from their packaging to avoid the influence of branding information. Trials also featured an ingredients list as well as front of package information including product descriptions and health claims under the header "Product Description." Price and content size of the item were included and reflected the purchase price of the items at the time they were acquired for the experiment. A sample trial screen for both the SNFL and ANFL are included as Figures 3 and 4, respectively.

Measures

Eye-tracking Measures.

Number of Fixations. Previous research has shown that to read a piece of information, ones must spend least 50ms fixating on the content. (Rayner, 1998; Reichle, Rayner & Pollatsek, 2003). For this reason, this experiment required a minimum of 50ms of viewing to be considered a fixation for an AOI. The frequency of a participant's fixation was recorded for each AOI.

Duration of Fixations. Fixation duration was measured in milliseconds and constituted the total amount of time the participant spent looking at a particular AOI during each trial. If the participant fixated on an AOI more than a single time during a trial, this measure constituted the sum of the duration of each fixation.

Purchase Intention. Participants were asked to indicate whether they would buy each of the items by clicking on one of three options on the computer screen: 'would buy', 'would not buy,' or 'not applicable'. Participants were instructed to select 'not applicable' only if they had a dietary restriction that prevented them from ever eating that food item.

Questionnaire Measures.

Demographics. Questions regarding the participants' sex, race, ethnicity and primary language were adapted from the US Department of Health and Human Services Data Standards (Dorsey & Graham, 2011). Participants were also asked to report their age (in years), height (in feet and inches) and their weight (in pounds). Height and weight values were used to compute the BMIs.

Attempts at Weight Loss. The participant's recent attempts at weight loss were measured using the following two yes-or-no questions: "During the past 12 months, have you tried to lose weight?" and "Are you currently trying to lose weight?"

Health Consciousness. Four questions were adapted from Gould's (1988) Health Consciousness Scale, which is a validated scale showing strong internal consistency (alpha=.851) that has been used in numerous studies regarding health attitudes and behaviors (Hong, 2009). Agreement with health-related statements was rated on a 7-point Likert scale ranging from "1- Strongly Disagree" to "7-Strongly Agree." One example statement from this scale is "I'm very self-conscious about my health." The remaining questions can be found in Table 2.

Health Literacy. Participants' ability to interpret NLs was objectively measured using the Newest Vital Sign Assessment tool (Pfizer, 2011). This assessment provides a NL for a container of ice cream and requires the participant to interpret the information given to answer 5-6 questions (with one question only being asked as a follow-up to a correct response). The instructions are given as "the information above is on the back of a container of ice cream. Please answer the following questions about this ice cream." Examples of the questions included are "If you eat the entire container, how many calories will you eat?" and "If you are allowed to eat 60 grams of carbohydrates as a snack, how much ice cream could you have?" Answers are coded as correct or incorrect and interpreted on a dichotomized key; 0-1 correct responses indicated "a high likelihood (50% or more) of limited literacy", 2-4 correct responses indicated "the possibility of limited literacy," and a score of 5-6 "almost always indicates adequate literacy." Please see Figure 5 for the NL and Table 3 for a complete list of the questions asked.

Nutrition Information Use. A self-report measure of the participant's use of nutritional information was measured as the response to the question: "How often do you read the nutrition information on food labels before purchasing foods or beverages?" Participants answered on a 4-point scale; "1- Never / rarely," "2-Sometimes," "3-Often," "4-Always/almost always."

Using the same Likert scale, participants were then asked how much they looked at the following information when shopping: calories, fat, saturated fat, trans fat, cholesterol, sodium, carbohydrates, fiber, sugar, protein, vitamins, minerals, ingredients, and price.

Perceived Importance of Healthy Food. Participants were asked to respond to the question, "How important is it to you to consume healthy foods?" using a 7-point Likert scale from "1- Not at all important" to "7-Extremely Important."

Purchasing Behaviors of Selected Foods. Participants were asked to report the frequency at which they purchase each of the food types presented in the study using a 4-point Likert scale ranging from "1-Never/Rarely" to "4-Very Often."

Important Factors in Intention to Purchase. Participants reported the importance they give to the following pieces of information when making their purchasing decisions on a 7-point scale ranging from "1- Not at all important" to "7-Extremely Important.": price, brand, taste, calories, fat, serving size, saturated fat, trans fat, sodium, sugar, fiber, protein, vitamins, minerals, artificial colors, artificial flavors, GMOs.

Restrained Eating. The level of participants' restrained eating was measured using 14 questions adapted from the Flexible and Rigid Control subscales of the Eating Inventory (Westenhoefer, Stunkard, & Pudel, 1999). This validated scale includes statements either requiring true or false responses or responses on a 4-point Likert scale. Two examples would be "I count calories as a conscious means of controlling my weight," answered as a true or false or "Do feelings of guilt about overeating help you to control your food intake?" answered on a scale ranging from "1-never" to "4-always". Please refer to Table 4 the full range of questions used.

Manipulation Checks. To assess participant's awareness of the aims of this study, they were asked to guess the purpose of the eye-tracking study. Participants were then told that the study used one of two possible NL format. The participants were presented with an example of one control and one experimental NL and asked to report which one they saw (control, experimental, both or none). Lastly, participants were asked to report whether or not they thought the NLs related to the food selections they made during the experiment.

Procedure

Institutional review board approval was obtained from the Colorado State University Institutional Review Board.

A copy of the researcher protocol can be found in Appendix B. When participants entered the lab, they were given the overview of the study:

"We are interested in people's perceptions and intentions with regard to different daily behaviors, like what foods people choose to eat. Today you will look at several images on a computer and answer some questions about them. It should take about 30 minutes. You will receive a half credit for completing this study."

They were then give a consent form (See Appendix A) outlining the purpose and risks of the study and were asked to read and sign the document if they agreed to participate. After consenting, participants used a simple perception task to establish which eye was their most dominant. The participants were then asked to get comfortable in the chin rest provided. The researcher directed the eye-tracker at the participant's dominant eye, brought the participant's pupil and cornea reflections into clear focus for the camera and calibrated the hardware to their gaze. After validating the calibration, the researcher gave the participant the following instructions:

> "We will now begin the experiment. You will need to use the mouse to click on your answers to the questions that will be asked during the study, so please place your hand on

the mouse now. You will see a series of foods on the screen and will tell us if these are foods you would choose. If you do your own grocery shopping, please choose the "Yes" button if this is a food you would purchase to eat, or the "No" button if it is not. If you have a meal plan or do not do your own food shopping, please choose the "Yes" or "No" buttons to indicate whether you would eat the food. We will ask you to use the mouse to click on one of the three buttons at the bottom: Click on the green "Yes" button if this is a product you would choose. Click on the red "No" button if this is NOT a product you would choose, and select "Not Applicable" if you have a food allergy that would prevent you from ever eating this product." Between each photo will be a short calibration – a target circle will appear somewhere on the screen in between each food screen and when you are looking directly at it, I'll advance you to the next screen. Then you will need to click the mouse to advance to the next photo. Any questions?"

Participants were then led through 64 trials, each including a single food item. In addition to a photograph, description, price, and ingredient information, participants were randomly assigned to view either an ANFP or SNFP of the item's nutrition information. After considering the information presented, participants selected whether or not they would purchase the food or if they had a dietary restriction that would prevent them from eating the food. There were no maximum or minimum time restrictions for participants to make their selections, so the participants advanced to the next food screen at their own speed. After completing all 64 trials, participants completed a questionnaire including demographic questions and measures of dietary habits and the use, knowledge, and perceived importance of nutrition information. Once they completed the survey, participants were debriefed and asked not to talk with others about the study to reduce information effects in other participants.

Table 1

Participant Demographics by Condition

Demographic characteristic	Overall (N = 112)		Altered Nutrition Facts Label (n=57)		Standard Nutrition Facts Label (n=55)	
	M	SD	M	SD	M	SD
Age (years)	19.66	2.11	19.82	2.34	19.49	1.86
BMI	23.60	3.82	23.92	3.97	23.26	3.66
	n	%	n	%	n	%
Female	59	52.7	30	52.6	29	52.7
Male	53	47.3	27	47.4	26	47.3
White	99	88.4	52	91.2	47	85.5
Black/African American	3	2.7	1	1.8	2	3.6
Other	10	8.9	4	7.0	6	10.9
Hispanic	18	16.1	10	17.5	8	14.5
Non-Hispanic	94	83.9	47	82.5	47	85.5

Table 2

Health Consciousness Measure

I reflect a lot about my health.
I'm very self-conscious about my health.
I'm constantly examining my health.
I am NOT very involved with my health.

Note: This measure uses a 7-point Likert scale ranging from “1- Strongly Disagree” to “7- Strongly Agree.” The final question is reverse coded.

Table 3
Newest Vital Sign Measure

If you eat the entire container, how many calories will you eat?
If you are allowed to eat 60 grams of carbohydrates as a snack, how much ice cream could you have?
Your doctor advises you to reduce the amount of saturated fat in your diet. You usually have 42g of saturated fat each day, which includes one serving of ice cream. If you stop eating ice cream, how many grams of saturated fat would you be consuming per day?
If you usually eat 2,500 calories in a day, what percentage of your daily value of calories will Q35 you be eating if you eat one serving?
For someone who is allergic to penicillin, peanuts, latex gloves, and bee stings, would it be safe to eat this ice cream?
Why would it not be safe for someone who is allergic to penicillin, peanuts, latex gloves, and bee stings to eat this ice cream?

Note. The nutrition label that corresponds with the above questions is included as Figure 5

Table 4

Restrained Eating Measure

Question	Scale	Range
When I have eaten my quota of calories, I am usually good about not eating any more.	True or False	
I deliberately take small helpings as a means of weight control.	True or False	
While on a diet, if I eat food that is not allowed, I consciously eat less for a period to make up for it.	True or False	
I consciously hold back at meals in order not to gain weight.	True or False	
I pay a great deal of attention to changes in my figure.	True or False	
How conscious are you of what you are eating?	4-point Likert	1- “Not at all” to 4- “Extremely”
How likely are you to consciously eat less than you want?	4-point Likert	1- “Unlikely” to 4- “Very Likely”
I have a pretty good idea of the number of calories in common food.	True or False	
I count calories as a conscious means of controlling my weight.	True or False	
How often are you dieting in a conscious effort to control your weight?	4-point Likert	1- “Rarely” to 4- “Always”
Would a weight fluctuation of 5 pounds affect the way you live your life?	4-point Likert	1- “Not at all” to 4- “Very Much”
Do feelings of guilt about overeating help you to control your food intake?	4-point Likert	1- “Never” to 4- “Always”
How frequently do you avoid "stocking up" on tempting foods?	4-point Likert	1- “Almost Never” to 4- “Always”
How likely are you to shop for low calorie foods?	4-point Likert	1- “Unlikely” to 4- “Very Likely”

Nutrition Facts

Serving Size 3/4 cup (30g)

Serving Per Container 10

Amount Per Serving

Calories 100 | Calories from Fat 0

	%Daily Value*
Total Fat 0.5g	**1**%
Saturated Fat 0g	**0**%
Trans Fat 0g	
Cholesterol 0mg	**0**%
Sodium 190mg	**8**%
Total Carbohydrate 23g	**8**%
Dietary Fiber 3g	**12**%
Sugars 5g	
Protein 2g	

Vitamin A 10% • Vitamin C 100%

Calcium 100% • Iron 100%

* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carb		300g	375g
Dietary Fiber		25g	30g

Figure 1. Standard Nutrition Facts Panel (SNFP)

Nutrition Facts
Serving Size 3/4 cup (30g)
Serving Per Container 10

	%Daily Value*
Sugars 5g	
Sodium 190mg	**8**%
Saturated Fat 0g	**0**%
Trans Fat 0g	
Dietary Fiber 3g	**12**%
Cholesterol 0mg	**0**%
Total Fat 0.5g	**1**%
Total Carbohydrate 23g	**8**%
Protein 2g	

Amount Per Serving

Calories 100 Calories from Fat 0

Vitamin A 10% • Vitamin C 100%
Calcium 100% • Iron 100%

* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carb		300g	375g
Dietary Fiber		25g	30g

Figure 2. Altered Nutrition Facts Panel (ANFP)

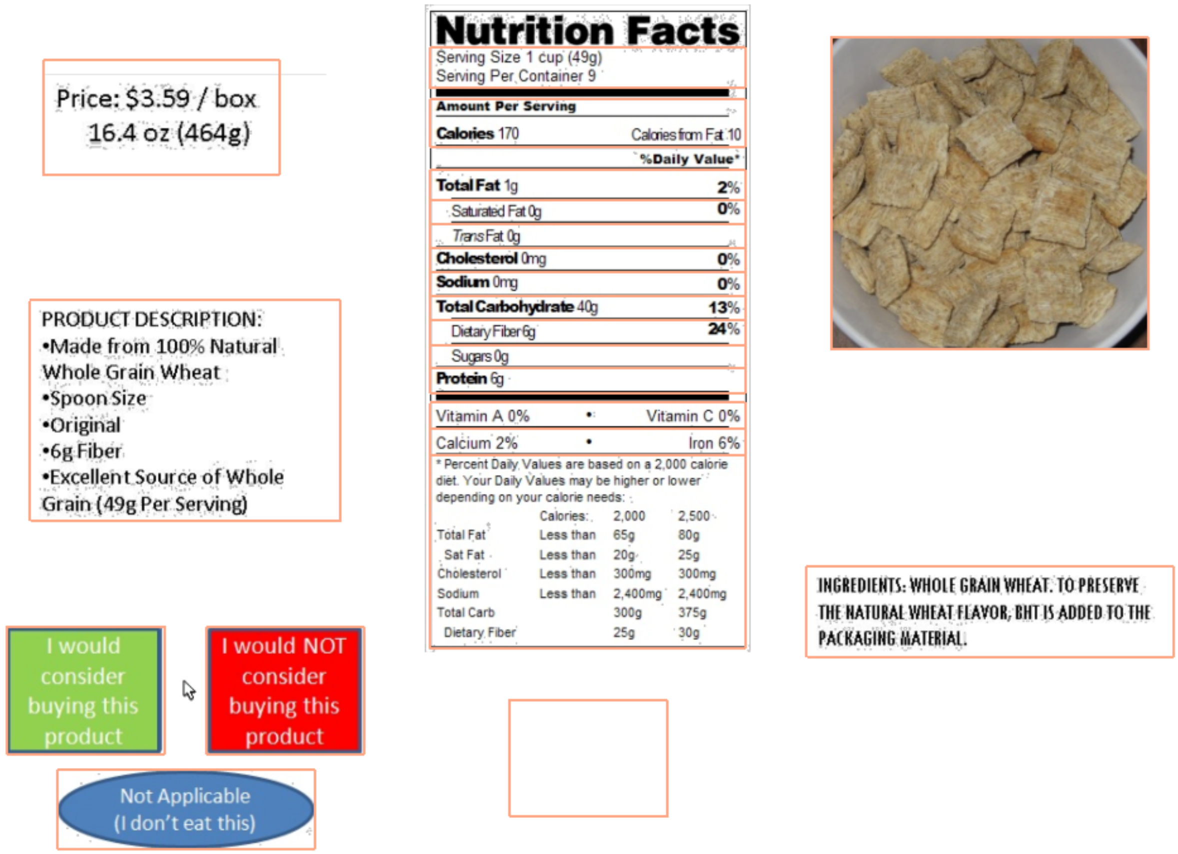

Figure 3. Trial containing a Standard Nutrition Facts Panel (SNFP)

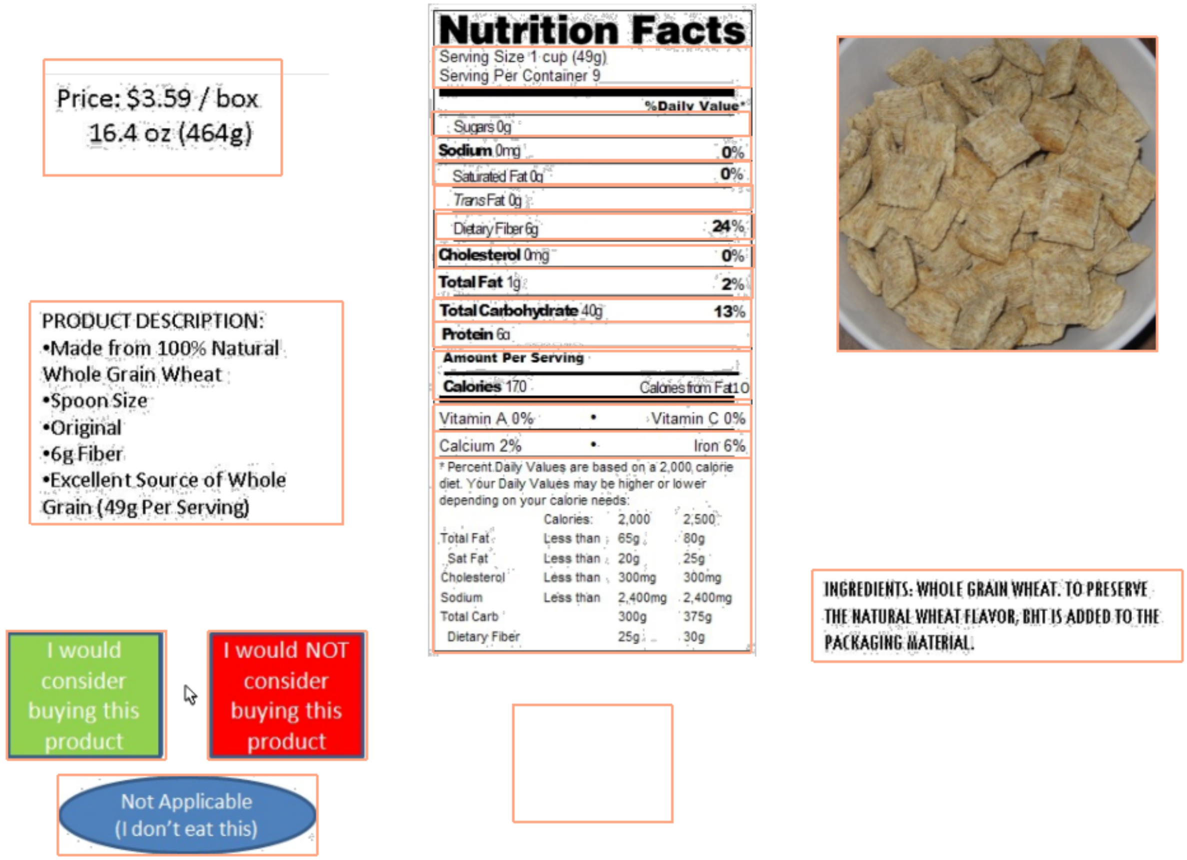

Figure 4. Trial containing an Altered Nutrition Facts Panel (ANFP)

Nutrition Facts

Serving Size			½ cup
Servings per container			4
Amount per serving			
Calories	250	Fat Cal	120
			%DV
Total Fat 13g			20%
Sat Fat 9g			40%
Cholesterol 28mg			12%
Sodium 55mg			2%
Total Carbohydrate 30g			12%
Dietary Fiber 2g			
Sugars 23g			
Protein 4g			8%

*Percentage Daily Values (DV) are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

Ingredients: Cream, Skim Milk, Liquid Sugar, Water, Egg Yolks, Brown Sugar, Milkfat, Peanut Oil, Sugar, Butter, Salt, Carrageenan, Vanilla Extract.

Figure 5. Newest Vital Sign nutrition label

CHAPTER 9: RESULTS

All analyses described below were conducted in 2018 using SPSS statistical software (Version 24.0. Armonk, NY: IBM Corp).

Viewing of AOIs

To explore the overall characteristics of the sample, averages of fixation count and dwell time durations for each AOI and for all AOIs combined (i.e., the entire NL) were calculated for each participant. Frequency distributions showed the responses for these attentions variables were positively skewed, so natural logarithmic transformations were used to normalize the data to meet the assumptions for inferential statistics. The means of the viewing for each AOI and total AOI viewing were compared using an independent samples t-test. See Table 5 and Table 6 for descriptive statistics for the fixation count and fixation duration of each AOI by condition with statistically significant differences (p <.05) noted.

Hypothesis 1: Differences in Attention to Select Nutrients

Bivariate correlation analyses were conducted (see Table 7 for correlations of primary constructs) to identify possible covariates to be used as controls. Significant, moderate correlations were shown between the total attention given to all AOIs throughout the study (both fixation count and duration) and attention to each of the nutrients. Total attention variables that matched the format of the outcome variable being tested (either count or duration) were therefore selected to be included in the models for each of the nutrients as controls.

To investigate whether those in the ANFL condition gave more attention to the relocated nutrients (i.e., sugar, sodium, and fiber) than those in the SNFL condition, individual analyses of covariance (ANCOVA) were conducted. Although all total models were significant, the effect of condition was not significant for either attention variable (fixation count or duration) for fiber, sugar, or sodium. *F*s ranged from .034 to .64, all *ps* >.05. See Tables 8 and 9 for summaries of each analysis. This suggests that while there were significant differences based on one's total AOI viewing tendencies, those in the experimental condition were not significantly more likely to view the nutrients sugar, sodium, or fiber, more than those in the control condition. This leads to a rejection of hypotheses H1a-H1f.

Hypothesis 2: Comparison of the Healthfulness of Food Selections by Label Type

To test whether those in the ANFL condition choose healthier food types than those in the SNFL condition, the means of the fiber, sodium, and sugar content of all intended food purchases were calculated for each participant. No statistically sufficient covariates (correlations > r=.30) were identified in the analysis of bivariate correlations, so analyses of variance (ANOVAs) were conducted to compare the averaged nutrient content of the foods selected for purchase between the two study conditions. All analyses showed that there were no significant differences between the ANFL and the SNFL condition in their food selections based on fiber, sugar, or sodium content; *F*s ranged from 0.265 to 1.25, p >.05. For these reasons, hypotheses H2a-H2c should be rejected. See Table 10 for a summary of results.

Manipulation check. Descriptive statistics showed that when asked whether or not the participants thought the NLs they saw were related to the food selections they made during the experiment, over half of the participants (55%) stated that they were not related. This suggests that a large portion of the sample did not expect our manipulation (or NLs in general) affected their food choices.

Hypothesis 3: Attention, Literacy, and Self- Reported NL Perceptions and Use by Sex

Please refer to Table 11 for a summary of descriptive statistics for primary constructs by sex, and Table 12 for a summary of two-tailed T-test statistics discussed in this section.

Attention. Contrary to the expected trends, descriptive statistics showed that men gave more attention to each of the three nutrients, as well as to the NL as a whole. However independent samples t-tests showed that none of these differences were significant. This suggests that there were no true differences in attention between the two sexes. This leads to a rejection of the H3a-b hypotheses.

Health literacy. While, on average, men tended to score slightly higher than women on the measure of health literacy, independent samples t-tests showed that the difference was not significant. These results show that H3c in not supported.

Self-reported NL use. An independent samples t-test comparing the rates of self-reported NL use supported H3d, showing that women were significantly more likely to report use of NLs when compared to men.

Health consciousness and perceived importance of healthy food. Independent samples t-tests were conducted to assess potential sex differences in participants' perceived importance of healthy foods and/or levels of health consciousness. Results showed that there were no significant differences between men and women on these two constructs, suggesting a rejection of hypotheses H3e-f.

Restrained eating and dieting behaviors. Independent samples t-tests were used to test potential eating behavior differences between men and women. In support of H3g-i, results showed that, compared to men, women reported significantly greater participation in restrained eating behaviors and were significantly more likely to have been dieting both in the past year and at the time of the study.

Hypothesis 4: Comparison of Self-Report and Objective Measure of NL Use

To compare the self-reported and observed attention to NL and nutrients, fixation counts for each nutrient and for the NL as a whole were summed across all 64 food trials for each participant. For each food, participants received a dichotomized score of "1" if they looked at the AOI (either the NL or each of the select nutrients) for at least 50ms at any point, or "0" if they did not look at the AOI or looked at it for < 50ms. The sum of these scores was used to calculate the percentage of foods for which the participants attended to the desired AOI. This percentage (X) was converted to a nominal scale to match the self-reported frequencies using cut points corresponding to previous research exploring NL reporting and use (Graham & Jeffery, 2011) such that $X \leq 10\%$ corresponded to "never/rarely", $10\% < X \leq 40\%$ corresponded to "sometimes", $40\% < X \leq 80\%$ corresponded to "often" and $X > 80\%$ corresponded to "always/almost always."

Descriptive statistics of self-report and objective attention were analyzed and are represented in Figure 6. Notably, results showed that while sugar was the highest in self-reported attention of the three variables (followed by sodium and then fiber), it was the lowest of the three in the eye-tracking measure of attention.

NL as a whole. A Pearson's Chi-square Test of Independence was used to assess if the observed frequency of NL viewing was independent of participants' self-reported rates of NL reading. Results showed that the observed frequency was not significantly different from the self-reported rates of NL reading $X^2(6, N=112) = 7.50$, $p=.277$. This suggests that there was not a significant relationship between participants' reported viewing and their measured attention to NLs, leading to the rejection of the H4a hypothesis.

Sugar. To assess if the observed frequency of viewing sugar content was significantly dependent on participants' self-reported frequency of viewing sugar, a Pearson's Chi-square Test of Independence was conducted. Results showed that self-reported and observed measures for sugar were not independent $X^2(6, N{=}112) = 16.309, p{=}.012$. This suggests that participants self-reported viewing of sugar was significantly related to our observations. Specifically, these results show that participants in our sample were significantly over-reporting their attention to sugar. These findings support H4b of this study.

Fiber. A Pearson's Chi-square Test of Independence showed that the observed frequency of viewing fiber was independent of the self-reported rates $X^2(6, N{=}111) = 10.725, p{=}.097$. This indicates that while there seemed to be a trend of individuals self-reporting higher levels of attention than observed, these variables were independent (not related). Thus, H4c was not supported.

Sodium. A Pearson's Chi-square Test of Independence was performed and showed that the self-reported frequencies of viewing sodium content were independent of observed frequencies, $X^2(6, N{=}111) = 7.502, p{=}.277$. This suggests that there was not a significant relationship between participants reported viewing and their measured attention to sodium content, thus H4d was not supported.

Supplemental Analysis: Perceived Relationship between NLs and Purchasing Decisions

Given the responses to our manipulation check assessing whether or not the participants thought the NLs they saw were related to the food selections they made (in which only 45% agreed that NLs influenced their choices), two-tailed independent samples t-test were used to assess the relationship between manipulation check agreement, attention, and the nutrient content of the foods chosen (see Table 13 for a summary). While the results showed that participants who believed their food selections were related to the NLs did not give significantly more attention to NLs and to individual nutrients, they did select foods with significantly more fiber and significantly less sodium. These results suggest subsequent nutrient content is related to the participants' perceptions of NLs, namely the belief that NLs were related to their food selections.

Table 5

Descriptive Statistics for AOI Fixation Count by Condition

	ANFL		SNFL	
	M	*SD*	*M*	*SD*
Total NL	2.78	2.829	2.5	3.76
Description	6.683	3.474	6.08	3.946
Picture	2.60	0.903	2.759	1.126
Ingredients	1.632	2.90	1.106	2.037
Price	1.229	1.088	1.005	1.056
Fiber	0.183	0.224	0.206	0.416
Sugar	0.204	0.321	0.155	0.269
Sodium	0.263	0.388	0.221	0.378
Protein	0.124	0.163	0.131	0.282
Calories*	0.38	0.512	0.227	0.335
Cholesterol	0.154	0.166	0.172	0.285
Total Carbs	0.178	0.251	0.207	0.378
Total Fat	0.217	0.231	0.259	0.403
Saturated Fat	0.192	0.231	0.237	0.416
Trans Fat	0.183	0.204	0.218	0.377
Serving Size*	0.382	0.541	0.192	0.256
Vitamins	0.076	0.097	0.076	0.163
Minerals	0.053	0.062	0.047	0.058
RDA	0.192	0.19	0.152	0.157
All AOIs	16.89	7.57	15.313	9.838

Note. Values represent the average number of fixations for each AOI on a single trial.
* indicates $p<.05$

Table 6

Descriptive Statistics for AOI Total Fixation Duration by Condition

	ANFL		SNFL	
	M	*SD*	*M*	*SD*
Total NL	544.42	613.72	478.28	816.23
Description	1358.23	744.96	1220.37	834.78
Picture	689.46	287.18	734.61	330.27
Ingredients*	361.76	750.71	219.91	436.81
Price	237.27	229.86	187.42	208.00
Fiber	34.65	45.49	40.11	93.56
Sugar	42.04	70.41	31.26	63.87
Sodium	53.60	90.32	44.49	86.06
Protein	24.49	35.61	25.85	64.39
Calories*	72.40	99.95	41.51	70.24
Cholesterol	30.49	39.30	32.36	60.82
Total Carbs	35.02	49.92	39.88	80.03
Total Fat	41.95	54.28	50.14	86.90
Saturated Fat	40.05	56.28	47.41	89.75
Trans Fat	35.84	47.01	41.51	80.08
Serving Size*	75.98	111.39	36.96	54.43
Vitamins	13.31	17.07	13.94	35.75
Minerals	9.68	11.98	7.68	10.69
RDA	34.92	37.91	25.20	29.70
All AOIs	3618.91	1814.92	3236.76	2123.07

Note. Values represent the average fixation duration (ms) for each AOI on a single trial.
* indicates $p<.05$

Table 7

Bivariate Correlations of Primary Constructs

	Con	Sex	BMI	YD	CD	RE	SRNL	Choice	HC	FNL	Ffib	Fsod	Fsug	FTAOI	DNL	Dfib	Dsod	Dsug	DTAOI
Con	-																		
Sex	0.00	-																	
BMI	-0.09	-.211*	-																
YD	-0.09	.235*	.301**	-															
CD	0.00	.344**	.230*	.781**	-														
RE	0.04	.390**	0.03	.551**	.603**	-													
SRNL	0.04	0.18	0.01	0.17	.217*	.428**	-												
Choice	0.01	0.09	0.11	0.02	-0.03	-0.08	-0.07	-											
HC	0.12	0.08	0.05	.373**	.306**	.478**	.465**	-0.05	-										
FNL	-0.12	-0.06	0.10	-0.07	-0.14	-0.08	-0.04	0.16	-0.04	-									
Ffib	-0.06	-0.04	0.18	-0.02	-0.08	-0.05	0.01	0.20	-0.03	.840**	-								
Fsod	-0.13	-0.12	0.15	-0.08	-0.10	-0.09	-0.05	0.15	-0.11	.881**	.807**	-							
Fsug	-0.08	-0.16	0.00	-0.11	-0.17	-.195*	-0.07	0.14	-0.09	.826**	.788**	.804**	-						
FTAOI	-0.16	0.05	0.08	-0.06	-0.14	-0.11	-0.02	0.09	0.00	.752**	.647**	.625**	.592**	-					
DNL	-0.14	-0.04	0.10	-0.06	-0.12	-0.07	-0.04	0.17	-0.04	.993**	.836**	.883**	.827**	.758**	-				
Dfib	-0.09	-0.05	0.16	-0.04	-0.08	-0.06	-0.02	0.19	-0.05	.856**	.986**	.817**	.792**	.678**	.860**	-			
Dsod	-0.17	-0.14	0.14	-0.06	-0.08	-0.10	-0.03	0.16	-0.09	.869**	.778**	.987**	.792**	.641**	.885**	.794**	-		
Dsug	-0.09	-0.16	0.01	-0.10	-0.15	-0.16	-0.07	0.16	-0.09	.825**	.790**	.807**	.982**	.600**	.841**	.801**	.815**	-	
DTAOI	-0.16	0.06	0.04	-0.04	-0.11	-0.09	-0.03	0.07	0.03	.739**	.628**	.618**	.593**	.976**	.761**	.670**	.652**	.619**	-

Note. * indicates $p<.05$; ** indicates $p<.01$. All attention variables (fixation counts and duration) are transformed. Key: Con=condition, YD=Dieting over the past year, CD=Current Dieting, RE=Restrained eating measure, SRNL=Self-report NL reading frequency, Choice=Manipulation check measure (did NL influence food selections during trials), HC= Health Consciousness, FNL=Total fixations on NLs, Ffib=Total fixations on fiber, Fsod=Total fixations on sodium, Fsug=Total fixations on sugar, FTAOI=Total fixations on all available AOIs, DNL=Total fixation duration on NLs, Dfib=Total fixation duration on fiber, Dsod=Total fixation duration on sodium, Dsug=Total fixation duration on sugar, DTAOI=Total fixation duration on all available AOIs.

Table 8

One-Way Analysis of Covariance in Fixation Count by Condition

	Source	*SS*	*df*	*MS*	*F*	*p*
Sugar						
	Corrected Model	50.440	2	25.22	27.614	0.000
	TotFixAOI	49.596	1	49.596	54.305	0.000
	Condition	0.057	1	0.057	0.063	0.803
Fiber						
	Corrected Model	62.241	2	31.121	38.557	0.000
	TotFixAOI	61.745	1	61.745	76.499	0.000
	Condition	0.365	1	0.365	0.453	0.503
Sodium						
	Corrected Model	62.719	2	31.36	33.737	0.000
	TotFixAOI	60.126	1	60.126	64.683	0.000
	Condition	0.122	1	0.122	0.131	0.718

Note. TotFixAOI variable refers to the summed fixation counts for all possible AOIs across all 64 trials.

Table 9

One-Way Analysis of Covariance in Fixation Duration by Condition

	Source	*SS*	*df*	*MS*	*F*	*p*
Sugar						
	Corrected Model	69.735	2	34.868	31.681	0.000
	TotFixAOI	68.216	1	68.216	61.982	0.000
	Condition	0.037	1	0.037	0.034	0.855
Fiber						
	Corrected Model	82.402	2	41.201	43.652	0.000
	TotFixAOI	80.798	1	80.798	85.604	0.000
	Condition	0.081	1	0.081	0.086	0.770
Sodium						
	Corrected Model	88.793	2	44.396	39.813	0.000
	TotFixAOI	83.135	1	83.135	74.551	0.000
	Condition	0.714	1	0.714	0.64	0.425

Note. TotFixAOI variable refers to the summed fixation counts for all possible AOIs across all 64 trials.

Table 10

One-Way Analysis of Variance in Food Selection Nutrient Content by Condition

	Source	*SS*	*df*	*MS*	*F*	*p*
Sugar						
	Condition	1.813	1	1.813	1.094	.298
Fiber						
	Condition	.076	1	.076	1.253	.265
Sodium						
	Condition	307.587	1	307.587	.265	.608

Table 11

Descriptive Statistics by Sex

	Women (n=59)		Men (n=53)	
	M	*SD*	*M*	*SD*
Total NL Fixation Count	2.43	3.43	2.870	3.19
Fiber Fixation Count	0.19	0.39	0.200	0.25
Sugar Fixation Count	0.15	0.26	0.210	0.33
Sodium Fixation Count	0.18	0.31	0.310	0.45
Total NL Fixation Duration	472.35	753.5	556.020	680.29
Fiber Fixation Duration	37.03	88.34	37.670	51.28
Sugar Fixation Duration	32.02	62.37	42.000	72.43
Sodium Fixation Duration	35.65	68.6	64.130	104.1
Health Literacy	2.360	0.713	2.530	0.668
Self-Reported NL Use	2.370	0.945	2.040	0.854
Health Consciousness	4.200	0.866	4.058	0.83961
Perceived Importance	5.220	1.018	5.040	0.876
Restrained Eating	7.290	3.833	4.440	2.796
	n	%	n	%
Current Dieting	32	54.2	11	20.8
In the Past Year	35	59.3	19	35.8

Note. Raw scores for the fixation count and fixation durations variables are computed using the average averaged totals for all 64 food trials (represents the average trial).

Table 12

Summary of T-tests by Sex

Variable	Specification	*t value*	*df*	*p*
Attention Fixation (H3a)				
	Total NL (H3a)	0.588	110	0.558
	Fiber	0.4	107	0.690
	Sugar	1.667	103	0.099
	Sodium	1.2	106	0.233
Attention Duration (H3b)				
	Total NL (H3b)	0.469	110	0.640
	Fiber	0.555	108	0.580
	Sugar	1.647	103	0.103
	Sodium	1.458	107	0.148
Health Literacy (H3c)		1.315	110	.191
Self-Reported NL Use (H3d)		-1.961	110	.052
Health Consciousness (H3e)		-0.871	109	.386
Perceived Importance(H3f)		-1.012	110	.314
Restrained Eating (H3g)**		-4.416	109	.000
Dieting Behaviors (H3h-i)				
	Current Dieting (H3h)**	-3.889	110	.000
	In the Past Year (H3i)*	-2.530	110	.013

Note: * indicates p<.05; ** indicates p<.01

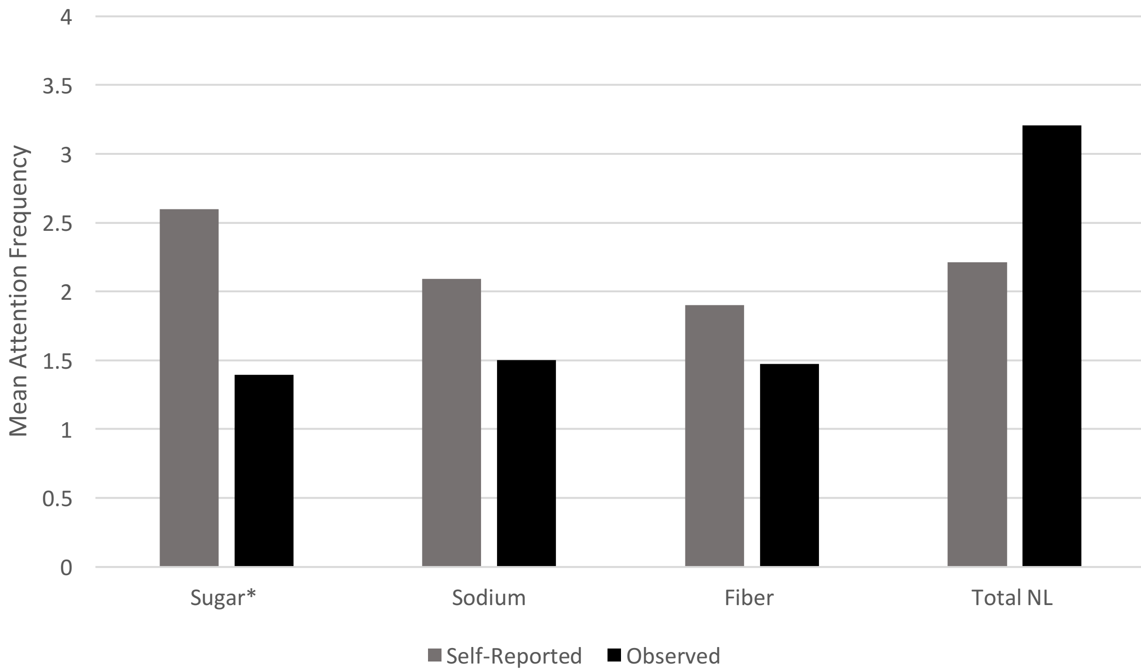

Figure 6. Mean frequencies of self-reported and observed attention to NL and selected nutrients. Frequencies are on a 4 point Likert scale ranging from “1-never/rarely” to “4-Always/almost always.” * indicates p<.05

Table 13

T-test statistics Comparing Attention and Nutrient Content by Manipulation Check Responses

Variable	Specification	*t value*	*df*	*p*
Attention Fixation				
	Total NL	-1.60	93	.112
	Fiber	-1.97	90	.052
	Sugar	-1.33	87	.185
	Sodium	-1.45	90	.150
Attention Duration				
	Total NL	-1.63	93	.107
	Fiber	-1.87	91	.065
	Sugar	-1.52	87	.133
	Sodium	-1.52	90	.132
Nutrient Content of Purchased Food				
	Fiber *	2.53	93	.013
	Sugar *	.042	93	.967
	Sodium *	-2.36	93	.021

Note. * indicates p<.05

CHAPTER 10: DISCUSSION

This study sought to explore the role of attention using eye-tracking in a simulated grocery shopping task involving young women and men. Specifically, we used an altered NL format to test whether changes in the location of key nutrients on a label would affect attention to those nutrients and participants' subsequent purchase intentions. Additionally, we sought to further characterize sex-related differences that may exist in NL reading and other health behaviors. Lastly, we compared the self-reported viewing rate to those observed in the eye-tracking task.

Differences in Attention to Select Nutrients

Previous research has shown that individuals tend to read the topmost portions of NLs regardless of their reported preference for viewing nutrients located in that portion of the label (Graham & Jeffery, 2011; Graham & Roberto, 2016). By moving certain nutrients (i.e., sugar, sodium, and fiber) closer to the top of the NL (experimental condition), it was predicted that individuals would attend to these nutrients more than individuals who viewed a standard, unaltered label (control condition). Our results from this study, however, do not support this prediction. Our results suggest that moving nutrients toward the top of the NL might not be an effective method to increase attention to these nutrients among young women and men.

Given the modest sample size of the current study, it is difficult to draw meaningful explanations of the trends observed; however, previous research exploring familiarity with labels and their formation might offer potential answers. While many studies have shown that attention tends to increase with the novelty of a stimulus (Horstmann & Herwig 2016; Wu & Huberman, 2008), some evidence has shown that in the case of NLs, familiarity may be key (Bialkova & van

Trijp 2010). Specifically, eye-tracking studies suggest that familiarity with label type and label location can significantly increase attention to labels and their components. In the context of the current study, it is possible that those in the ANFL condition were attending to stimuli at a lower rate due to a decreased familiarity with the central stimuli of the trial. Future research could address this possibility by implementing educational programs meant to increase familiarity and decay the novelty of the stimuli and offer an equitable comparison to standard NL formats.

Previous research suggests that attention to nutrients can have implications for food selections (Kristal et al., 2001; Variyam, 2008). Given that attention to nutrients is a prerequisite for the use of nutrient information in food selection decisions and attention is theorized to be a limited resource affected by competing stimuli, it is important to further study factors that can increase attention to nutrients such as sugar, fiber, and sodium (Bridewell & Bello, 2016). It is important to replicate this study and explore the effects of other NL arrangements to further elucidate factors involved in NL attention.

Differences in Food Selections

Prior evidence suggests that changes in NL format can have significant effects on the nutrients individuals choose to attend to and that these differences in attention can be consequential in one's assessment of healthful food types (Jones, & Richardson, 2007). This study sought to increase attention to key nutrients through a manipulation in label format and predicted that those in this ANFL condition would have significantly healthier food selections, (total selections with lower levels of sugar and sodium and higher levels of fiber) compared to those in the SNFL condition. This hypothesis was not supported as there were no significant differences between the conditions in terms of fiber, sugar, and sodium content of chosen products. These results are likely related to the null findings in our first hypothesis; there was no significant difference in attention by condition, leaving our prediction of increased attention leading to healthier food choices slightly unfounded.

Another possible explanation for the null results by condition stems from potential individual differences in perception and motivations toward NL use. Those who perceived the NL as being influential in their purchasing intentions were more likely to choose foods that were higher in fiber and lower in sodium than those who responded that the NLs were not influential. This suggests that underlying individual differences in the perceived utility of NLs may be related to their subsequent purchasing intentions. These results warrant further exploration given the rather large proportion (55%) of individuals who reported that they did not believe that NLs influenced their purchasing decisions over the course of the study.

Attention theories and previous research suggests that attention is a limited resource and that increasing the saliency of the given information may give content a needed boost in viewing frequencies and durations (Bialkova, & van Trijp, 2010; Bridewell & Bello, 2016; Itti et al., 1998; Orquin et al., 2012). Given the previous research supporting links between attention and food intention, future experiments should incorporate a wider array of manipulations to increase attention. Specifically, experimental conditions that explore a variety of nutrients, organization arrangements (such as the altered locations in this study), and other formatting options like color and text size are recommended to determine how to increase consumer attention to the most consequential nutrients amid countless other stimuli.

Sex Differences

The preponderance of the literature regarding NL use, health perceptions, and eating behaviors offers support that women and men tend to differ in responses on these measures and in the outcomes associated with them. This study sought to replicate these previous findings;

however, results suggest deviations from established trends. Notably, while survey data confirm previous evidence that women report significantly higher levels of NL use, eye-tracking measures showed no significant sex differences in attention to NLs and each of this study's target nutrients. These results, which contrast with previous findings, require further exploration to allow for interpretations. It is possible that previous experience with NLs or with the products shown could have led women to become overconfident in their health knowledge or otherwise become less reliant on the NLs shown. Additionally, contrary to previous research, this study showed inconclusive evidence regarding sex differences in health literacy, health consciousness, and the perceived importance of eating healthy foods. This lack of differences by sex could indicate that women and men had similar levels of motivations surrounding NL use, which may explain the null results seen in comparisons of attention. It is possible that women and men were relying on stimulus-driven attention processes at comparable rates, leading to similar rather than disparate levels of attention.

There were, however, significant differences between women and men with regard to dieting and eating behaviors. Our study showed that women reported significantly higher rates of restrained eating behaviors and dieting both at the time of the study and over the preceding year. This is consistent with previous findings (Campos et al., 2011; Grunert, & Wills, 2007), and these eating behaviors have been shown to be related to a host of complex processes such as increased self-objectification and body dissatisfaction. (Cheney, 2011; Fredrickson, Roberts, Noll, Quinn, & Twenge 1998, Paa & Larson, 1998). Increased dieting and restrictive eating habits are rooted in the cultural pressures on women to be slim (Cheney, 2011; Fredrickson et al., 1998).

It is important to continue studying the intersection of sex and health-based measures. Previous research has shown that women and men differ in the attention they give to nutrients, consideration for food purchases and eating behaviors (Graham, & Jeffery, 2012; Grunert & Wills, 2007). In similar ways, women and men also show disparities in the prevalence of and symptom of eating disorders (Striegel-Moore et al., 2009). It is critical to further characterize the behaviors and outcomes of a diverse array of intersectionalities including by sex and gender to better understand both the effect that societal norms have on a diversity of individuals and to develop dietary intervention strategies tailored to the individual.

Self-Report and Objective measures of NL Use

Past studies have highlighted the tendency for self-report NL use frequencies to be significantly higher than actual attention measured by objective measures such as eye-tracking technologies (Cowburn & Stockley, 2005; Graham & Jeffery, 2011). This study sought to replicate these findings and did so with variable success. Results showed that sugar was the only nutrient for which participants over reported use; there were no significant differences between self-reported and observed attention rates with regard to the total NL, sodium, and fiber (though differences in fiber viewing seemed to be approaching a significant trend). This nonconcordance with previous results could be due to the reported low levels of NL use seen overall in our study. In fact, with the majority of our sample reporting that they only viewed NLs "sometimes" or less, it is possible that the participants in this sample were being more honest and transparent about their non-use or, perhaps, they hold more realistic views of their own use compared to other samples studied. It is also possible that the design of the study, in which the NL was placed central to all other product purchasing factors, lowered the barriers of attending to such information. Participants did not have to search the item (rotate and/or locate) to find the NL and attend to its contents. Therefore, the increased availability of the NL could also explain why this study failed to replicate previous finding of over-reporting use.

The one exception to the null findings in over-reporting was in attention to sugar, with participants reporting significantly higher levels of attention than what was observed. This interesting trend likely results from the fact that, out of the three nutrients, sugar was reported as being viewed at the highest frequency, but in actual observed measures was the *least* viewed of the three targets. This could be related to sugar's status as a popularized macronutrient. It is well known that sugar is a component of our diet that we are meant to reduce. In fact, one survey found that those from the U.S. guessed that 65% of the U.S. citizens ate too much sugar, and 55% of participants reported that they themselves consumed over the recommended amount (Ipsos Global, 2016). It is, therefore, possible that individuals know that they *should* be paying more attention to sugar content, and are possibly unaware of their low levels of actual attention.

More research is needed to explore the trends regarding self-reported and objective measures of attention. Several health-behavior change models such as the theory of planned behavior model and the health belief model highlight the ways in which self-perceptions can affect subsequent behavioral choices. The effects of perceptions could be important when considering NLs and their use in healthful food selection. For example, if it is shown that individuals do, in fact, over-report their own attention to NLs or individual nutrients they could feel they are being more health conscious then they truly are. This could potentially have diminishing effects on the participant's level of perceived susceptibility to making poor food choices, making it less likely that they will engage in preventative actions from doing so. By drawing attention to these trends seen in NL reading, researchers will be able to better identify the gaps and inconsistencies in perceptions of health behaviors. Further knowledge of these trends can be used in intervention studies seeking to increase participant awareness, reduce the occurrence of false perceptions, and possibly increase the perceived susceptibility of making poor food selections.

Limitations and Future Directions

This study had several limitations, perhaps the most consequential of them being a small sample size. Due to complications in the data collection and the integration of eye tracking with survey measures, the sample size of this study was lower than planned (over 15% reduction in total N). As a result, this study was diminished in its power to detect significant differences between conditions. In fact, a power analysis conducted using G*Power 3.1 showed that this was likely the case. It was found that our sample size was insufficient to detect even large effect sizes (d=.4, needs 313 participants), let alone the medium (d=.25, needs 725 participants), or small (d=.4, needs 4225 participants) effects sizes that are common in studies such as these. Because of this reduced sample, our analyses were left vulnerable to the effects of individual differences, therefore, it would be beneficial for future research to explore these effects using larger sample sizes.

Another overarching limitation stems from the computerized, lab-based format of this study. Little is known about the extent to which attention and purchase intentions observed in computer simulated grocery tasks accurately represent real-world grocery shopping experiences. Factors related to the environment, presentation format, the participants' mobility (in this study the participants used a chin rest, which restricted head movements), and even their lack of being able to hold the product could all potentially affect the participant's attention and purchasing decisions. Of primary concern is the validity of the food purchase intention measure. The design of our study, in which participants are presented foods one at a time and are asked to select an unlimited amount to purchase, reduces the validity we need to robustly generalize to the actual shopping behaviors due to two key factors.

First, this study's primary outcome measure – food choice – lacks the constraints seen in typical shopping behaviors, such as financial limitations; the participants were not made to limit their selection in any way based on the amount of money they had available or their capacities to consume all of the food selected. In real-world situations, participants would likely engage in additional selection and comparison processes that were made unnecessary by our design. It could be that participants exhibit different NL reading tendencies when faced with limitations in purchasing power. Therefore, future studies should explore the ways in which participants interact with different label formats when certain restrictions (such as limiting the amount of food or the total purchase price) are imposed on their purchase selections.

Secondly, it is relatively unknown if and how self-report purchase intention measures are associated with actual purchasing behaviors in grocery stores. This highlights the need to incorporate behavioral observations into future studies to see how the trends explored in the present study relate to food purchases made in physical grocery store settings. Additionally, given the benefits in experimental freedom and feasibility that come with using measures such as purchase intention, it would be advantageous for researchers to more formally assess the relationship between these self-report, lab-based measures and behavioral outcomes. Establishing the validity of this measure would facilitate future investigations for a variety of settings and conditions.

Validity concerns are important to note when generalizing consumption behaviors in standard brick-and-mortar stores, however, the growing trend of online grocery shopping suggests that designs such as these might be increasingly relevant as food selection and purchasing practices become more modernized. In fact, recent research suggests that online grocery shopping itself might help improve the health of consumers; it was shown that when shopping online, participants selected less unhealthy food than they did in offline settings (Huyghe, Verstraeten, Geuens, & Van Kerckhove, 2017). These results highlight an additional benefit in continuing computer-based studies to explore the effects of formatting and contextual differences in the presentation of nutrition information on consumer food selections.

Another limitation of this study comes from the transformation of observed attention variables to match self-reported NL viewing scales. To assess whether individuals were over-reporting their personal NL use, objective viewing rates were converted to the same 4 point Likert scale as the self-report items seen on the survey. This not only reduced the variance in the overall attention measure, but it was also reliant on the researcher's interpretation of how much attention was equivalent to the responses given on the scale (i.e. that $10\% < X \leq 40\%$ viewing of a nutrient corresponded to "sometimes"). For future studies, it would be useful to make these designations clear to that participant during the survey to improve the accuracy in data representation and reduce dependence on the researcher's interpretation.

One of the primary goals in this study was to see if attention to key nutrients could be altered through label format changes and if this predicted change would sway individuals to choose healthier food types. In determining the healthfulness of the selections made by participants, this study faces another notable limitation inherent to studying NLs: the foods selected were manufactured foods which tend to be less nutritious and less healthful than non-labeled, whole food products. Sixty-four foods were selected to represent a variety of food types, and while canned/packaged whole foods were available, it is difficult to conclude that the options given encompassed the variety of healthful food options available in the typical grocery store setting. By narrowing the range of options to solely include manufactured, labeled food, this study might be overestimating the amount of unhealthful purchases individuals make. Therefore, it would likely be inappropriate to generalize food selections on tasks such as these to be indicative of a participant's purchasing or eating habits overall.

In addition to the recommendations for future research discussed above, the current study underlines the need for further exploration in several areas related to labeling formats and food selection factors. Prospective studies should use larger sample sizes and explore a wider variety of label orientations and formats. Previous evidence suggests that attention is strongly related to factors that increase salience, such as the use of color, text size, and label location; it is recommended that future eye-tracking researchers test a combination of these elements to explore the arrangements for which individuals maximize attention to consequential nutrients. Additional studies should explore trends in a variety of populations including those of non-college-student adults from a diversity of backgrounds. Lastly, it is suggested that researchers work to validate eye-tracking measures with real-world purchasing outcomes to assess whether label attention in the lab predictive of shopping habits outside of the lab.

Implications

Attention to NLs has been shown to increase one's accurate judgment of the healthfulness of foods, making it an invaluable tool for those seeking to pursue a healthy diet. It has been shown that increased attention is also beneficial in the food selection behaviors of those who are not particularly motivated to read NLs. By exploring formats that promote greater attention to NLs in general, researchers can make informed recommendations for policymakers seeking to improve the health of the general public.

It would be constructive to consider eye-tracking studies like the current investigation as necessary prerequisites to large-scale NL changes. Similar to the findings of the current study, previous research has shown that increasing attention to NLs is a complex process and one that is not always responsive to seemingly inutuitve strategies. For example, one study tested the FDA's consideration to move the daily value percentages to the Nutrition Facts Label's left side, which the FDA suggested would increase attention to that nutrient based on the left-to-right reading pattern of standard English. Surprisingly, however, it was found that the modification actually led to less attention to this information! Not only did moving the daily recommended values to the left fail to capture greater amounts of attention, but the authors suggest this modification would be inadvisable due to the move's detrimental effects in reducing attention to this information (Graham & Roberto, 2016). Conversely, researchers have found evidence to support some of the considerations made by the FDA; one study showed that individuals will seek out information regarding "added sugars" more than the standard sugar component, supporting the addition of this information in the newest NL formatting (Graham & Roberto, 2016). Testing these types of additions is a vital step before implementing changes because attention is also significantly related to the amount of "visual clutter" present. As previously mentioned, consumers have a tendency to attend more to simpler labels and it has been shown that there is an inverse relationship to the number of features on a given label and the attention it receives (Visschers et al., 2010).

While further research is needed to confirm the real-world, behavioral outcomes of NL attention, previous findings suggest that increased NL use can lead to healthier food selections (Campos et al., 2011). Research has also shown that the foods people purchase in the store largely reflect their consumption patterns of food overall, suggesting the strategies that increase healthy food purchases can have a meaningful impact on eating behaviors (Appelhans, French, Tangney, Powell, & Wang, 2017). While changes in attention to NLs may have a relatively small effect on something as multifaceted as a single individual's overall health, it is useful to consider the scale at which NLs are applied in food selection settings. Given this potential for exposure, it is advantageous to explore how alternations in NLs formats to improve attention to nutrients, especially those that have been linked to diet-related diseases, might be a feasible way to reach a significant portion of the population with one more nudge toward healthier food choices.

CHAPTER 11: CONCLUSION

This study found that a novel arrangement of the current Nutrition Facts Label was not effective in increasing attention to nutrients moved to the top of the label. These findings suggest that, despite previous evidence indicating increased attention to the topmost position of the NL, one's attention to the label components might be affected by more than just the location on the label. This study also showed that in the current arrangement, alterations in NL were not related to subsequent food selections, and were ineffective in increasing healthful food choices. More research is needed to explore the possible relationships between nutrients, location and possibly label familiarity in an effort to inform policies for future label designs.

Sex differences were found with regard to eating and dieting behaviors, however contrary to previous findings and self-report data, no significant differences were seen in label viewing or viewing of the nutrients for sugar, fiber, and sodium. It is important to replicate the findings of this study to further understand the relationship (if any) that sex might have with measures of attention to nutrition information. Given the disparate rates of eating-related morbidities, further studies could be beneficial in identifying the most effective targets for behavior change interventions among women and men.

Furthermore, our study showed that with the exception of sugar, our sample was fairly accurate in reporting their label use; low label use was both reported and observed. Given the small size and potentially confounding characteristics of the sample (living in one of the healthiest cities in the U.S.), it is important to continue exploring potential differences in reported and observed attention among individuals from a diversity of backgrounds.

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APPENDIX A

Consent Form

Eye-tracking and Daily Activities
Investigators: Dan J Graham, Ph.D., Katie L Hodgin, M.P.H., M.S., Andrew Ogle, M.S., Charles Heidrick, B.S., Pam Lundeberg, M.A., Department of Psychology

Why am I being invited to take part in this research? You are invited to take part in a research study because you have shown interest in participating in experiments conducted by Colorado State University's Psychology Department. Please read this form carefully and ask any questions you may have.

Who is conducting the study? Dan J Graham, Ph.D., an Assistant Professor, and Katie L Hodgin, Andrew Ogle, Charles Heidrick, and Pam Lundeberg, who are graduate students at Colorado State University.

What is the purpose of this study? The purpose of this study is to learn about your food preferences.

Where is this study going to take place and how long is it going to last? This study will take place in Clark C-12. The study will take roughly 30 minutes to complete.

What will I be asked to do? Participation in this study will involve looking at pictures of foods on a computer and indicating which of these foods you would consume. We anticipate that your involvement will require approximately 30 minutes.

Are there any reasons why I should not take part in this study? Your participation is voluntary. If at any time you would like to discontinue with the research study, you can simply inform the experimenter.

What are the possible risks and discomforts? There are no known risks associated with participating in this study.

Are there any benefits from taking part in this study? There are no benefits to you. Your participation will contribute to the understanding of food purchasing and you may gain insight into the research process.

Do I have to take part in the study? Participation in this study is completely voluntary. You are free to decline to participate, to end participation at any time for any reason, or to refuse to answer any individual question without penalty or loss of compensation. With our eye-tracking technology, if you have hard-lens contacts you may not be able to complete the eye-tracking task, but you can complete the survey portion of the study and will still receive research credit.

Who will see the information that I give? The researchers are the only people that will have access to the data you provide today.

Your information will be combined with information from other people taking part in the study. When we write about the study to share it with other researchers, we will write about the combined information we have gathered. You will not be identified in these written materials. We may publish the results of this study; however, we will keep your name and other identifying information private.

We will make every effort to prevent anyone who is not on the research team from knowing that you gave us information and what that information is.

Your identity/record of receiving research credit (NOT your data) will be available to those personnel who are in need of it.

Will I receive any compensation for taking part in this study?
Participants may receive course credit.

What if I have questions? If you have any questions about this study, you may contact the principal investigators, Dan Graham (dan.graham@colostate.edu), Katie Hodgin (katie.hodgin@colostate.edu), Andrew Ogle (andrew.ogle@colostate.edu), Charles Heidrick (charles.heidrick@colostate.edu), or Pam Lundeberg (pamela.lundeberg@colostate.edu) in the Psychology Department. If you have any questions about your rights as a volunteer in this research, contact Tammy Felton-Noyle, in the Research Integrity and Compliance Review Office, at 970-491-1655.

Your signature acknowledges that you have read the information stated and willingly sign this consent form. Your signature also acknowledges that you have received, on the date signed, a copy of this document containing __2__ pages.

____ ____________________
Printed name of person agreeing to take part in the study Date

____
Signature of person agreeing to take part in the study

____ ____________________
Printed name of person providing information to participant Date

____
Signature of Research Staff

APPENDIX B

Study Protocol

Protocol – Study #26 Eye-tracking and Daily Activities

To find if a participant is signed up for your scheduled session, login to: https://psy.psych.colostate.edu/Research/Spring/researcher/begin.asp

Prepare the room

1. Logon to lab computer: Username: grahamRA   Password:
2. Make sure a consent form is available for the participant to sign (they may also take an unsigned version if they would like)
3. Prepare the demographic survey:
    a. Open the Qualtrics link on desktop. This survey will be completed AFTER the eye-tracking task.
4. Prepare the eye-tracker:
    a. Take lens cap off of eye tracker
    b. Check tracker distance (55 cm from knob to chin rest) [use small thin white measuring tape]
    c. Wipe down chin rest and forehead bar with sterile alcohol prep pads in bottom left desk drawer.
    d. Make sure both computers are on and the host computer (near the window) is logged onto the Eyelink setting (that is the default – you shouldn't need to change anything)

Introduction

1. "Are you here for Study #26 Eye-tracking and Daily Activities?"
[if YES:] "Great, thank you for coming, my name is ___________ and I'll be running the study today. Please have a seat at this computer." [If NO: redirect elsewhere…]
2. "We are interested in people's perceptions and intentions with regard to different daily behaviors, like what foods people choose to eat. Today you will look at several images on a computer and answer some questions about them. It should take about 30 minutes. You will receive a half credit for completing this study."
3. Give participant consent form: "Here is a description of this experiment. It explains your rights as a participant and what you will be asked to do. Please read it now and let me know if you have any questions." [Subjects who refuse to participate are dismissed without penalty.]
4. Collect signed consent form. Offer unsigned form for participant to take.

Running Study

1. "If you do not have any additional questions at this time, we will now begin the first eye-tracking task."
2. Ask about contact lenses (hard contacts won't work – skip eye tracking task and do the survey only; soft contacts are fine and will work with the eye-tracker; glasses will work too. *If calibration is not working*, try adjusting the camera angle up or down

slightly and try again; you can also try asking the participant to tip their head slightly up or down or to open their eyes wider. If calibrating is not working after 5 minutes, please contact me and the graduate students by email. One of us will try to come help. If we cannot make it, continue to try calibrating for 10-15 minutes – if nothing is working at that point, start survey instead.)

3. Test for eye dominance (ask participant to make a circle with their thumb and first finger, hold the circle at arm's length; look through circle to see clock, move circle all the way in to face while seeing clock the whole time. The circle will move toward the face and end up surrounding the dominant eye.)
    a. Open the eyetracking file: (Click on the eyeball icon in upper right corner of desktop to open the program). If a popup window appears telling you that you need to login again (it shouldn't! but just in case), use this information:
        i. Login: GRAHAMLAB1\GrahamAdmin   Password: 4Eyelink.Graham
    b. Enter participant ID number into box that says "Enter EDF Filename" (you can find participant ID number on participant information sheet)
    c. Select condition C, E, or H (the appropriate condition is listed on the participant information sheet)
    d. Enter today's date, the time, and your name in the boxes on information sheet
    e. If anything goes wrong during the experiment, make a note of it on the information sheet.
4. Give big-picture overview of experimental session to participant
    a. We are going to be doing an eye-tracking experiment and you will be looking at different images on the computer in front of you. To make accurate measurements, the eye-tracker needs to know exactly where your eye is at all times. Throughout this experiment you will be resting your chin on the chin rest in front of you, which has just been cleaned. Help participant onto chin rest. It is important to keep your head as still as possible throughout this experiment, so get as comfortable as you can now. The chin rest and forehead rest are there to help.
5. Position camera correctly
    a. Point camera at dominant eye. Have participant cover their non-dominant eye, so you can be sure you are tracking the correct eye.
    b. Push enter twice on participant computer to show eye (enter will also remove the image to show a blank screen); right and left arrow keys to zoom in and out; when zoomed in - turn the lens (gently!) on camera so participant's eye lashes are as clear as possible, then begin fine focusing (step 6).
6. Focus participant's pupil and cornea reflection
    a. Directions to do this are on table next to experimenter's computer (use up and down arrow keys to minimize the amount of black around the edge of the large blue circle – the participant's pupil. And use the + and – keys to minimize the amount of white around the edge of the teal corneal reflection)
7. Give calibration instructions
    a. We will now be calibrating the eye-tracking software to your eye. Please stare at the dot on your screen and move your gaze, but not your head, to wherever the dot goes, but do not try and anticipate where the dot will go before it moves. Does this make sense?

8. Calibrate
    a. Click on "calibrate" button
    b. Space bar begins calibration (if fails, start calibration over). If participant misses one or more of the nine points, use backspace to move back in the calibration to redo the points they missed.
    c. If green "good" message appears on experimenter computer, accept calibration by clicking "accept"
9. Give validation instructions
    a. We will now do a second calibration with the targets around the screen, just like before.
10. Validate
    a. Click on "validate" button
    b. Press space bar to begin (if fails, start over. Again you can use backspace to redo missed points.)
    c. If green "good" message appears on experimenter computer, accept validation by clicking "accept"
11. Explain experiment
    a. We will now begin the experiment. You will need to use the mouse to click on your answers to the questions that will be asked during the study, so please place your hand on the mouse now. You will see a series of foods on the screen and will tell us if these are foods you would choose. If you do your own grocery shopping, please choose the "Yes" button if this is a food you would purchase to eat, or the "No" button if it is not. If you have a meal plan or do not do your own food shopping, please choose the "Yes" or "No" buttons to indicate whether you would *eat* the food. We will ask you to use the mouse to click on one of the three buttons at the bottom: Click on the green "Yes" button if this is a product you would choose. Click on the red "No" button if this is NOT a product you would choose, and select "Not Applicable" if you have a food allergy that would prevent you from ever eating this product." Between each photo will be a short calibration – a target circle will appear somewhere on the screen in between each food screen and when you are looking directly at it, I'll advance you to the next screen. Then you will need to click the mouse to advance to the next photo. Any questions?
12. Begin experiment by clicking on output/record
13. After participant completes eye-tracking task, remove the chinrest and start the survey.
14. Open survey (Qualtrics link in upper right corner of desktop) on the participant's computer:
    a. "Here is a survey containing a few brief demographic questions for you. Please let me know if you have any questions."
15. The final screen the participant sees after completing the questionnaire is the debriefing. This tells the participant what this study was all about and tells them they can ask you any questions they have now. If anyone has questions you do not know the answer to, please provide them my email address: dan.graham@colostate.edu (business cards with my email address are in the upper left desk drawer)
16. Thank participant for coming! "Thank you again for your participation!"

After the Participant has left

1. Close down any open windows on participant computer
2. Assign participant credit through the online psych experiment program
3. Make sure you have completed the participant sheet with your name and today's date and participant times
4. Make sure that everything is put where it belongs and is ready for the next session.