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Effect of front-of-package labels on consumer product evaluation and preferences

Carlyn Oswald, Koushik Adhikari, Anand Mohan *

Department of Food Science and Technology, University of Georgia, Athens, GA, USA

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ABSTRACT

Front-of-Package (FOP) labels highlight important nutrients and help consumers make informed decisions about food purchases. In this study, we investigated consumer comprehension, opinion, and preference associated with two different formats of FOP labels and compared consumer shopping behavior and general trends related to nutrition labeling. Consumer eye-tracking was used for measuring perceived understanding of nutritional information objectively. Results revealed that a color-coded FOP label would garner more attention than a black and white FOP label. Subjects found color-coded FOP labels more straightforward than black and white labels. Participants used the information provided on the FOP for shopping goals. Still, FOPs did not affect objective consumer attention to labels, and labeling schemes did not significantly affect participants' decisions. Participating subjects did use FOP labels instead of the nutrition facts panels. Still, FOP groups scored lower on a nutrition literacy quiz, indicating that their perceived and actual understanding of nutritional information differed. Our findings suggest that subjects pay attention to FOP labels but do not make decisions.

1. Introduction

The US food industry has increased its attention in search of a simpler and attention-grabbing nutritional labeling system to provide clear information about the nutritional content of food products. The marketplace has seen an exponential increase in different use of *front-of-package* (FOP) food labels (Brownell and Koplan, 2011). However, the actual effects of FOP labels on food packaging to convey nutritional information to consumers has remained unclear. The Nutrition Labeling and Education Act of 1990 provide labeling regulations and guidance to the food industry on 'how-to-use' nutrition information and 'claims' on food packages (Institute of Medicine, 2010; Kees et al., 2014).

In recent years, various FOP labels have appeared on food packages with non-standardized and misleading nutritional information (Ikonen et al., 2020). The proliferation of nutrition indicating icons and schemes has fueled the search for developing simple, standardized, and science-based criteria for communicating food products' nutritional content and relative healthfulness (Smith et al., 2014; Bialkova and Trijp, 2010). Comprehension of these food labels is vital in communicating a healthy and nutritious diet and helps consumers recover from chronic illnesses like heart failure and other diseases, including obesity (Nyilasy et al., 2016). The *Nutrition Facts Panel* (NFP) display provides consumers with more detailed nutrient-specific information than the FOP. The FOP label highlights the energy content of ingredients (e.g., saturated fat, sugar, and sodium), including total fat content and amounts per serving. However, many population groups (for example, those with lower incomes and education) find it challenging to understand the nutrient information, mainly as it is currently presented (Campos et al., 2011). Consumers, while focusing on one nutrient, may ignore other problem nutrients (Feunekes et al., 2008) or fully process the information they read (Bialkova et al., 2013, 2014).

In recent years, several new nutrient label designs and display formats have been adopted worldwide. More specifically, nutrient-specific color-coded FOP labels seem more acceptable to consumers than summary-type NFP labels (Grunert et al., 2010). The traffic light is a type of color-coded FOP label that incorporates color schemes to indicate high (red), medium (orange), or low (green) saturated fat, sugar, and sodium content (and sometimes total fat). Nyilasy et al. (2016) found that color-coded nutrition information reduced consumer perception of the healthiness of foods. However, in some studies, this type of label increased consumer ability to find healthier food options and attention to food labels (Campos et al., 2011; Kelly et al., 2009).

Eye-tracking technology has been used to objectively measure eye movements and subsequent consumer behavior across package and label

* Corresponding author. The University of Georgia, Department of Food Science and Technology, 100 Cedar Street, Athens, GA, 30602, USA.
E-mail address: anandmohan@uga.edu (A. Mohan).

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types (Morimoto and Mimica, 2005; Zhang et al., 2007). Attention determines where the eye goes, so monitoring eye movements might effectively describe directed attention (Bialkova and Trijp, 2011). People selectively direct their attention based on top-down factors (such as information that advances their personal goals) or bottom-up factors (such as information or stimuli that stand out in the visual field) (van Herpen and van Trijp, 2011). When shopping, consumers make purchases for various reasons, among them price, familiarity, and dietary habits (Graham et al., 2012). In a research study, some of these variables must be controlled. Manipulating the goal of a subject's shopping trip, a top-down factor reveals whether varying goals (i.e., shopping for the healthiest item versus shopping for the preferred item) changes attention.

Experiments with nutrient-specific FOP labels evaluated in real situations have not been empirically assessed. Additionally, documented research in understanding nutritional information using objective and subjective measures is also limited. Little information is available on how much consumers pay attention to labels, and also, the key determinants that affect label attention are not known. There is a knowledge gap evaluating the effectiveness of different nutrient-specific FOP labels, consumer awareness and preference, and how well consumers understand these labels to make sure that consumers can understand nutritional information. Limited information is available on measuring the effectiveness of FOP label schemes using human eye tracking as an objective measure of visual attention.

The primary focus of this study was to investigate the effectiveness of two different FOP labeling schemes (color-coded and black and white) using human eye tracking. The objective of this study was to compare subjective and objective measures of how well consumers understand two nutrient-specific FOP labels along with their symbols. This study used eye-tracking technology, visual search, choice, nutrient literacy quiz, and self-reported survey questionnaire. This study evaluated the effectiveness of nutrient-specific FOP labels and FOP symbols on consumer attention to brands and how FOP label display information affected consumer purchasing behavior.

2. Materials and methods

The protocol used in this study was approved by the Institutional Review Board (IRB; STUDY00005146) of the University of Georgia (Athens, GA, U.S.A). Before joining the study, each participant was given a consent statement summarizing the time commitment, incentive, and procedures involved in the study. A signed copy of the consent statement was retained.

2.1. Sensory subject selection protocol

Participants completed the study in the Food Science Department building at the University of Georgia, Athens campus. Each participant was invited into a private room and seated in front of a computer with dual monitors. One monitor was positioned below the monitor with the Tobii X2-60 eye tracker (iMotions A/S, Copenhagen, Denmark). The other monitor displayed the survey created in Qualtrics (Provo, Utah, USA). After signing the consent form, the participants were led through a short five-point calibration test in which participants followed a dot with their eyes as it bounced around the screen.

The experiment was divided into three parts: Task 1, Task 2, and survey questions. For Task 1, participants were asked to read instructions on the computer screen to choose three food items in a simulated grocery shopping scenario. Each participant was given a goal for this task: either to shop as they usually do (control), pick the healthiest food, or like the lowest sodium food. Each goal group was further separated into three different label conditions. The participant was either not exposed to an FOP label (just given the NFP) or exposed to one of the two FOP labels (color or black & white). To minimize the influence of any personal dietary restriction on choice, all participants were told they were shopping for a friend with no dietary restrictions or food allergies. Participants in the two experimental groups were also instructed that this friend wanted the food that was either lowest in sodium or healthiest. Participants were not given a time limit to make their selections. After scrolling through the options, making their choices, and answering a few survey questions, the participants moved to Task 2 (Fig. 1).

For Task 2, participants were shown NFP label generated with Genesis R&D software (Salem, OR, USA) with no accompanying packaging and were told it was a label for a package of donuts. For Task 1 participants (in the FOP group), either a color or black & white was added next to the NFP, matching the label they saw previously during screening. Participants then completed the questionnaire and remaining survey questions before being thanked for their time and allowed to leave.

2.2. Participants

The participants' recruitment procedure was reviewed and approved by the University of Georgia, Institutional Review Board (UGA-IRB). The flyer was published and distributed using emails, social media, and in-person with detailed directions for program participants (minimum 18-years or older) to a website that would allow them to sign up for a 15-min time screening slot to participate and complete the study. To participate in the study, participants were asked not to use bifocal, trifocal, or progressive lenses to see correctly. Additionally, participants with eye surgery (such as corneal, cataract, or intraocular implants) or eye movement abnormalities (such as lazy eye, strabismus, or nystagmus) were excluded from the study. A total of 304 participants (18–62 years) were enrolled. Due to an error within the software that required the experimenter to count and tally fixations, eye-tracking fixations were calculated for only 200 participants in each area of interest. Because some participants did not follow the experimental directions, only 189 were analyzed for Task-1. The percent distribution of the participants for this task is presented in Fig. 2. For Task-2, 287 participants were selected, and approximately 17 participants were eliminated from this analysis because of an error in the survey.

2.3. Food products and packaging

In Task-1, three different brands of macaroni and cheese, 0% fat vanilla Greek yogurt, and chewy granola bars were used (a total of 9 products). Past research has used mock food packages, so real brand name and familiarity did not influence choice (18). In this study, existing brands were used to increase the study's external validity and make the experience more realistic for participants. The three products chosen for each food category comprised a well-known national brand, store brand, and organic. These food categories were chosen because they typically have both fronts of package and back of package labels or health claims (unlike unpackaged foods like fruits or vegetables). In addition, previous research has shown that shoppers look at nutrition information differently for products in different categories, tending to look at nutrition information more on products that are generally regarded as healthy (Grunert et al., 2007). Therefore, the three product types differ in the overall perception of healthiness and include both snack and meal categories. Packages were purchased at a local grocery store (Athens, GA, USA), disassembled, and photocopied flat. We photographed pictures of the front and back for yogurt packages straight on. All images were edited using Adobe Photoshop. The essential integrity of the box was maintained, but some health claims and extra advertising were removed or cropped. Claims like "No artificial flavors" and "No preservatives" were retained for product categories. The macaroni and cheese panels included nutrition facts for the product "as prepared," in addition to the contents as packaged. The "as prepared" portion was edited out, so only the "as packaged" part of the NFPs remained to prevent any possible confusion about which column should be examined

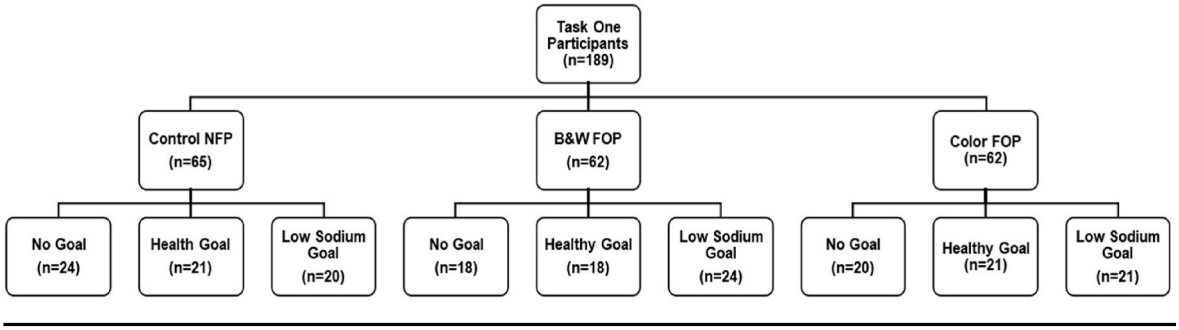

Fig. 1. Distribution, by group, of participants who participated in Task One for eye tracking.

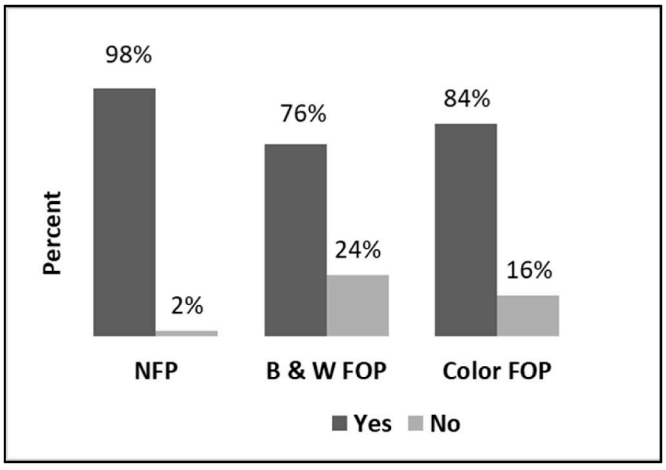

Fig. 2. Yes/No bar graph illustrating whether participants had previously seen the label according to the assigned condition. NFP = Nutrition Fact Panel; B & W FOP = Black and White Front of the Package; Color FOP = Color-coded Front of the Package.

by the participants.

2.4. Front-of-Package labels

The Grocery Manufacturers Association provided a template of the "Facts Up Front" label for this research; the template was used as the framework for testing FOP labels (http://www.factsupfront.org). One experimental group was assigned an FOP label in black & white. This label was mirrored the "Facts-Up-Front" design, except that it displayed only the calories, saturated fat, sodium, and sugar, without any "nutrients to encourage," a feature allowed with "Facts Up Front." The other experimental group was offered the same but color-coded label. In the color-coded FOP label, nutrients were classified as red, yellow, or green based upon the United Kingdom Department of Health color coding label criteria, as described in Table 1.

Table 1
Criteria per 100 g of prepared food adapted from UK Department of Health color coding label guidelines.

Criterion	Low	Medium	High
Color Code	Green	Yellow	Red
Saturated Fat	≤1.5 g	>1.5 g to ≤5.0 g	>5.0 g
Total Sugar	≤5.0 g	>5.0 g ≤ 22.5 g	>22.5 g
Sodium	≤300 mg	>300 mg to ≤1500 mg	>1500 mg

2.5. Eye tracking measures

Images of three packages of each food type were arranged on a grey background, chosen to reduce eye stress caused by the high contrast colors of black or white (Yantis, 2000). Fourteen Areas of Interest (AOIs) were defined for each product package: brand name, FOP label, additional claims, serving size, calories, fat, sodium, carbohydrates, sugar, fiber, protein, ingredient statements, vitamins/minerals, and images. According to Tobii Pro Studio software, raw gaze point data was translated to larger, attentional fixation points (iMotions A/S). A screen recording was saved for each participant, allowing the experimenter to replay each participant's experience. This recording displayed the fixation points appearing and disappearing as the participant scrolled through the items. The experimenter played each participant's screen recording to enumerate the data, advancing once every frame (every 333 ms). One fixation typically lasts 50–600 ms (Taylor and Wilkening, 2008); therefore, watching the recordings frame by frame was the most effective method of capturing all fixations. The number of times a participant had a fixation point located on an AOI as they scrolled through each of the three options was recorded. For analysis, the fixations on the FOP label were not separated into the four components displayed. For instance, if the participant looked at the sugar component on the FOP label, it was marked as a fixation on the FOP, not sugar-FOP. In addition, the fat AOI included any focus on total fat, saturated fat, and trans-fat, as well as polyunsaturated and monounsaturated fats, which are optional but may have been included on the nutrition facts panel. Multiple fixations could be recorded in the same frame. If a participant looked at the same AOI for more than one frame, the count increased by one "fixation" per frame. As the subject spends looking at the same spot for a fixed amount of time, the fixation count increases. In addition to the total count of fixations as the subject's eye bounced from one AOI to the next, this count gave a reasonable estimate of the amount of time spent on each AOI.

2.6. Post-eye tracking survey

Participants completed a 27-question survey after the tasks. For Task-1, participants were asked to select which options they would purchase, how often they shop for these food items, and how much they like them. Participants were briefed on the definitions/descriptions of both NFP and FOP labels. Then, participants were asked to mark what criteria they used in making their choice. Each participant was allowed to select any or all that applied from the ingredient statement, brand name, look of the package, NFP label, FOP label, and familiarity. Participants were shown the image of the product label and asked questions that would indicate their health literacy, such as "How many grams of total fat would be in 6 donuts?" and "Is this food item low, medium, or high in fat?". Participants were asked to rate the donuts on a scale from "very healthy" to "not at all healthy." Healthiness was defined in the survey as being a food that is lower in nutrients that contribute to heart diseases and weight gain.

Nine Likert-scale questions were asked to illustrate consumer opinion of NFP and FOP labels, preferences, and use. The participants were also asked if they had ever seen this label before. They were asked where and if the label helped improve their understanding of the nutritional content. Participants in the NFP label group had questions referring to NFPs, while participants in the two FOP label groups received the same questions but referred to FOPs. All participants were asked to identify the extent to which they believe they fully understand the nutrition facts panel from "No, not at all" to "Yes, completely." When asked how helpful they would find FOP and NFP labels in making a product choice, subjects chose an answer anchored from "very helpful" (1) to "not at all helpful" (5). Lastly, participants were asked questions about their dietary and grocery shopping behaviors, what specific nutrients and factors (such as price, convenience, and organic) they find most important when choosing a food item, and how healthy they perceive themselves. The survey ended with demographic questions about age, gender, race, and highest education level completed.

2.7. Statistical analysis

Data were analyzed using STATA (Stata Corp., College Station, TX, USA). The fixation count data was used as either a mean count or as the mean percentage, calculated from the number of fixations associated with a particular AOI out of the total fixations for that group. Descriptive statistics were calculated to analyze the data, differences between groups (non-parametric and parametric). Participants were placed into complete randomized experimental groups. One-way ANOVA and Pearson's Chi-square tests were conducted to test for significant differences among goal and label groups for the distribution of age, gender, education level, and ethnicity. Tests were performed for participants whose data were used for Task 1 (n = 187) separated by goal (no goal, health goal, and sodium goal), and Task 2 (n = 285) separated by label (no label, color-coded FOP, and black & white FOP).

One-way analysis of variance (ANOVA) was used to determine any statistically significant differences among the mean values of two or more independent groups. A two-way ANOVA was performed to compare two or more independent categorical groups on a continuous dependent variable, in this case, to differentiate both food type and goal type for effects on the mean number of fixations in each AOI. Pearson's Chi-Square Test, which tests sets of categorical variables to evaluate how likely differences occur by chance, was used to analyze the larger sets of data with no dependent variables. The data were analyzed at the significance level of 10% ($p \leq 0.10$).

3. Results

3.1. Demographics

Of the participants chosen for analysis for Task-1, 66% were women, and 34% were men; for Task 2, 67% were women, and 33% were men. The Task-2 data set showed significant differences in age between label groups at F (2, 283) = 2.44, p = 0.089. On average, subjects rated their health and overall diet as being either "average" or "good" (health = 3.77 ± 0.80; diet = 3.44 ± 0.88). More than half (58%) reported that they were the primary shopper in their household. Additionally, 40% of participants indicated that they shop for someone in the household with dietary restrictions, food allergies, or strict dietary needs. Nearly a third of the participants reported reading food labels most of the time, and a quarter indicated that they always read food labels when looking at a food product for the first time.

To evaluate what product factors are most important to consumers during grocery shopping, mean ratings (from 0 to 10) were collected from the survey data of all participants for eight common purchasing factors. Participants were separated into four age groups (18–23, 24–30, 31–40, and 41–62) to test if the mean rating assigned by each age group was significantly different across different age groups (Table 2).

Age groups showed no significant difference in mean ratings for any grocery shopping factors, except for price [(300) = 5.94, $p < 0.001$] and convenience [(300) = 2.83, p = 0.04], with price being substantially different and convenience being moderately different across age groups. The taste was rated as most important in all age groups. Those participants between 18 and 30 years old (the first two age groups) ranked product price as the next highest in importance. In contrast, older subjects, ages 41–62, rated nutritional value as the next highest priority. Younger subjects also rated convenience higher than older subjects.

3.2. Product relevance

To test the relevance of the product categories, participants were asked how often they purchased and how much they liked each food category: macaroni and cheese, yogurt, and granola bars. Approximately three-quarters of the participants reported liking macaroni and cheese, yogurt, and granola bars. Though most participants enjoyed these foods overall, said purchases were lower, ranging from 25% to nearly 50%.

3.3. Effect of label type and goal condition on fixation count

The mean fixation counts were calculated for all product categories for each shopping goal group (no goal, health goal, low-sodium goal) to observe time spent on each AOI (Table 3). On average, subjects with the low-sodium goal spent the least amount of time on each AOI, with a range of 114.9–136.7 fixations for all three food product categories. The subjects given the health goal spent the most extended amount of time on each AOI (range: 173.7–201.1 fixations). The participants with no plans were between the sodium and the health goal groups.

To compare the effect of goal type on the mean percentage of fixations on yogurt, granola bars, and macaroni and cheese, data were analyzed for the 14 separate areas of interest (Table 4). Goal conditions (e.g., health and sodium goals) exhibited significant interaction on all AOI fixation percentages except serving size and calories. People's time

Table 2
Rated importance (0 being not at all important, 10 being extremely important) when asked to assign importance of factors when picking a product during grocery shopping.

Factors	Age Group[a]				Total (n = 304)	One-Way ANOVA		
	18-23 (n = 147)	24-30 (n = 88)	31-40 (n = 47)	41-62 (n = 22)		df	F	Prob > F
Price	8.39	8.08	7.11	7.68	8.05	3, 300	5.94	0.00***
Convenience	6.60	6.13	5.47	5.86	6.23	3, 300	2.83	0.04**
Organic/Natural	4.09	4.81	5.06	4.77	4.50	3, 300	1.95	0.12
Special Dietary Requirements	4.61	4.44	5.79	4.14	4.71	3, 300	1.73	0.16
Nutritional Value	7.19	7.47	7.74	8.14	7.42	3, 300	1.71	0.17
Taste	8.76	8.60	8.60	8.86	8.70	3, 300	0.34	0.78
Packaging/Look of Package	4.57	4.08	3.89	4.59	4.33	3, 300	1.12	0.34
Brand Name/Familiarity	5.61	5.20	4.64	5.77	5.35	3, 300	1.72	0.16

** Significance at $p < 0.05$; *** Significance at $p < 0.01$.
[a] Represents participants age group from 18 to 62 years.

Table 3
Average number of fixations on each area of interest separated by product type and goal group.

Areas of Interest (AOI)	No Goal (n = 64)			Goal Condition			Sodium Goal (n = 64)		
				Health Goal (n = 60)					
	Greek Yogurt	Granola Bar	Mac & Cheese	Greek Yogurt	Granola Bar	Mac & Cheese	Greek Yogurt	Granola Bar	Mac & Cheese
Name	39.5	34.8	28.6	38.1	32.4	29.1	26.2	19.1	22.3
FOP (if applicable)	21.5	9.8	5.9	23.7	10.8	5.6	21.3	10.1	11.2
Additional Claims	11.8	3.7	25.9	11.7	2.5	24.5	7.6	1.1	15.3
Ingredients	14.4	16.6	12.7	16.2	18.6	15.3	8.3	2.1	3.5
Serving Size	7.2	5.2	5.9	7.2	7.4	12.0	6.2	5.6	7.2
Calories	8.9	6.2	10.0	9.4	10.7	17.5	7.4	5.2	8.2
Fats	13.6	11.1	12.8	16.8	24.0	24.9	9.9	11.5	13.2
Sodium	6.9	3.9	4.6	9.8	9.2	10.2	11.2	8.7	8.6
Total Carbohydrate	5.4	3.7	5.3	8.4	10.8	12.2	2.2	8.4	10.3
Fiber	3.0	2.8	4.8	4.7	6.9	6.0	1.3	4.7	5.3
Sugar	4.5	3.2	3.0	6.6	5.6	4.9	1.9	3.8	3.5
Protein	5.0	3.7	3.8	8.1	7.3	6.4	2.1	3.9	5.1
Vitamins/Minerals	5.1	2.3	5.0	9.8	6.6	10.8	6.8	2.7	6.9
Images	3.3	24.0	24.7	3.3	21.5	21.7	2.5	11.2	16.0
Total Fixations	150.2	130.9	153.0	173.7	174.4	201.1	114.9	97.8	136.7
Total/Group	434.1			549.3			349.4		

Table 4
Mean proportion of fixations on fourteen areas of interest for each food product by goal condition.

Areas of Interest (AOI)	No Goal (n = 64)			Goal Condition						One-Way ANOVA		
				Health Goal (n = 60)			Sodium Goal (n = 64)					
	Greek Yogurt	Granola Bar	Mac & Cheese	Greek Yogurt	Granola Bar	Mac & Cheese	Greek Yogurt	Granola Bar	Mac & Cheese	df	F	Prob > F
Name	38.39	36.87	25.53	32.47	24.99	20.00	27.10	23.07	18.06	8, 179	10.88	0.00***
FOP[a]	15.98	6.31	4.29	15.11	6.26	2.79	19.57	9.46	7.01	8, 179	10.01	0.00***
Additional Claims	8.97	3.00	18.58	7.08	1.81	14.59	7.27	1.22	10.79	8, 179	49.96	0.00***
Ingredients	7.20	8.24	5.14	7.22	7.44	6.01	8.49	2.97	4.00	8, 179	2.07	0.04**
Serving Size	4.27	3.25	3.17	3.70	3.91	4.81	4.68	3.74	3.74	8, 179	0.91	0.51
Calories	5.31	3.82	4.97	4.32	5.23	6.75	6.61	4.37	5.20	8, 179	0.99	0.45
Fats	8.36	5.89	6.63	8.99	11.73	10.14	8.45	11.01	9.71	8, 179	3.61	0.00***
Sodium	3.91	1.94	2.24	5.12	4.56	3.91	9.47	8.26	6.17	8, 179	14.16	0.00***
Carbohydrate	2.41	1.95	2.36	4.64	4.83	4.55	1.52	9.07	7.85	8, 179	17.01	0.00***
Fiber	1.40	1.50	1.81	2.66	3.25	2.55	0.99	4.79	4.13	8, 179	9.11	0.00***
Sugar	2.16	1.70	1.18	3.31	2.53	2.10	1.41	4.22	2.86	8, 179	6.13	0.00***
Protein	2.12	1.92	1.65	3.50	3.36	2.44	1.46	4.38	4.06	8, 179	5.02	0.00***
Vitamins/ Minerals	2.57	1.30	2.47	4.34	3.01	3.65	6.40	3.36	5.39	8, 179	7.30	0.00***
Images	2.94	24.71	21.59	2.83	19.26	16.69	2.60	13.01	13.18	8, 179	32.38	0.00***

** significance at $p < 0.05$; *** significance at $p < 0.01$ measured using one-way ANOVA test.
[a] "No label" group was excluded from FOP two-way ANOVA test.

spent on the AOIs differed significantly among the three products for each goal type. For example, participants spent much higher on the AOIs on FOPs, ingredients, fats, claims, and sodium content and very little on the AOIs on fiber and sugar content, etc. Overall, the observed difference was not as vital for ingredients, serving size, and calories, with the latter two showing no significance.

To test for statistical differences between the mean numbers of fixations on each AOI based on label type, a one-way ANOVA was performed on the 14 AOIs (Table 5). Calories ($p = 0.0626$), fats ($p = 0.0766$), sodium ($p = 0.0087$), and vitamins/minerals were significantly different ($p = 0.02$), with calories and fat showing weak significance and sodium and vitamins/minerals showing more decisive relevance.

3.4. Consumer opinion of FOPs and NFPs

A Likert scale ranging from strongly disagree (1) to strongly agree (5) was created for participant opinions of FOP and NFP labels (Table 6). Approximately half (47.53%) of participants in the FOP groups strongly agreed or somewhat agreed that FOP labels did not provide enough information. Most subjects preferred products with NFP labels (90.2%).

Table 5
Average number of eye-tracking fixations on areas of interest by the nutritional label groups.

Areas of Interest (AOI)	Label Type			One-way ANOVA		
	No Label (n = 585)	Color (n = 558)	BW (n = 558)	df	F	Prob > F
Name	10.61	9.76	9.47	2, 1700	2.86	0.06*
FOP[a]	–	5.08	3.83	1, 1115	6.60	0.01***
Additional Claims	4.35	3.56	3.59	2, 1700	2.85	0.06*
Ingredients	3.40	4.47	3.99	2, 1700	1.48	0.23
Serving Size	2.84	2.17	2.01	2, 1700	4.96	0.01***
Calories	3.94	2.68	2.53	2, 1700	11.78	0.00***
Fats	6.27	4.67	4.15	2, 1700	11.85	0.00***
Sodium	3.69	2.31	2.04	2, 1700	21.43	0.00***
Total Carbohydrate	2.97	2.28	2.05	2, 1700	6.58	0.00***
Fiber	1.80	1.16	1.38	2, 1700	6.94	0.00***
Sugar	1.57	1.25	1.24	2, 1700	3.32	0.04**
Protein	2.03	1.68	1.28	2, 1700	7.66	0.00***
Vitamins/ Minerals	2.86	2.02	1.25	2, 1700	17.24	0.00***
Images	5.14	4.37	4.67	2, 1700	2.22	0.11

significance at $p < 0.05$; * significance at $p < 0.01$ according to one-way ANOVA test.
[a] "No label" groups were excluded from FOP two-way ANOVA test.

Many participants (85.9%) thought food packaging did not contain too much nutritional information, and a similar number (83.9%) thought a single standardized nutrition labeling format would be helpful.

3.5. Subjective vs. objective comparisons

Subjective and objective comparisons were determined to evaluate how participants rated themselves on the importance of nutrients compared to their measured attention to the nutrients on NFPs (Table 7). The three groups assigned no specific shopping goal were selected for this analysis because their data appear similar to actual, individual shopping experiences. The survey question asked participants to give a level of importance to the nutrient, not how long or intently they looked at the nutrient information. Therefore, scored significance cannot be compared directly to the eye-tracking data. However, the assigned importance can be examined in parallel with the percentage to indicate the time and attention participants spent on each part of the NFP compared to the level of importance they assigned to it.

In the control and FOP groups, participants said sugar was significant and had the highest assigned score of all nutrients. However, this was not reflected in the eye-tracking data; sugar was only viewed 6.6% (control) and 6.0% (FOP) of the time. Moreover, fats were considered 38.3% (control) and 34.4% (FOP), which was the highest of all AOIs, although participants in the control group identified fat as having far less importance. The score assigned to fats varied from 4.9% (control) to 6.5% (FOP), with 4.9% being the lowest average assigned a score for all nutrients. On the other hand, participants in the FOP groups ranked each nutrient higher than the control group.

Table 7
A comparison of Self-Reported importance of individual nutrients with the FOP labels. The participants asked to pick an item with no particular nutritional goals either given or provided on the label type on packaging.

Nutrients	Label Type			
	Control (n = 24)		FOP[a] (n = 40)	
	SR Importance[b], %	Eye Tracking[c], %	SR Importance[b], %	Eye Tracking[c], %
Calories	6.3	23.7	7.2	25.0
Sugar	7.0	6.6	7.7	6.0
Protein	5.8	5.9	6.8	7.6
Fiber	5.0	5.5	5.3	5.8
Fats[d]	4.9	38.3	6.5	34.4
Sodium	5.5	12.6	5.9	12.3
Carbohydrates	5.3	7.5	5.9	8.7
FOP Average[e]	5.8	–	6.8	–

[a] FOP column included data from both color and black and white FOP groups.
[b] SR = Self-Reported importance of a nutrient when choosing a food item was rated on a scale of 0–10 (0 = not at all important, 10 = extremely important).
[c] the percentage a participant looked at the stated nutrient out of the total times they looked at a nutrient.
[d] Though the survey asked to rank importance of saturated fat, and trans-fat, these values were averaged in order to compare to the eye tracking data.
[e] The average importance of calories, sodium, fat, and sugar.

Table 6
Consumers' opinion of NFP (n = 102) and FOP (n = 202).

Statement[1]	Label	Strongly Agree	Somewhat Agree	Neither Agree/ Disagree	Somewhat Disagree	Strongly Disagree
The **Label** is easy to find on food packaging	NFP	70.6%	24.5%	1.0%	3.9%	0.0%
	FOP	63.9%	29.2%	2.0%	4.5%	0.5%
Label is easy to understand	NFP	30.4%	43.1%	7.8%	16.7%	2.0%
	FOP	50.0%	41.1%	4.0%	5.0%	0.0%
I find everything I need on the **Label**	NFP	21.6%	37.3%	14.7%	25.5%	1.0%
	FOP	10.4%	17.3%	11.4%	40.1%	20.8%
There is not enough information on the **Label**	NFP	2.9%	27.5%	30.4%	28.4%	10.8%
	FOP	17.3%	30.2%	23.8%	19.3%	9.4%
Food Packaging contains too much nutritional information [a]	NFP	1.0%	6.9%	4.9%	47.1%	40.2%
	FOP	1.5%	5.0%	8.4%	36.1%	49.0%
I prefer products with a **Label**	NFP	62.8%	27.5%	8.8%	1.0%	0.0%
	FOP	24.8%	26.2%	37.6%	9.4%	2.0%
There should be a single standardized nutrition labeling format [a]	NFP	57.8%	27.5%	8.8%	4.9%	1.0%
	FOP	50.0%	33.2%	11.4%	4.0%	1.5%
The **Label** is believable and trustworthy	NFP	20.6%	36.3%	23.5%	17.7%	2.0%
	FOP	12.9%	28.2%	26.2%	26.2%	6.4%
I would use **Label** when making a product choice	NFP	49.0%	33.3%	12.8%	4.9%	0.0%
	FOP	13.4%	39.1%	11.4%	24.8%	11.4%

[1]Questions were asked to both label groups (NFP and FOP) with same wordings.

Pearson's chi-square test was used to test if consumers paid more attention to the colored label than the black and white label. No relationship was found between FOP label type and FOP label fixations [$\chi^2(1, n = 40) = 2.10$, $p = 0.147$]. To investigate the self-reported recollection of nutrition labels, participants were asked on the survey whether they had seen an NFP or FOP label (Fig. 3). Each label group was asked about the label they saw during the study. No FOP labels were provided to the control group, just the NFP label. Yogurt and granola bars were already packaged as prepared, so the nutrients were divided by their serving size weight and multiplied by 100. To get the fully prepared weight of one serving for the macaroni and cheese, the product was prepared without any extra ingredients (such as butter and milk), weighed, and then divided by the number of servings in the box.

Because NFPs are required on all food packaging, it was assumed that participants have some prior knowledge of nutritional labeling (NFP and/or FOP). Therefore, we investigated only FOP groups to discover when subjects reported seeing the assigned FOP label (Fig. 4). Most participants said they had seen the FOP label on the food package.

3.6. FOP label effect on perceived healthiness of products

Participants may look at FOP labels in general or the nutrients displayed on FOP labels when searching for healthy foods, so the groups assigned to find the most nourishing product were further analyzed. The percentage of participants who either looked at the FOP (for groups given the FOP) or looked at the nutrients found on the FOP (calories, sodium, sugar, and saturated fat) at least once were tabulated (Table 8). Then, a Pearson's chi-square test was conducted to test the relationship between label groups and product types.

Participants showed a significant difference found between label types [$\chi^2(4) = 6.94$, $p = 0.03$) for granola bars and considerable difference between label types [$\chi^2(4) = 18.66$, $p < 0.001$] for yogurt. Overall, participants looked at FOP labels for granola bars and yogurt most often. Without the FOP, participants looked at calories, sodium, sugar, and fat only about half the time. Participants looked at these nutrients least when choosing macaroni and cheese. A significance was identified between quiz scores in investigating if adding either color or black and white FOP label helped participants score higher on the donut quiz. Participants given no additional FOP label scored the highest, and those given the black and white FOP label scored the second highest. Participants with the colored FOP label scored the lowest.

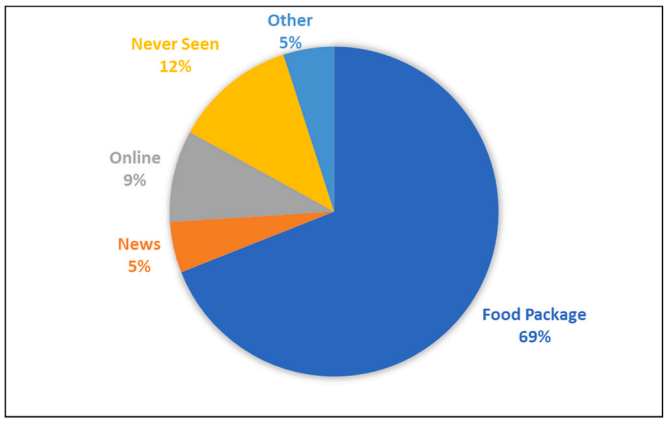

Fig. 4. Pie chart summarizing where participants had seen an FOP label.

Table 8
The percentage of participants in each label group asked to choose the healthiest option in Task 1 who fixated on FOP nutrients (calories, sodium, sugar, and saturated fat) at least once for the three food types.

Option	Label Group				
	No Label (n = 21)	Color (n = 21)	BW (n = 18)	χ^2	Prob>χ^2
Yogurt	48%	100%	89%	18.66	0.00***
Granola Bar	57%	86%	89%	6.94	0.03**
Mac & Cheese	57%	67%	83%	3.11	0.21

** significance at $p < 0.05$; *** significance at $p < 0.01$.

3.7. Effect of FOP label on product choice

The choices participants made in Task 1 were compared across label conditions (Table 9) to see if adding color or black and the white label had any effect. There were no significant observable differences in the choice between label groups for any product (see Table 9). This indicates that labels did not affect choice. To investigate how the FOP label affects choice when there is a clear, correct choice, the sodium goal group was further examined.

In all three products, one choice had less sodium than the others; sodium for that choice was listed on the NFP and FOP with a lower numerical value. In this case, the low sodium answers were "C" for

Fig. 3. Example of packaging seen by participants for Task One. This package was one of three that were displayed on the same page, allowing the participant to scroll back and forth between the three options. For the Great Value brand Macaroni & Cheese (package A), saturated fat appeared red and sodium and total sugars appeared yellow; Kraft brand Macaroni & Cheese (package B) saturated fat and sugar appeared in the same blue color; and Annie's brand Macaroni & Cheese (package C) saturated fat and sugar did not appear in the FOP.

Table 9
Participants in Task 1 choosing option A, B, or C of each food type within each label condition.

Label Group	Yogurt			Granola Bar			Mac & Cheese		
	A	B	C[a]	A	B[a]	C	A	B	C[a]
Control	0.20	0.16	0.64	0.21	0.42	0.36	0.28	0.26	0.45
Black & White	0.28	0.18	0.55	0.32	0.34	0.34	0.32	0.27	0.41
Color	0.24	0.16	0.60	0.025	0.41	0.34	0.31	0.20	0.49

[a] The lowest sodium option of the three choices.

yogurt, "B" for granola bars, and "C" for macaroni and cheese (Fig. 5). Most participants picked the lowest-sodium option if that was their goal in the experiment. The control group chose the low sodium yogurt option most often (91%), and the group with black and white FOP labels picked the low sodium granola bar (73%) and macaroni and cheese (76%) most often.

4. Discussion

The primary purpose of this study was to investigate if consumer comprehension, opinion, and preference were affected by two different schematic layouts of FOP labels. In addition, this study assessed if manipulating top-down factors, such as a shopping goal, would change how well consumers use these labels during purchasing at retails. Lastly, the study evaluated consumer shopping behavior, attention to nutritional labeling during grocery shopping, and how nutrition labeling can help consumers choose appropriate food products.

Color-coded FOP labels should garner more attention from consumers than black and white FOP labels. Comparing the average number of fixations per AOI by label type revealed that color-coded FOPs are more effective than black and white FOPs. Our findings suggest that most participants ignore FOP labels on food packages during grocery shopping. Participants viewed NFP labels for information on calories, fat, and sodium content more often than the color-coded and black and white FOP labels.

Empirical attention to nutrient-specific information on food labels shows that study participants were driven more by signage on the package to view FOP than NFP labels. Our findings align with previous research (Becker et al., 2015), indicating that consumers look at FOP labels, not NFP labels, for nutrient information. The study results suggest that consumers use the information on the FOP labels without any preference for color-coded FOP labels.

There was a preferential view of nutritional information on food packages. Participants viewed half the time only those nutrients (calories, sugar, fat, and sodium) on the FOP label that they were concerned for certain types of food products. For instance, the study participant did not view the sodium content on the FOP label for granola bars. Similarly, they did not consider the sugar for macaroni and cheese or fat in yogurt. Likely, those nutrients may not be of concern in those food products. For certain food groups like yogurt and granola bars, participants viewed all four nutrients (calories, sugar, fat, and sodium) on the FOP label compared with the control group. It is evident from this study that consumers find FOP labels easier and simpler to read nutrients on food packages. However, to be effective, nutrient and product-specific FOP labels must be designed to capture consumer attention and promote positive healthfulness nutrient information.

In this study, participants choose the product based on perceived taste without preference for nutritional content or FOP labels. For example, participants viewed macaroni and cheese as comfort food, which is not traditionally perceived as healthy.

Such consumer attitudes and behaviors towards comfort food or selective food for perceived taste could weaken the message of an FOP nutrition label intended to lead consumers to choose healthier foods. Participants in FOP groups were expected to score better on the donut nutrient literacy quiz, indicating a higher understanding of the nutrition facts (Mozaffarian, 2016). However, both FOP groups scored significantly lower than the control group, with the color FOP group performing the worst. These findings indicate that FOP labels did not increase nutrition understanding and that the presence and color-coding of the label may confuse consumers rather than help. In addition, FOP groups did not rate the donuts as significantly different in perceived healthiness. This indicates that the presence of an FOP label does not change the perceived healthiness of a product. However, this concept should be tested with other food packages and food types to validate our results.

An FOP label should help participants choose appropriately when given a nutrient-specific goal. We found significant differences in the proportion of AOI fixations between goal group and product type. This confirms that viewing behavior varies for different product categories and shopping goals. However, in an ideal comparison, all packages would have the same design to remove unintentional variables. Previous research has found that components located at the top of the nutrition

Fig. 5. Product options A, B, and C were offered to participants during the eye tracking experiment.

facts panel are viewed most often (Graham and Jeffery, 2011), with calories and serving size viewed only 4.6% of total fixation time. Another study (Bialkova et al., 2013) reported that consumers are more likely to rely on bottom-up factors like images and packaging design when no specific health goals are present.

Most consumers prefer FOP labels on food packages (Talati et al., 2016). However, whether consumers would use FOP labels when making product choices remains open. Consumers are open to having an FOP label on the package and can understand them, but until a single standardized format is created, using these labels may be limited. In terms of trends, consumers' age may significantly affect the importance of price and convenience when purchasing food products, with both factors being more important to younger age groups. The cost was not included in this study as another purchasing decision factor. However, this would be interesting in future studies to investigate how age differences interact with price and label preference. Emphasizing nutrients by placing them on the package front will affect when nutrient components are essential (Kuvykaite et al., 2015).

Approximately 75% of participants reported seeing the black and white FOP label, while 84% reported seeing the color-coded FOP label, with most reporting seeing these labels on a basic food package. However, the color-coded FOP label does not exist; it was created solely for this research study. Though similar labels appear on food packages in the U.K. (Traffic Lights Labels), we do not think many consumers shopping in the U.S. market have seen them. We believe the high proportion of "yes, I have seen this label before" may contain false positives. Though a "Front-of-package Label" was clearly defined within the survey, some confusion may have remained.

5. Conclusions

The food industry has increased FOP food labels over the years, leaving the FDA scrambling to develop standardized, science-based criteria for an FOP food label, which is mandated and regulated on all food packaging. This study, which investigated two FOP labels (one that mirrors a label from the FDA and one that reflects the most popular FOP label in the U.K.), is timely. Few studies in the US have investigated FOP labels through eye tracking as an objective measure of visual attention. In addition, few studies have investigated adding a shopping goal to manipulate variables in shopping. Results indicate that FOP labels did not affect choice, product evaluation, or nutrition knowledge.

Task 1 of the Experiments involved manipulating shopping goals (preference goal, general health goal, or nutrient-specific) and labeling schemes (NFP/Control, color FOP, and black & white FOP) to evaluate how shopping intention and displayed information affect behavior. Task 2 extended the first experiment to investigate how these labeling schemes affected scores on a short nutrition knowledge questionnaire.

However, participants did look at FOP labels and used what they saw on the label as a reference to nutrients they should find important. Because FOP labels had so little effect on consumers while reading labeled information, FOP is likely to provide only supplemental information to consumers' choices. Consumers believe that the FOP label is easy to understand, but more educational campaigns may be needed to increase comprehension. Although the black and white FOP label group achieved a higher score in the nutrient literacy quiz, we do not have sufficient data to conclude that this label is recommended over the color FOP label. This study was based on a relatively small number of product types with a minor participant pool. More research is needed.

CRediT authorship contribution statement

Carlyn Oswald: Conceptualization, Methodology, Investigation, Writing – original draft. **Koushik Adhikari:** Methodology, Validation, Writing – original draft, Writing – review & editing. **Anand Mohan:** Conceptualization, Methodology, Validation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.crfs.2021.12.016.

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