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Assessing Attentional Prioritization of Front-of-Pack Nutrition Labels using Change Detection

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Abstract

We used a change detection method to evaluate attentional prioritization of nutrition information that appears in the traditional “Nutrition Facts Panel” and in front-of-pack nutrition labels. Results provide compelling evidence that front-of-pack labels attract attention more readily than the Nutrition Facts Panel, even when participants are not specifically tasked with searching for nutrition information. Further, color-coding the relative nutritional value of key nutrients within the front-of-pack label resulted in increased attentional prioritization of nutrition information, but coding using facial icons did not significantly increase attention to the label. Finally, the general pattern of attentional prioritization across front-of-pack designs was consistent across a diverse sample of participants. Our results indicate that color-coded, front-of-pack nutrition labels increase attention to the nutrition information of packaged food, a finding that has implications for current policy discussions regarding labeling change.

Keywords

Nutritional Labeling; Front-of-Pack Labels; Change Detection; Attention; Color- Coding; Attentional Allocation; Information Search

1 INTRODUCTION

Obesity is associated with increased rates of morbidity, mortality (Pi-Sunyer, 1993) and health costs (Finkelstein et al., 2003; E. Finkelstein, Trogon, Cohen, & Dietz, 2009). Given the high prevalence of obesity in society and its negative impacts, the US Government has articulated a vested interest in curbing the epidemic (Office of Foods, Center for Food

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Safety and Applied Nutrition, Center for Veterinary Medicine, & Office of Regulatory Affairs, 2012; US White House Task Force on Childhood Obesity, 2010). One approach to do so involves regulating environmental factors; examples include: subsidizing healthy foods, limiting the sales of nutrient empty foods in places like schools, and taxing nutrient-empty foods (Brownell & Horgen, 2007). Nutrition labeling offers a cost-effective intervention with potential for wide reach in an readily accessible format (Campos, Doxey, & Hammond, 2011; K.L. Hawley, 2012; Kelly et al., 2009; Roberto et al., 2012; Temple & Fraser, 2014).

To increase the use and impact of nutrition labels, there has been a global push to adopt front-of-pack formats. These labels typically present a few key ingredients on the principal display panel of a package. Formatting can be text based, though it often includes color-coding to present a qualitative evaluation of the health of the food product (for review see Schor, Maniscalco, Tuttle, Alligood, & Reinhardt Kapsak, 2010). Examples include the Multiple Traffic Light System (MTL), a color-coded system introduced by the Food Standards Association in the UK, and the Guideline Daily Amount (GDA), which is a monochromatic format introduced by the Food and Drink Federation in the European Union.

The US Government has also expressed interest in developing a standardized front-of-pack label that is supported by empirical research. More specifically, the Whitehouse's Task Force on Childhood Obesity has explicitly recommended the development and implementation of standardized front-of-pack nutritional label based on scientific research (White House Task Force on Childhood Obesity, 2010), and the US Food and Drug Administration has identified investigation of potential front-of-pack labels as a key initiative in its 2012-2016 Strategic Plan (Office of Foods, Center for Food Safety and Applied Nutrition, Center for Veterinary Medicine, & Office of Regulatory Affairs, 2012). Similarly, the Institute of Medicine has called for objective evaluation of the efficacy of front-of-pack labels, including recommendations regarding design requirements (Nathan, Lichtenstein, Yaktine, & Wartella, 2011).

1.1 Research Investigating Front of Pack Labeling

There has been a recent flurry of research investigating front-of-pack labeling (for review see Kristy L. Hawley et al., 2013). While the ultimate research goal is to identify labeling techniques that influence dietary choices, the application of models of information processing suggests that information must go through a number of serial stages of processing (DeJoy, 1991) before it can impact decision making. More specifically, prior to influencing decision making, information presented on the label must be attended, encoded into working memory, and understood by the consumer.

Much of the research regarding the design of nutrition labels has focused primarily on relatively late stages of information processing stages involving comprehension (for review see Vyth et al., 2012). While the comprehension of the label is important, this research typically by-passes the attentional stage by giving participants explicit instructions to attend to nutrition information. Doing so is problematic for two reasons. First, there is ample evidence that conscious recognition of information requires attention (Becker & Pashler, 2005; Rensink, O'Reagan, & Clark, 1997; Simons, 1996). As a result, if a label design does

not garner attention, the processing of the nutrition information will be derailed early in the processing stream, never reaching the comprehension stage. Second, by-passing the attentive stage ignores the fact that one of the reasons to adopt a front-of-pack label is to increase the conspicuity of the nutrition information, thereby making it more likely to receive attention.

Recognizing this short coming, a handful of researchers have begun to evaluate attention to front-of-pack labels. Some of these investigations have used visual search tasks (Bialkova & van Trijp, 2010). While visual search has a long history in basic research on visual attention (Wolfe, 1998), the technique typically involves informing participants about the search target. For instance, in a study by Bialkova and Trijp (2010), participants were asked to search for front-of-pack labels on existing products' principal display panels. This approach is an effective method of determining how quickly people can access the information presented on the front-of-pack label *when that is their goal*. However, labels that attract attention even when goals are not explicit to dietary needs are more likely to convey nutritional information to a wider segment of the population. Traditional visual search requires pre-specifying the target, which makes it ill-suited for evaluating attention to nutrition labels among participants who are not given an explicit nutritional goal.

1.2 Our Contribution

Here, we use a flicker change detection method (Rensink, O'Regan, & Clark, 1997) to investigate attention to nutrition labels, including a variety of front-of-pack labels. In flicker change detection, an image and a slightly altered image are continually alternated while separated by a brief blank screen (Figure 1A). In this type of display the blank screen interrupts the motion transient that would draw attention to the change in the image if the change was made during steady viewing. As a result, the detection of the change requires focal attention on the aspect of the scene that changes (Rensink et al., 1997). Thus, the time required to detect the change can be used as a proxy of the time when attention was first deployed to the location of the change (Bix, Kosugi, Bello, Sundar, & Becker, 2010; Tse, 2004). That is, the change detection task acts like a visual search task, but the participant searches for a change rather than an explicit, pre-specified target. As such, it allows evaluation of attentional prioritization of nutrition labels in their various formats without informing participants that nutritional information is important to our study, and without letting participants know that we are tracking attentional deployment.

Using this method, we evaluated whether front-of-pack labels attract attention more readily than the traditional Nutrition Facts Panel. In addition, by making comparisons of the change detection times for different types of front-of-pack label designs, we evaluated which types of design characteristics were most attention grabbing.

2 MATERIALS AND METHODS

2.1 Study Participants

All procedures were approved by the Institutional Review Board of the Michigan State University. To obtain a diverse socioeconomic sample, we recruited participants from a community center in a low income neighborhood in Lansing, MI, from the Work First/

PATH Program of Lansing Community College (a community organization that helps unemployed people on public assistance to find employment), and from a family resource list serv comprised of families within and surrounding Michigan State University. Participants had to be 18 or older, not legally blind and have no history of seizure.

Five participants discontinued participation before completing the experiment and the data from two participants was unusable due to technical issues. Analyses included data from the remaining 55 participants (38 Female), who ranged in age from 18 to 74 (Mean $\pm$ SD =31.45 $\pm$ 16.37 years). Table 1 presents the participant characteristics in terms of ethnicity, household income, education level, and weight status.

2.2 Package Designs

To avoid confounds associated with participants' familiarity or preconceived notions with existing brands, we created three novel brands to be used as test stimulus in this study (see Figure 2). Further, we purposefully avoided using spokes-characters or photos from nature to preclude a graphically suggestive message about nutrient value. Designs included a background comprised of muted colors with a photo depicting the intended product. As shown in Figure 2, stimuli were presented as flattened images showing both the front of the cereal box and the side panel with the traditional Nutrition Facts Panel. All stimuli had a front of pack label in the lower right corner (see below for further details).

2.2.1 Front-Of-Pack Label Designs—We designed a total of twelve front-of-pack labels that resulted from a factorial combination of 3 (text, facial Icons, checkmarks) $\times$ 2 (color/no color) $\times$ 2 (healthy/ unhealthy) design elements (see Figures 3 and 4). The front-of-pack labels contained nutrition information for calories, fat, saturated fat, sugar and salt. These nutrients are the ones that appear in the Multiple Traffic Light system used in the UK and have been suggested to be the most commonly used for front-of-pack labels worldwide (Wartella, Lichtenstien, & Boon, 2010).

The Text system used descriptive text-cues (i.e. “high”, “med” or “low”) to indicate the relative health value of each nutrient in the front-of-pack label. In turn, the Face Icon system replaced text cues with facial expression icons to indicate the relative health value of each nutrient in the front-of-pack label. High, medium, and low nutritional values of individual nutrients were depicted by sad, neutral, and smiling facial expressions of emotion, respectively (Figure 3). We chose to develop and test this novel label design based on the large amount of evidence indicating that face stimuli receive extremely high attentional priority (Langton, Law, Burton, & Schweinberger, 2008; Mack, Pappas, Silverman, & Gay, 2002) and that the processing of facial expressions of emotion requires very few cognitive resources (Bishop, Jenkins, & Lawrence, 2007; de Gelder, Vroomen, Pourtois, & Weiskrantz, 1999; Mack et al., 2002; Whalen et al., 1998; Bindemann, Burton, Langton, Schweinberger, & Doherty, 2007; Ro, Russell, & Lavie, 2001; Theeuwes & Van der Stigchel, 2006). These findings suggest that a face might be a particularly effective stimulus for both garnering attention and providing rapidly assessed qualitative information about the nutritional value of a product.

Third, we used the check-mark system based on proposals published by the US Institute of Medicine (IOM) in 2012 (Nathan et al., 2011). In its report, the IOM made the case for a simple check-mark system that awards ‘points’ to products based on whether they meet pre-determined criteria. Following the IOMs guidelines, this system only awards a check-mark when the nutrient appears in low quantities, so checks always indicate health and are simply absent if the product does not reach the health criteria. We included this system to directly compare the IOM’s recommended system to the Text system (in the color-coded condition this is kindred to the UK’s Traffic Light System) and to the novel Face Icon system.

For each front-of-pack system, we created color-coded and black-and-white versions of the label. For the Text and Face Icon systems we adopted the color coding system of the UK’s Multiple Traffic Light system, using green, amber, and red to code for healthy, moderate, and unhealthy levels of each particular nutrient, respectively. Calories were not color coded to keep the system consistent with the Multiple Traffic Light system. For the Checkmark system, the color-coded version always presented the checks in green (since checks are only given for nutrients present at health levels per serving, see below).

Finally, we created “healthy” and “unhealthy” versions of each label type. To do so we modified the amount of the front-of-pack nutrients (sugar, salt, fat and saturated fat) that were depicted (see Figure 4). In the “healthy” condition, three of the four nutrients featured on the front-of-pack label had low (i.e. desirable) values that would receive a green label based on the Food Standards Agency (Food Standards Agency 2007) guidelines. In turn, for the “unhealthy” condition, values for three of the four nutrients on the front-of-pack label were high enough (i.e. undesirable) and would be presented in red based on these guidelines. Thus, in the Text and Face Icon systems, a healthy product would receive three green symbols and an unhealthy would receive three red symbols when presented in the colored conditions. Since the Checkmark system only presents checks for healthy nutrients, the healthy version would receive three green checks, and the unhealthy received only one green check. All package displays contained the standard Nutrition Facts Panel on their right side. The information in the traditional Nutrition Facts Panel always agreed with the information in the front-of-pack label. Nutrients that appeared in the Nutrition Facts Panel but not in the front-of-pack label were held constant across packages of the same brand.

2.3 Change detection trials

Each participant performed a total of 216 trials. Each trial consisted of a four frame movie that looped until either the participant indicated that they had found the change or the trial timed out at 18 seconds. The four frames consisted of an original image (240ms), a blank frame (80ms), a modified image in which one element was changed (240ms), and a blank frame (80 ms) (see Figure 1A). These timings are commonly used in the flicker change detection task to ensure that the change does not produce a low-level visual transient that would draw attention to the location of the change (*c.f.*, Rensink, O’Regan & Clark (1997)).

Of the 216 trials, 144 were “filler” change trials, 36 trials involved front-of-pack changes, and 36 trials consisted of changes to the traditional Nutrition Facts Panel. These trial types were counterbalanced across the cereal brands, so that each of the three brands was tested in 48 filler trials, 12 front-of-pack trials, and 12 traditional Nutrition Facts Panel trials. The

filler trials were used to keep participants from preferentially attending to nutrition information, but were not considered for analysis. In addition, to ensure that changes were equally likely in any of the change locations on the package, the 48 filler trials per brand involved 12 changes to each of four filler locations (see figure 1b). Treatment factors were counterbalanced so each subject saw one instance of every possible combination of brand, health level, color, and FOP system changing, thereby allowing comparisons within subjects.

In each trial, a change consisted of the appearance and disappearance of a section of the image. In the case of front-of-pack changes the entire front-of-pack label appeared and disappeared. In the case of the Nutrition Facts Panel, a section of the panel that was the same overall size as the front-of-pack label appeared and disappeared. In the filler tasks, some element of the principal display panel appeared and disappeared.

2.4 Procedure

After providing informed consent, participants were seated at a table with a laptop equipped with E-Prime software (Psychology Software Tools, Sharpsburg, PA) with screen resolution set to 1024×768 and given task instructions to detect change, though without any mention to nutritional information on the package.

Testing began with a set of six practice trials designed to familiarize participants with the change detection task and the method of responding. None of these practice trials included packages that were the subject of the main study. After this brief orientation, the 216 trials of the main task began with trials presented in random order. Participants looked for the change and hit the space bar as soon as they detected the change. This button press stopped the reaction timer (RT), and caused the screen to display a blank frame (80ms) followed by the image that did not contain the object that was appearing and disappearing. This image remained on the screen while participants used the mouse to indicate the location of the change¹. These clicks were untimed, and were used to ensure that participants were correctly finding the change. For each trial, we recorded whether or not a change had been successfully detected, and when successfully detected, the time to change detection.

2.5 Demographic Information

Once the flicker task was complete, participants answered a demographic survey regarding their age, education level, income level, employment status, family make-up and role within the household. Information regarding subject literacy, health status and ability to see color were also collected. This was followed by a Brief Block Food Frequency Questionnaire (BFFQ; Berkley, CA) that collected information about the quality of their diet. Lastly, with their consent, participants had their height and weight recorded using a digital scale and standard stadiometer. From these measures, participant Body Mass Index (BMI) was calculated as $BMI = \text{weight} / (\text{height})^2$.

¹A handful of participants were clearly uncomfortable using a computer and had difficulty operating the mouse. The procedure was slightly modified for those participants. After they hit the space bar to indicate that they had seen the change and stop the reaction time clock, they indicated the location of the change by pointing on the screen. An experimenter who sat with them operated the mouse to click on the location the participant indicated.

2.6 Statistical Analyses

Only critical trials (those pertaining to nutrition information; Figure 1B) were considered for analyses. Two dependent variables were analyzed, the binary response (Yes/No) of successful detection, and, if so, the time to successfully detect a change. The probability of successful change detection was modeled using a generalized linear mixed model with a Bernoulli distribution on the response and a logit link function. The linear predictor included the fixed effects of front-of-package label type (3 systems $\times$ 2 color coding; see Figure 2), health level (2 levels - healthy vs unhealthy) (see Figure 3), location of change (2 locations – front-of-pack vs Nutrition Facts Panel) (see Figure 1B) and all possible 2-way and 3-way interactions. Demographic covariates and factors, including BMI, age, sex, income category, education level (high school graduate or below, vs more than high school), a health index, as well as the interaction of age and front-of-pack label type were evaluated for inclusion in the model. Only age and education level were kept in the final model based on their P-values. Inclusion of these factors did not change the nature of the inference on front-of-pack label type, location of change, health level or any of their interactions. Also included in the linear predictor were the random effect of subject fitted as a blocking factor and the random effect of subject crossed with front-of-package label type, location of change and health status, to properly recognize the experimental unit for these fixed effect factors. Additional random blocking effects of brand, session and computer number were fitted to the model in order to recognize variability between levels of these factors. However, the corresponding variance component estimates converged to zero, thus the effects were removed from the model. Overdispersion was evaluated using the maximum-likelihood based fit statistic Pearson Chi-Square/DF. No evidence for overdispersion was apparent. The final statistical model used for inference was fitted using residual Pseudo-Likelihood.

The response variable time to successful detection was also analyzed. A general linear mixed model was fitted to the response, measured in milliseconds and expressed in the log scale. The linear predictor for this model included similar fixed and random effect specifications as described in the previous paragraph.

All statistical models were fitted using the GLIMMIX procedure of SAS (Version 9.3, SAS Institute, Cary, NC) implemented using Newton-Raphson with ridging as the optimization technique. Kenward-Roger's approach was used to estimate degrees of freedom and to correct estimated standard errors. Estimated least square means and corresponding 95% confidence intervals are reported. Relevant pairwise comparisons were conducted using either Tukey-Kramer or Bonferroni adjustments, as appropriate in each case, to avoid inflation of Type I error rate due to multiple comparisons. Contrasts were tailor-built to evaluate the effect of color and front-of-pack label design on probability of or time to successful change detection.

3 RESULTS

3.1 Attention to Front-of-Pack Labels Versus Nutrition Facts Panel

Overall, results indicate that changes on front-of-pack labels were detected more readily than changes to the traditional Nutrition Facts Panel. Participants were more likely

[F(1,1462)= 372.2, $p<0.0001$], to detect changes in the front-of-pack label (Mean=99.2%; 95% Confidence interval= [98.3, 99.6]%) relative to size-matched changes in the Nutrition Facts Panel (85.4%; [75.4, 91.8]%) (see Figure 5 left panel). The difference in probability of successful change detection between front-of-pack labels and the Nutrition Facts Panel held for all designs of front-of-pack labels ($p<0.001$ in all cases), regardless of label color or health status of the package.

Similarly, the time required to successfully detect a change was significantly reduced [F(1,1024)= 511.01, $p<0.001$] when the change occurred in the front-of-pack nutrition label (2865.7ms; [2556.1, 3212.8] ms) as compared to the Nutrition Facts Panel location (4614.3 ms; [4111.7, 5178.3] ms) (see Figure 5 right panel). Faster detection of changes presented in the front-of-pack location was observed for all designs of front-of-pack labels ($p<0.001$ in all cases), regardless of color presence and health status of the package.

Our results regarding enhanced probability of, and a reduced time to, successful change detection, jointly support the conclusion that front-of-pack labels garner attention more readily and rapidly than the information that is currently mandated (i.e. the Nutrition Facts Panel).

3.2 Optimal Front-of-Pack Designs

Next, we compared *front-of-pack labels* to examine how *design features* of the labels impacted how readily changes were detected. Since all changes on FOP labels were detected at a level near ceiling (i.e. close to 100%), we focused subsequent analyses on time to successfully detect a change. We evaluated the effects of the three types of front-of-pack label designs (i.e. checkmark, traffic light and facial icons-see Figure 3), combined with use of color as well as health level, on times to successful change detection. We did this in order to identify specific design features, or combinations thereof, that may be most effective at capturing attention.

Within the front-of-pack designs, we found evidence for a significant interaction between use of color and design of the front-of-pack label], on time to successfully detect change [F(2,933.2)=9.14, $p<0.0001$] (Figure 6), after accounting for health level. More specifically, presenting a color-coded front-of-pack label decreased time to successful change detection relative to presenting the same label in black in white; however, the effect of color was more pronounced for the text [t(934.5)=8.26, $p<0.0001$] and facial icon designs [t(937) = 8.21, $p<0.001$] than for the checkmark design [t(929.3) = 3.04, $p=.037$]. The partially mitigated effect of color on the checkmark FOP design is likely explained by the fact that the checkmark design resulted in the use of fewer colors (only green was used) and a smaller surface area of color relative to the other designs. That is, one check mark in green for the “unhealthy” conditions versus three checkmarks in green for the “healthy” condition). By contrast, both the facial icon and text based FOP designs coded relative health value for all labeled nutrients using three colors (red, yellow, green) in the color-coded condition.

After the color-coding effect was accounted for, we found further evidence for an interaction between health level and front-of-pack label design on time to successful change detection [F(2,933.3)=5.06, $p=.004$] (Figure 7). To explain this interaction, we note that change in the

unhealthy version of packages with facial icons in the FOP label was detected faster than in the corresponding healthy version [$t(938)=3.9$, $p<.0001$]; however, there was no evidence that health level impacted change detection times for front-of-pack labels using the text [$t(932.8)=-.97$, $p=.334$] or the checkmark [$t(929.1) = .79$, $p=.429$] FOP designs. Our finding of faster detection of unhealthy labels when the label codes health level via facial expressions is consistent with previous work supporting an attentional bias towards negative facial expressions of emotion (Eastwood, Smilek, & Merikle, 2001).

3.3 Demographic Variables

Among the demographic variables evaluated in this study, the education level of participants was significantly associated with the probability of successful change detection [$F(1,48.45)=7.2$, $p=0.0099$] and with speed to successfully detect a change [$F(1,43.9) = 9.62$, $p=.0034$], regardless of type of FOP label used. Participants who did not complete high school were less likely to detect changes (86.1%; [75.4, 92.6] %) and also detected changes more slowly (4130.2 ms; [3634.2, 4693.8]) than participants who had graduated from high school or had post-high school education (96.8%; [92.1, 98.85]% and 201.6 ms; [2770.4, 3699.0] ms, respectively).

There was also a significant association between age and successful change detection, whereby regardless of type of label used, older subjects were less likely [$F(1,44) = 22.07$, $p<0.0001$] and slower [$F(1,48.69) = 30.18$, $p<.0001$], on average, to detect changes. In fact, every one year increase in participant age was associated with a multiplicative increase of approximately 1.4% (95%CI=[0.9, 1.9]%) in time to successfully detect change.

Finally, we note that our analyses evaluated a number of demographic variables, including: body mass index, sex, income, education level and participant health for inclusion in the statistical model as explanatory covariates. None of these demographic variables improved model fit to the data and were, thus, not included in the final model used for inference.

4 DISCUSSION

We used a change detection method to evaluate attentional prioritization of nutritional information that appeared in the traditional Nutrition Facts Panel and in a variety of front-of-pack nutrition labels. Our results provide compelling evidence that front-of-pack labels are more effective at attracting attention to nutrition information than the current US standard, the Nutrition Facts Panel.

Most critically, we note that the observed benefit of front-of-pack labels for attentional prioritization was obtained with a task that did not emphasize the importance of nutrition information. This implies that front-of-pack labels may be more likely to be attended than current nutritional facts panels by people who do not have an explicit, nutrition-related goal, which is likely the case in many purchase scenarios. This finding is consistent with work showing that people who have little motivation to shop for healthy products, still fixated front-of-pack labels, while ignoring the Nutrition Facts Panel (Turner, Skubisz, Patel Pandya, Silverman, & Austin, 2014).

Further, we compared various front-of-pack label formats to determine which design factors were most likely to garner attention. Color-coding the front-of-pack label increased its attentional prioritization for all formats evaluated (i.e. text, facial icons, or checkmarks, see Figure 3), although the effect of color was less pronounced for the checkmark format. The check mark format, as suggested by the IOM (Institute of Medicine, 2012), gives a check mark only for nutrients that are presented at healthy levels but it does not provide any explicit indication for unhealthy levels of nutrients, other than “absence” of a checkmark. Thus, colored checkmarks were presented in a single color, namely green; further, we note that the checkmark icons take up less surface area than their traffic light counter-parts. Thus, it is possible that the text and facial icon stimuli derived increased benefit through the use of multiple colors and a greater number of printed pixels in the colored conditions, thereby increasing their low-level visual saliency (see below).

Further, our results support color-coding the key nutrients in the front-of-pack label to increase attentional prioritization to key nutrition information. Color-coding seems to be particularly effective when the color system has different colors depicting the relative health value of a specific nutrient. This attentional result is particularly encouraging as a number of studies investigating the comprehension of front-of-pack labeling systems suggest that color-coded (i.e. traffic light) formats are the most effective (for review see K.L. Hawley, 2012). From the standpoint of practical applications, it is encouraging that the particular format that is most easily understood and usable is also the one that draws the most attention.

We found it somewhat surprising that the novel facial icon format of front-of-pack labels performed no better than the traffic light format. The inclusion of facial icon stimuli was intended to apply basic research on attentional prioritization, which suggests that face stimuli are among the most highly prioritized stimuli for attention (e.g., Bindemann et al., 2007; Ro et al., 2001; Theeuwes & Van der Stigchel, 2006). It is somewhat surprising then, that these basic research results fail to generalize to front-of-package labels for nutrition applications. The fact that adding the facial icons to the traffic light design did not significantly improve attention capture of nutrition information on front-of-pack labels highlights some of the difficulty in directly applying basic research to real-world applications.

Along these lines, future work should seek to replicate the colored FOP advantage using realistic three dimensional stimuli rather than “flattened” boxes as we have used here. We anticipate that the FOP advantage over the NFP will be even more pronounced in such cases, since the NFP would not be visible when viewing the principle display panel, but would instead require one to rotate the box to bring the NFP into view. We are currently investigating this issue using eye tracking to index people’s attention while they interact with realistic, three dimensional cereal boxes. Finally, it will be important to validate that these types of FOP labels garner attention in real world shopping contexts where multiple products compete for attention.

4.1 A Saliency Model Approach

Why should a color-coded label attract attention so effectively? One possible explanation is that color coding the labels may have increased their low-level visual saliency (i.e., distinctiveness). Attention can be driven by low-level visual saliency (Itti & Koch, 2000), particularly in the absence of a specific task (Henderson, Brockmole, Castelhamo, & Mack, 2007). If the inclusion of color created more salient labels, this saliency explanation might explain the attention benefit of color coding. To explore this possible mechanism we used the SaliencyToolbox in Matlab (Walther & Koch, 2006) to calculate the mean saliency value for the FOP label area of each of our stimuli. This program calculates the saliency of each location in an image using a biologically plausible simulation of the early visual system. The model outputs an image that codes the relative saliency of each location as value in a gray-scaled image, with the brightness of each pixel representing the saliency value of that point in the image. We then identified the front-of-pack label region as an area of interest and used Photoshop to calculate the mean saliency value for that area of each of our stimuli. We then correlated each FOP label's saliency value with the mean time to successfully detect change on that label (Figure 7). The time to detect a change in a front of pack label decreased linearly [$r(36) = -0.64$, $p < .001$] as the saliency of the changing label increased, indicating enhanced attentive response. Moreover, colored FOP designs seemed to cluster at greater values of saliency whereas black-and-white designs clustered around lower values of saliency (Figure 8). While exploratory, this pattern supports a potential role of color-coding on enhancing the low-level saliency of the Text and Face Icon designs. Although additional research specifically designed to investigate the role of salience on label attention is needed, this pattern is consistent with the view that color-coding of labels derives its benefit, at least partially, by increasing the low-level visual saliency of the front-of-pack label.

Finally, we highlight the demographic diversity of the participants in our study, which contrasts with the more prevalent use of convenient samples of university students used by other studies (Bialkova et al., 2014; Bialkova, Grunert, & van Trijp, 2013; Bialkova & van Trijp, 2011; Orquin & Scholderer, 2011; Turner et al., 2014; Van Herpen & Trijp, 2011; Visschers, Hess, & Siegrist, 2010). Our use of a broadly diverse sample of participants suggests that the results we report apply to a wider population swath than those typically reported in the literature. Given that the results of these studies are meant to inform policy that will impact a diverse population, our use of a diverse sample is warranted.

5 CONCLUSIONS

Using a change detection method, our results provide compelling evidence that, among those who do not have the explicit goal of detecting nutritional information, front-of-pack labels are more likely to draw attention to nutrition information than the currently mandated Nutrition Facts Panel. As such, we strongly recommend that future labeling regulations consider mandating a standardized front-of-pack nutritional label. Specifically, our results indicate that color-coding such a label will lead to more attention to the label, particularly if the color-coding provides qualitative evaluation of the health status of the food and thus results in multiple possible colored icons. These findings have direct implications for policies that are currently under consideration by the US Food and Drug Administration, and

add to a growing body of literature that supports the use of front-of-pack nutritional labels that color-code relative nutritional value of key nutrients (Campos et al., 2011; K.L. Hawley, 2012; Kelly et al., 2009; Roberto et al., 2012; Temple & Fraser, 2014).

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We used a change detection method to track the deployment of attention.

Participants were not given a nutrition-relevant goal.

Front of pack labels were attended much more rapidly than the nutrition facts panel.

Color coding nutrient values in front of pack labels increased attentional prioritization.

Results support the use of color coded front of pack nutrition labels.

Figure 1.

(a) Schematic diagram of the flicker-change detection method. An image and a slightly altered image are continuously alternated on the screen, while separated by a brief blank screen. The alternation continues until the participant hits the spacebar to indicate that change has been located or until the trial times-out at 18 seconds. (b) Possible locations of changes on the packages. Across all 216 trials, change was equally likely to appear in each of the six possible change locations indicated on the figure. That is, there were 12 changes in each filler location, the critical front-of-pack (FOP) location, and the critical Nutrition Facts Panel (NFP) location.

Figure 2.

Packages depicting the three brands created for this study. The images displayed consist of the base images without a front-of-pack label. It is noted, however, that each time a package was displayed, it appeared with one of the possible front-of-pack labels (see Figure 3) in the lower right corner of the front of the package.

Figure 3.

Alternative format designs of front-of-pack labels used for this study. The designs displayed include color coding or black-and-white (i.e. no color coding) presentations of healthy versions of three systems of front-of-pack labeling, namely Text, Facial Icons, and Checkmarks.

Figure 4.
Example of healthy and unhealthy versions of the colored Face Icon front-of-pack (FOP) label displayed on cereal boxes.

Figure 5.

Estimated mean probability of correct change detection within the allotted trial time (Left) and estimated mean time to detect changes for trials in which the change was successfully detected (Right) when presented in any of the three types of front-of-pack labels or in a size-matched traditional Nutrition Facts Panel. Whiskers depict 95% confidence intervals.

Figure 6.

Estimated mean time to detect a front-of-pack label change for color-coded and black-and-white versions of front-of-pack labels presented as text only, facial icons or checkmarks, after adjusting for health effects. Whiskers represent 95% confidence intervals.

Figure 7. Estimated mean time to detect a front-of-pack label change for healthy and unhealthy versions of front-of-pack labels presented as text only, facial icons or checkmarks, after adjusting for color effects. Whiskers represent 95% confidence intervals.

Figure 8. Scatterplot of mean time to successfully detect change (averaged across participants) plotted as a function of mean saliency value of front-of-pack labels that were either color-coded (filled circles) or black-and-white (open circles).

Table 1

Demographic characteristics of study participants

Characteristic	Number	Percent
<i>Ethnicity</i>		
White/Caucasian	17	30.9%
Black/African American	19	34.5%
Hispanic	9	16.4%
Native American	1	1.8%
Asian	5	9.1%
Biracial	3	5.50%
Did not report	1	1.8%
<i>Household Income</i>		
< \$20,000	40	72%
\$20,000-\$49,999	8	14.5%
\$50,000-\$74,999	1	1.8%
\$75,000-\$99,999	0	0%
>\$100,000	4	7.3%
Did not report	2	3.6%
<i>Education</i>		
Less than High School Graduate	9	16.4%
High School Graduate	26	47.3%
At least some college	16	29.1%
Graduate degree	4	7.3%
<i>Weight Status</i>		
Underweight (BMI<18.5)	2	3.6%
Healthy Weight (BMI 18.5-24.9)	17	30.9%
Overweight (BMI 25-29.9)	16	29.1%
Obese (BMI > 29.9)	17	30.9%
Did not report	3	5.5%