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Front of pack labels enhance attention to nutrition information in novel and commercial brands

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ABSTRACT

Objectives: (1) To assess whether Front-of-Pack (FOP) nutrition labels garner attention more readily than more complete, mandated nutrition information (the Nutrition Facts Panel (NFP), required in the US), and (2) To determine whether label design characteristics, specifically, color coding and/or coding with facial icons, increase attention to the FOP label.
Methods: In two experiments, we tracked the allocation of attention while participants ($n = 125$) viewed novel and commercial packages with varied FOP designs using a change detection methodology.
Results: We found empirical evidence that FOP labels are attended more often, and earlier, than the currently mandated NFP, and that this benefit is due both to its placement on the front of the package and to the design characteristics of the FOP. Specifically, the use of color in FOPs increased attention to the label, but there was no evidence that coding information via facial icons impacted attention.
Conclusions: Our work supports a growing body of evidence supporting the use of FOP labels to attract attention to nutritional information. Findings may be relevant to inform policy decisions on labeling standards.

Introduction

Obesity is a serious and growing public health crisis throughout the World. In fact, the World Health Organization (WHO) estimates that worldwide obesity has more than doubled since 1980, and that in 2014 39% of all adults were overweight and 13% obese (WHO, 2015). Given the increased morbidity, mortality (Pi-Sunyer, 1993) and health care costs associated with obesity (Colditz, 1999; Finkelstein et al., 2003; Wolf and Colditz, 1998), strategies to curb the obesity epidemic are of global interest.

Current understanding indicates that obesity is a multifactorial condition resulting from a confluence of individual, social, and environmental factors (Ogden et al., 2006; Centers for Disease Control and Prevention, 2003; TOS, 2008; Draper et al., 2013). However, the fact that obesity rates have increased for all age groups, regardless of genetic predisposition, highlights the pivotal role of the obesigenic environment (Keith et al., 2006). Environmental factors include: expanding portions, the ubiquitous nature of foods high in sugar, fat, sodium and high-fructose corn syrup, as well as the emphatic promotion of these foods. As such, the attempts of policy makers to mitigate obesity, and its effects on society, should consider regulation of the environment. Potential legislative and regulatory actions for this purpose include: subsidizing healthy foods, restricting marketing and/or advertising, limiting the sales of nutrient empty foods in places like schools, taxing nutrient-empty foods (Brownell and Horgen, 2007), and changing labeling requirements (e.g. consideration of requirements for Front of Pack (FOP) labeling in New Zealand, Australia and the US, mandatory FOP labels for five snack categories in Thailand (Food Information Council, 2013), the required listing of trans-fat on packaged products (Trans fatty acids in nutrition labeling, 2003) and nutrition information on menus in chain restaurants by the US government (Food Labeling, 2014).

Front of Pack (FOP) labels present truncated nutrition information on the front of the package, in varied forms. Due to a combination of their simplified format and their prominent position on the front of the package, it has been suggested that FOP labels are more noticeable than the traditional labeling (those on the backs of package (BOP) in many countries, or the Nutrition Facts Panel (NFP) on the side panel in the US (Alexander and Hazel, 2008; Feunekes, 2008; Mackintosh, 2008; Wansink, 2003)).

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A variety of FOP labeling systems have emerged over the last decade with the intent of enhancing the efficacy of nutritional labeling (Sacks et al., 2009; Vyth et al., 2010a,b, 2009; Kelly et al., 2009). Forms range from those which detail specific nutrients, sometimes overlaying text with symbols or color, to simple visual "health logos" that sum product healthfulness in general or with regard to specific parameters (e.g. heart health) Hodgkins et al., 2012 (see Fig. 1).

Despite their prevalence, no single system for FOP labels has emerged and a lack of standardized requirements has enabled a proliferation of manufacturer-driven formats. This has negative consequences. First, the varied formats can be confusing (Draper et al., 2013), making it "difficult for consumers to evaluate and compare the nutritional profiles of foods" (Hawley et al., 2012). Second, the lack of a standardized approach to FOP nutrition labeling can be misleading to consumers due to the potential for selective reporting and manipulation of information (Hawley et al., 2012). Consumers have reported confusion with having to contend with multiple FOP label formats in various countries, including: Germany (Borgmeier and Westenhoefer, 2009), Australia (Kelly et al., 2009; Louie et al., 2008) and the US (Hawley et al., 2012).

In response to the emergence of these varied systems and the resulting consequences, there has been a great deal of recent research investigating FOP labeling (Rensink et al., 1997; Simons, 1996). To provide a framework for understanding the strengths, weaknesses and gaps in this research, we used a commonly employed model of information processing (DeJoy, 1991). Using this approach, information must undergo five, serialized stages of processing in order to impact behavior (see Table 1).

If a label fails at any one of these processing stages, it not possible for the information it contains to successfully impact behavior. Simply providing information with a label is inadequate. Instead, an effective label must be designed so that it catalyzes exposure, garners attention and is easily encoded and comprehended (Stages 1–4) DeJoy, 1991; de la Fuente and Bix, 2011; only then can the label influence decision-making (i.e. compliance – Stage 5). Consider, for example, a shopper with diabetes; information regarding several nutrients (fats and carbohydrates with emphasis on simple sugar) is critical for informed decisions. If this information is not provided on the product labeling (i.e. the consumer is not exposed to it), they are not able to make an informed choice. That said, simply providing the information on the labeling does not guarantee its use. It must also be assimilated through the senses; in this specific example, the consumer must direct their vision toward the information (Stage 2 – perception). Resources within the brain must then be allocated to convert the external signal falling on the retina into an internal one that can be further processed (Stage 3 – encodation). Participants that are preoccupied with other thoughts, multitasking, etc. may not have adequate cognitive resources available to encode said signal. Even

Table 1
Serialized stages of information processing.

Stage of processing	Relevance to nutrition labeling
1. Exposure to information	The panel with the nutrition information must be visible to the consumer. Given that the front panel (PDP) of a package is customarily displayed in retail environments Front of Pack (FOP) nutrition labels have an advantage over Nutrition Facts Panel (NFP) labels at this stage
2. Attention to information	The consumer must focally attend to the nutrition information. If FOP designs attract more attention than the NFP, they may have an advantage at this stage
3. Encoding of information	The consumer must encode the information into working memory. Since the FOP presents a limited number of key nutrients/ingredients, the encoding demands of an FOP may be reduced relative to the NFP
4. Comprehension of information	The consumer must comprehend the meaning of the information presented in the label. The use of icon and color coding schemes may provide a benefit to FOPs in this stage
5. Compliance to information	Ideally, the information will catalyze appropriate behavior (selection, consumption). Information can influence behavior only if it completes the prior stages

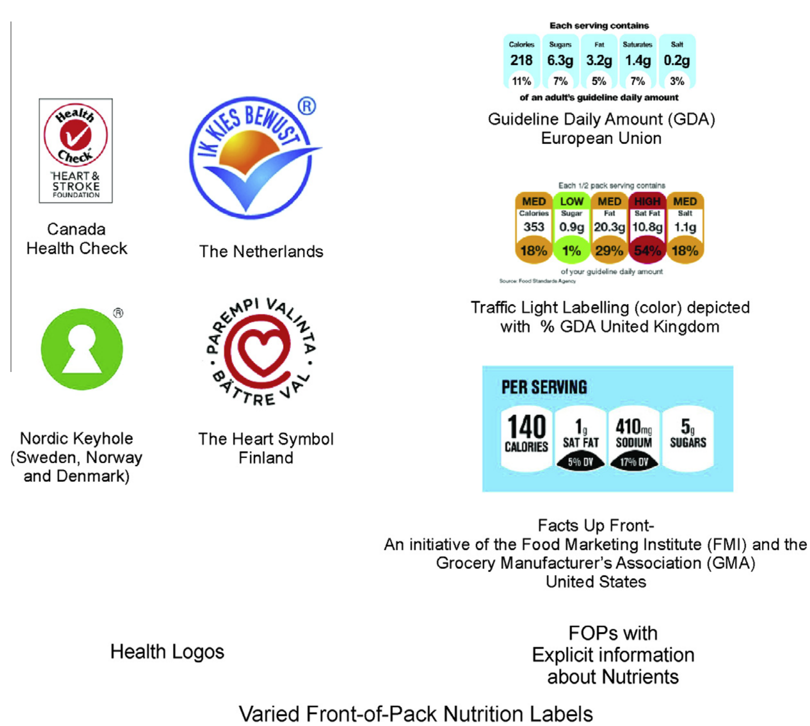


Fig. 1. Varied Front of Pack (FOP) labels ranging from summation logos to those which provide explicit information regarding specific components.

if the signal is successfully encoded, if it is in a language that is unfamiliar to the shopper, at a reading level beyond their capability, or phrased in a way that is confusing or unfamiliar to them (e.g. listing as saccharides), meaningful processing can fail (Stage 4 – comprehension). Beyond that, the person must use the knowledge appropriately and engage their motor system to an informed conclusion (e.g. this product will likely result in a period of high blood sugar if I consume it. I will not purchase it) (Stage 5 – execution).

Utilizing this as a conceptual frame, a great deal of the research on FOPs has focused on the late stages of information processing, specifically, comprehension (Campos et al., 2011; Hawley et al., 2013). One common aspect of these studies is that participants are given the goal of evaluating the healthfulness of products. As such, these studies are good at evaluating how well a particular FOP works *when the person's goal is to evaluate healthiness*. This type of comprehension work is important; a label must be comprehensible to be effective. By and large, these studies suggest that color-coded multiple traffic light systems are easily understood (Borgmeier and Westenhoefer, 2009; Hawley et al., 2013; Kelly et al., 2009; Roberto et al., 2012, 2010; Hersey et al., 2013). However, since these studies give people a nutrition-relevant goal, they by-pass the early attentional stage of the processing model, which limits this research to people who already have the goal of assessing nutritional information.

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 nutritional information, thereby making it more likely to receive attention. Early stages of processing (Stage 1 – exposure and Stage 2 – perception) are critical to the FOPs success; ample evidence finds that attention is critical to the conscious recognition of stimuli (Rensink et al., 1997; Simons, 1996; Becker and Pashler, 2005). As a result, if a label design does not garner attention, the processing of the nutritional information will be derailed early in the processing stream, never reaching the comprehension/usability stage.

A label that is effective at attracting attention, even among those without the specific goal of assessing the nutritional value of a product, will have the greatest potential to impact the widest segment of the population. Several researchers have acknowledged the importance of evaluating the effect that FOP labels have on attention, and have adopted methods from basic research on attention to the evaluation of nutritional labels. Some of these researchers have adopted visual search tasks or eye tracking methods (Bialkova et al., 2013; Bialkova and van Trijp, 2010, 2011).

During a typical visual search task, subjects are asked to find a specific target or piece of information; in studies on nutrition people are asked to find the nutrition information contained within that label. The label can be manipulated so that it is presented in varied formats from trial to trial in an attempt to assess how formatting helps or hinders the search for the target information. Dependent variables can be binary (e.g. the proportion of participants who correctly answered the question requiring the nutrition information prior to timing out), or continuous (e.g. the amount of time to correctly answer the question). While visual search is a powerful paradigm for investigating attention, it typically requires that participants be told the target of the search (Wolfe, 1998); (e.g. how many calories does this product contain?). Obviously, this prompts participants to seek nutrition information. These methods can effectively determine which design elements (e.g., large FOPs that appear in predictable locations within an uncluttered package) increase the ability of people to guide attention to nutrition information *when that is their goal* (Bialkova et al., 2013; Bialkova and van Trijp, 2010, 2011). However, they still do not allow evaluation of the visual saliency of varied label types for a person who does not have a nutrition-related goal. As the authors of one visual search study acknowledged, most ''mainstream consumers" will not have a specific goal of attending nutritional information (Bialkova and van Trijp, 2010).

To avoid having to give people explicit instructions, catalyzing a search for nutritional information, a few researchers have used eye-tracking methods with more realistic shopping scenarios (Koenigstorfer et al., 2013; Turner et al., 2014). During eye tracking, the point of gaze of a person is superimposed over a scene, enabling researchers to measure many dependent variables, including: the gaze trail (what elements participants look at first, second, etc.), the number of times participants fixate a particular aspect of a scene, the amount of time that a participant fixates a particular aspect of a scene, etc.

Koenigstorfer and colleagues used a mobile eye tracker to monitor gaze position while German participants performed a mock shopping task (Koenigstorfer et al., 2013). They found that the presence of color-coded, FOP labels increased the number of gazes and the total gaze duration spent inspecting packages while making a selection; this was not true of monochromatic FOPs. This finding suggests that the presence of a color-coded FOP label draws attention. However, the mobile eye-tracker and experimental setup that they employed did not provide adequate precision to determine when and for how long people were inspecting the actual FOP label versus other aspects of the packaging, just the overall time spent on the entire package.

Even so, eye tracking is a promising method for evaluating attention to nutritional labels in scenarios where attention to nutrition information is not an explicit goal of the experiment. Future work using the method is likely to prove informative; however, the method requires the use of expensive and specialized equipment and is a single measure.

Here, we adopt a change detection method from visual cognition (Rensink et al., 1997) to provide a converging method that does not require sophisticated equipment. This method is similar to a visual search; however, rather than directing participants to a specific target (e.g. nutrition information as in Bialkova and van Trijp (2010)), participants are told to search for a changing object within a scene. Change detection has been used extensively in the visual cognition literature, but is novel within the labeling literature. During a change detection task, subjects view an image on a computer screen for a brief period of time (240 ms) this is followed by a brief, blank display (80 ms) and then the same image viewed previously with a slight alteration (240 ms) followed by another blank display (80 ms). This test image, blank, altered image, blank sequence loops, providing a ''flickering" appearance in the area of change (see Fig. 2). In our experiment, the changing aspect of the scene may or may not be related to nutritional information. Successful detection prior to timing out at a predetermined time, and time to successfully detect a change (prior to time out) can be analyzed as dependent variables for analysis. Faster detection implies early attention to the changed property as well as insight about viewer's attentional scan paths; as such, it is seen as measuring the locus of attention (Rensink et al., 1997).

Thus, change detection allows us to objectively evaluate the ability of varied FOP label designs to attract the attention of participants who did not have the specific goal of attending to nutrition information.

Goals and objectives

Our goals in doing so were: (1) to assess whether FOP nutrition labels garner attention more readily than the traditional NFP, and (2) to determine the effect of specific label design characteristics (color and facial icons) on attention.

To accomplish these goals, we compared the attentional prioritization of four FOP label designs consisting of combinations of

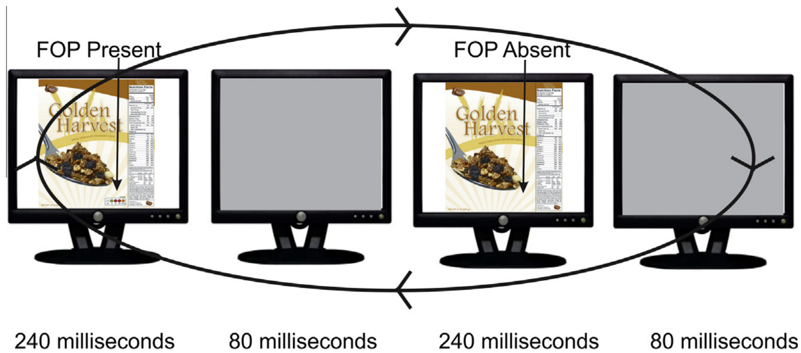


Fig. 2. Change detection methodology.

color (yes/no) and facial icon (yes/no; see Fig. 3). In addition to the FOP labels, each stimulus image also contained a Nutrition Facts Panel (NFP), the current required, standard for nutrition information in the US (see Fig. 3). NFPs were designed according to the regulations authorized under the Nutrition Labeling and Education Act of 1990 (NLEA).

We chose to evaluate the impact of color coding of FOP labels because color is commonly used in the FOP systems throughout the world, but its use is the topic of significant debate (ElAmin, 2006; Cooper, 2012). We also chose to test schematic facial icons (i.e. sad for high, neutral for medium, happy for low; see Fig. 3) because abundant data suggests that face stimuli are given extremely high attentional priority and that the processing of facial expressions of emotion requires very few cognitive resources. For example, research indicates that facial stimuli capture attention even when people are engaged in another task (Langton et al., 2008); that is, facial icons seem to be relatively immune to the phenomena of inattentional blindness (Mack et al., 2002) and attentional blink (Awh et al., 2004; Landau and Bentin, 2008). In addition, facial expressions of emotion are readily evaluated in the near absence of attention (de Gelder et al., 1999; Whalen et al., 1998). Finally, the inclusion of pictorial icons in an FOP label may increase the ease with which the information is encoded and remembered (Paivio, 1978). People extract basic meaning from pictures extremely rapidly (Greene and Oliva, 2009) and form relatively long lasting memory of them (Shepard, 1967), even when people are not actively attempting to form memories of the pictures (Becker and Rasmussen, 2008). These findings suggest that a face might be a particularly effective stimulus for drawing attention to the FOP and conveying relative, qualitative information about the nutritional value of a product. Finally, it is worth noting that color coding and/or coding by facial icons may provide a benefit to children or people who have difficulty reading (Haldeman et al., 2000).

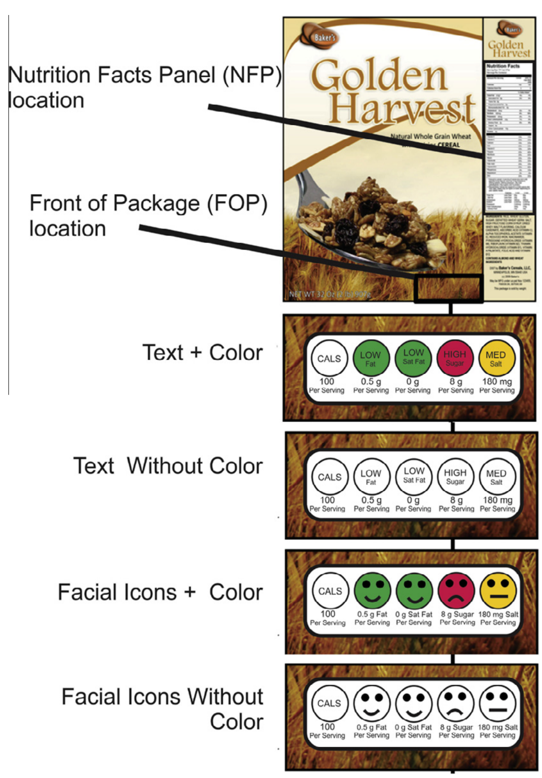


Fig. 3. Label treatments.

Materials and methods

Breakfast cereals were used as the stimuli images for these experiments because of their presence in the literature examining various effects related to graphics and consumer behavior, the existence of commercially available cereals at varied levels of nutrient and caloric density, and ease of prototyping these images.

Tested images included FOP labels (see Fig. 3), which presented information regarding four nutrient components, namely: fat, saturated fat, sugars and salt. These components were selected because they represent nutrients commonly found on FOP labels throughout the world (e.g. the European Union, the United Kingdom), and are among those consistently implicated in diet-related illness. Also presented on the FOP labels was information on calorie values; consistent with common global practice and the Food Standards Association (FSA – United Kingdom) guidelines, the circle containing calorie values was not coded by color (or facial icon).

Design characteristics of FOP labels included combinations of color and schematic facial icons which coded the *qualitative* nutritional value of these nutrients. The treatment structure consisted of a $2 \times 2 \times 2$ factorial design for FOP designs consisting of combinations of color (presence/absence) and schematic facial icons (presence/absence) presented with two nutrient levels, namely "high health" and "low health". When present, colors used in the FOP designs included: green, amber and red; schematic facial icons were: happy, neutral, or frowning. The "healthy" form was at least one qualitative nutritional step lower than the "high health" case for three of the four nutrients listed on the FOP. For example, if the high had three greens and a yellow, then the low could have one red and three yellows. Cutoffs for "high, medium and low" levels were categorized into the red/amber/green (and/or appropriate facial icon) based on the high/medium/low Traffic Light Label guidelines released by the Food Standards Agency based on a 30 g serving (Food Standards Agency, 2007).

We conducted two experiments, both of which utilized the "flicker" change detection task developed by Rensink et al.

(1997). During each trial, an original image (240 ms) and an altered image (240 ms) were continuously alternated with an interleaving gray screen (80 ms) separating them (see Fig. 2). The "flicker" of these two images looped until participants pressed the space bar to indicate that they had spotted the change, thereby halting the timer and the flicker task. Participants then used a mouse to click on the location of the change, to verify that they, indeed, had detected the change. Trials were deemed "failed" if participants did not correctly identify the location of the change after stopping the trial, or if they "timed out" by not successfully identifying the change within 10 s.

The objective of Experiment 1 was to assess the ability of different designs of FOP labels to garner attention relative to the more complete information provided by the required label, the NFP (see Fig. 3). For this experiment, we designed and created three novel brands of breakfast cereal (Fig. 4A) that were devoid of any health claims, spokes-characters and special offers on the PDP. Further, we designed the change detection task such that the flickering involved the disappearance and reappearance of the FOP label or a portion of the traditional NFP that was size-matched to that of the flickering FOP label.

In Experiment 2, we used commercial brands of breakfast cereal (see Fig. 4B) to accomplish two objectives. First, we wanted to evaluate the extent to which increased attention to the FOP label relative to the NFP (as indicated by results from Experiment 1) was based solely on location or whether it could be attributed to the design characteristics (e.g. color) of the FOP label itself. To achieve this objective, the changes that occurred in the traditional NFP location involved the disappearance of FOP designs *within the NFP location*. Thus, the only difference between FOP and NFP changes was the location during Experiment 2. Our second objective for this experiment was to determine whether the effects of specific FOP design characteristics (i.e., color and facial icons), as identified in Experiment 1, would generalize to more complex, real world packages (see Fig. 4B).

For each of Experiments 1 and 2, each subject performed 168 change detection trials presented in random order. Forty-eight trials were "critical" trials, 24 of which involved the flickering of the FOP label (3 brands × 4 FOP designs × 2 levels of health for each experiment), and 24 consisted of changes within the NFP (sector 7 – see Fig. 5). In order to prevent subjects from preferentially attending to nutritional information, the remaining 120 "noncritical" trials consisted of flickering changes in sectors 1, 2, 3, 4 and 5 of the package (see Fig. 5), corresponding to brand name, package graphics, net weight and others.

Subjects and equipment

Participants were recruited through the Department of Psychology's participant pool. Participants needed to be at least 18 years of age with no known history of seizures and not be legally blind in order to participate in either experiment.

Forty-seven subjects participated in Experiment 1, and 81 subjects participated in Experiment 2. Usable data was obtained from 45 subjects for Experiment 1, and 80 subjects for Experiment 2. Data from subjects who failed to correctly identify the change location on more than 50% of the trials ($n = 2$ Experiment 1 and $n = 1$ Experiment 2) were excluded from analyses. All protocols were approved by the Institutional Review Board at the Michigan State University.

EPrime® software was used to run change detection trials in isolated booths on computers with a screen resolution of 1024 × 768 pixels. For each trial, subjects indicated that a change has been detected by pressing any key on the computer keyboard. Identification of the proper change location was confirmed by having the subject use the mouse to verify the change location, ensuring that the subject had, indeed, identified the change. For trials where subjects recorded the change in an incorrect location, or when subjects did not indicate that they had seen the change within 10 s, the trial was recorded as "failed to detect change".

Statistical methods

Experiment 1 involved a 2-way factorial treatment structure consisting of 4 FOP designs (color no facial icon, color with facial icon, non-color with facial icon, non-color without facial icon) and two levels of health status (high and low). Experiment two, by contrast, involved a 3-way factorial treatment structure consisting of the aforementioned factors, but also considered location of the change. The statistical models used for data analyses in Experiments 1 and 2 included fixed effects that reflected the corresponding factors described above and their interactions. Next, we describe further details of the statistical approach taken on each of the response variables.

Successful detection (binary variable, yes/no)

Successful change detection of critical trials was analyzed separately for each experiment using a generalized linear mixed model that assumed a Bernoulli distribution and a logit link function. We note the correlation structure in the data due to multiple observations on each subject and on each brand. To account for this, we fitted corresponding random effects in the linear predictor of the generalized linear mixed model. Additional random effects were also included to ensure that the experimental unit for each factor was properly recognized. No evidence for overdispersion was apparent using a maximum-likelihood-based Pearson Chi-Square statistic. The final statistical model used for inference was fitted using residual pseudo-likelihood to ensure efficient estimation of variance components.

Time to detect change (continuous variable, milliseconds)

A generalized linear mixed model was fitted to the response time, measured in milliseconds, and expressed in the log scale (Experiment 1) or in the log–log scale (Experiment 2). Data transformations were selected to ensure that the residual variance was stabilized and that model assumptions were reasonably met. Only critical trials, i.e. those that involved changes to the FOP label and NFP (sectors 6 and 7, Fig. 4) were considered for analyses. For each model, the linear predictor included the same fixed and random effects described above for successful change detection. Variance components were estimated using residual maximum likelihood. Model assumptions were checked using studentized residuals.

All statistical models were fitted using the GLIMMIX procedure of SAS (version 9.2, SAS Institute, Cary, NC) implemented using Newton–Raphson with ridging as the optimization technique. In all cases, Kenward Roger's procedure was used to estimate degrees of freedom and make corresponding adjustments in the estimation of standard errors. In each case, we report least square mean estimates of combinations of treatment factors of interest and corresponding 95% confidence intervals. Relevant post hoc pairwise comparisons were conducted using either Tukey–Kramer or Bonferroni adjustments, as appropriate in each case, to avoid inflation of Type I error rates due to multiple comparisons.

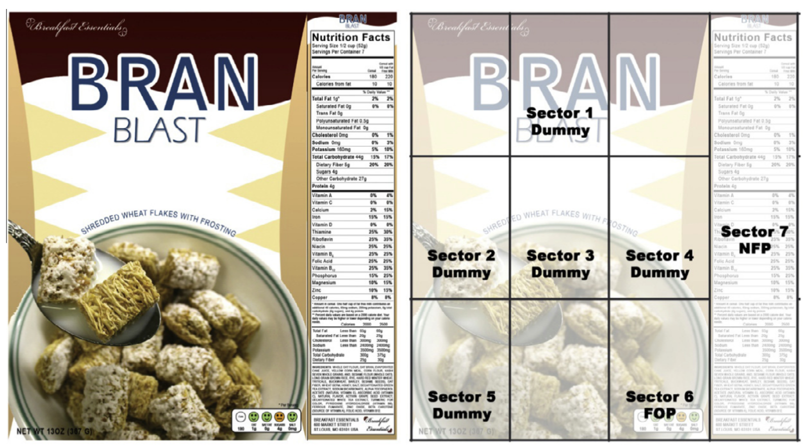
Results

Experiment 1

Change detection in FOP labels vs NFP

Changes to the FOP labels were more likely to be detected than changes to the traditional NFP ($p < 0.001$; Fig. 6a). In fact, almost all changes on the Front of Package (FOP) were successfully detected

Fig. 4. Test stimulus.



(a) (b)

Fig. 5. (a) Example stimulus for change detection testing in Experiment 1. Flattened Principle Display Panel (PDP) and side panel (NFP). (b) Sectorization of the example stimulus to indicate location of the non critical or filler trials (sectors 105) and critical trials (sectors 6 and 7).

(LSME = 98.3% ± SE = 0.8%), while a majority of changes in the NFP were missed (only LSME = 31.4% ± SE = 0.089 detected), mostly due to trials that "timed out".

For all trials in which changes were successfully detected, changes were detected more rapidly (Fig. 6b) when they occurred to the FOP label than to the NFP ($p < 0.001$), with an estimated time to detection of 2.7 s (95% confidence interval = 2.5–2.9) as compared with 4.5 s (95% confidence interval = 4.1–5.0), respectively. In short, FOP changes were more likely to be found and were located more rapidly than changes to the NFP.

Effect of design characteristics on change detection within the FOP label

Of primary interest was whether designing FOP labels that included color and/or facial icons would increase attention to nutrition information. Additionally, we specifically investigated whether the effect of these design factors would differ between high and low health cereal products. Label design features (e.g., color, facial icons) that increased the attentional prioritization of the FOP label should result in faster change detections.

A main effect ($p < 0.0001$) of color was evident on time to detect change, changes were detected faster for colored FOP label designs, as compared with non-colored, regardless of the status of facial icon (Fig. 7). There was no evidence for any main effect of facial icons ($p = 0.375$) nor of an interaction with color ($p = 0.617$) on time to change detection. Further, there was no evidence for an effect of health status of the package, nor any interactions with FOP designs, on time to detect change in the FOP label ($p > 0.18$).

Experiment 2

While Experiment 1 showed a clear attentional advantage for FOP labels relative to the standard NFP (see Fig. 6a and b), it was unclear whether the FOP's advantage was due primarily to the location of the labels, to differences in the visual aspects of the changing stimuli (design elements in the FOP while the NFP was merely text) or a combination thereof. In Experiment 1, the FOP changes involved the flicker of the FOP label, while the NFP changes involved the flicker of the NFP text. As such, both the visual features of the change and its location differed between FOP and NFP changes. Experiment 2 was designed to discriminate

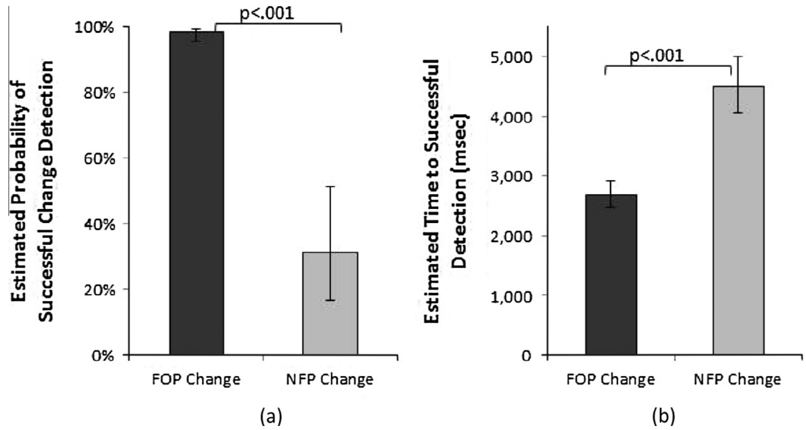


Fig. 6. Estimated probability of successful change detection during the allotted 10 s trial period as a function of whether the change occurred to the FOP or NFP (panel a). Estimated time to detect the change for those trials in which the change was correctly identified as a function of whether the change occurred to the FOP or NFP (panel b) Whiskers indicate the 95% confidence interval.

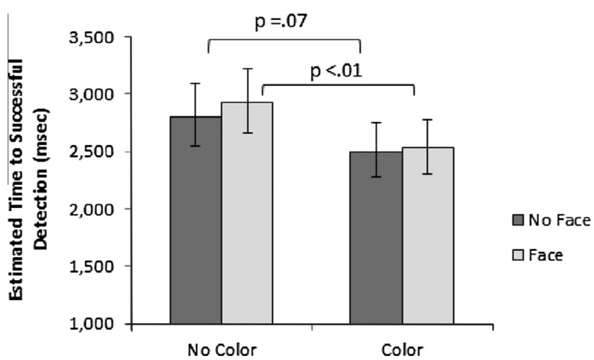


Fig. 7. Estimated time to successfully detect an FOP change in Experiment 1 (novel brands) as a function of whether the FOP label had color or facial expressions. Whiskers indicate the 95% confidence interval.

between these mechanisms. For this purpose, we equated the visual characteristics of the changes in the FOP label and in the NFP, such that the NFP change trials involved the same visual stimulus flickering *within the location of the NFP*. That is, the NFP changes in Experiment 2 involved the flicker of one of the FOP labels within the NFP panel. Thus, in Experiment 2, the only difference between FOP and NFP changes was the location of the change, allowing us to evaluate the effect of location independently from the effect of the visual characteristics of the change.

In Experiment 2 we also switched the packages from novel packages to commercial packages (Fig. 4B). Three brands of breakfast cereal were selected from brands being sold in the mid-Michigan area at the time of the study. These were: Post® Cocoa Pebbles™, Post® Grape Nuts™ and Kashi® Cinnamon Harvest™ (see Fig. 4B). The flattened PDP and NFP panels were scanned into the computer, and FOP labels containing combinations of color and facial icons were digitally added to the stimulus. These stimuli allowed us to evaluate whether the FOP design characteristics that were most effective at drawing attention in Experiment 1 (e.g., color; see Fig. 7) generalized to more realistic packages in which branding information would compete for attention with the FOP label.

In all other respects, the experimental design, procedure, and statistical analyses were identical to Experiment 1. Eighty-one participants who had not participated in Experiment 1 participated in Experiment 2. One subject successfully detected changes in less than 50% of the trials; this subject's data was eliminated from further analysis leaving usable data from 80 participants.

Change detection in FOP labels vs NFP

Similar to Experiment 1, in Experiment 2 we found that changes were more likely to be detected in the FOP than in the NFP condition ($p < .001$; Fig. 8a); estimates of 98.9% (CI 97.9–99.4) vs 96.6% (CI 94.5–97.9%) respectively. Also, the time required to successfully detect changes in those trials where a change was detected was shorter when the change was located in the FOP label (1978.7 ms (CI 1632.8–2409.9 ms)) as compared to the NFP (2699.2 ms (CI 2210.9–3312.4 ms)) ($p < 0.001$; Fig. 8b).

Effect of design characteristics on change detection within the FOP label

The results of Experiment 2 concerning the effect of design characteristics within the FOP label further replicated those of Experiment 1. We found evidence for a main effect of color ($p < 0.0001$), whereby changes were detected faster in colored than non-colored FOP labels. In turn, we found no evidence for any effect of facial icons ($p > 0.61$) nor a facial icon by color interaction ($p > 0.05$) on time to detect change in the FOP label. Similarly, there was no evidence of differences in time to detect change as a function of health status of the product, neither any of its interactions with design characteristics ($p > 0.15$ in all cases) (Fig. 9).

Discussion

Our results suggest that FOP labels are effective at capturing attention for both novel brands (Experiment 1; Fig. 4A) and existing commercial brands (Experiment 2; Fig. 4B) and that color coding the relative nutritional value of nutrients in the FOP significantly increases attention to FOP labels relative to a monochromatic FOP. Importantly, this attentional benefit occurred even though participants did not have a nutritional goal. Given that attention to a label is a prerequisite for comprehension and compliance, the finding that FOP labels garner attention among those without a nutritional goal suggests that presenting information in this format would be likely to penetrate a larger segment of consumers (Bialkova and van Trijp, 2010).

In Experiment 1, changes that involved the appearance and disappearance of FOP labels were found significantly more frequently and rapidly than changes that involved the appearance and disappearance of a size-matched portion of the traditional NFP (Fig. 6). These differences were dramatic. The probability of detecting the change within the allotted 10 s trial duration was 31.4% (LSME ± SE = 0.089) for the standard labeling (the NFP) and 98.3% (LSME ± SE = 0.008) for FOP changes. Considering only those trials

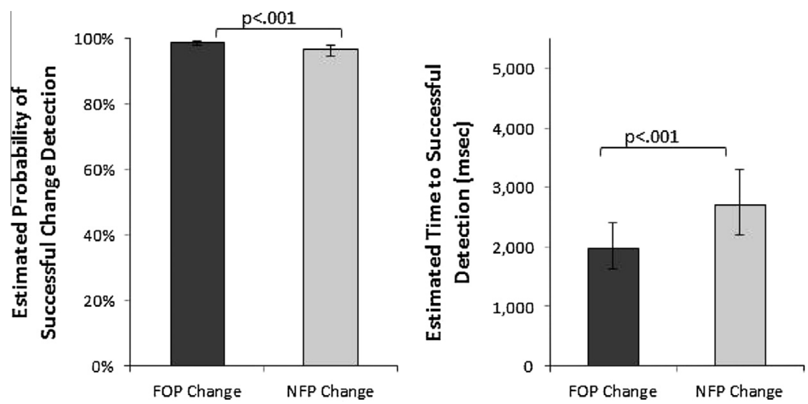


Fig. 8. Experiment 2 – Estimated probability of successful change detection during the allotted 10 s trial period as a function of whether the change occurred to the FOP or NFP (panel a). Estimated time to detect the change for those trials in which the change was correctly identified as a function of whether the change occurred to the FOP or NFP (panel b). Whiskers indicate the 95% confidence interval.

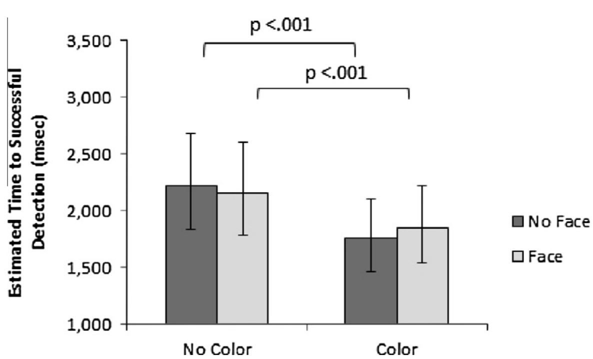


Fig. 9. Estimated time to successfully detect an FOP change in Experiment 2 (commercial brands) as a function of whether the FOP label had color or facial expressions. Whiskers indicate the 95% confidence intervals.

in which the change was successfully detected, changes to the traditional NFP took approximately twice as long to detect as changes in the FOP label (approximately 4.5 vs. 2.7 s, respectively), regardless of design characteristics of the latter.

While we report a rather large attentional benefit for FOPs, there are reasons to believe that our method most likely underestimated the true magnitude of the FOP advantage. We used *flattened images* of the packages such that the side panel with the traditional NFP was visible on the same plane as the FOP label. This label location, while logistically inevitable in our experimental setting, provided the NFP with a potential advantage for attention garnering. In real world scenarios, the FOP label and the NFP would not be visible simultaneously; rather, the former would reside on the front panel and the latter on the side panel of the package. Even when on the same plane, our results indicate that participants attended to FOP labels more often, and faster, than the NFP; therefore, it is likely that the attention garnering difference between FOP labels and NFP would be exacerbated if rotation of a package were necessary to access the NFP information, as is the case in real world scenarios.

In addition, our estimates of detection time were based only on trials in which the change was correctly identified within the allotted 10 s trial period. Many of the NFP changes were not detected within 10 s (see Fig. 6), and, thus, those trials did not contribute to the estimated time required to detect an NFP change. Including those trials in the estimate (provided that time to actual change detection had been observed) would greatly increase the estimated time required to detect a NFP change, making the difference between the FOP and NFP changes even more pronounced. Thus, the true difference in time required to detect changes between the FOP and NFP labels is probably even greater than the values we report here.

Finally, it is worth noting that Experiment 1 involved a comparison between the *current US standard* for presenting nutritional information, the NFP, and a proposed alternative method for presenting information, the FOP label. Our findings of large attentional advantages for the FOP labels in this experiment provide empirical evidence that FOP labels are more attention grabbing than the current NFP, and, therefore, offer a promising strategy to guide evidence-based policy.

While Experiment 1 showed a clear attentional advantage for FOP labels relative to the standard NFP, the two conditions differed both in location AND in type of visual stimuli that changed. As such, it was unclear whether the FOP's advantage was due, at least in part, to its location on the front panel of the package, to the design characteristics of the visual stimuli, or a combination of both. To isolate the mechanism, in Experiment 2, all critical changes involved the appearance and disappearance of an FOP label in either the FOP location (package front) or the NFP location (on the side panel). The only difference between conditions was the location where the change occurred; NFP changes involved an FOP appearing and disappearing within the NFP label location, and FOP changes involved an FOP appearing and disappearing in its typical front of pack location. Results from Experiment 2 indicated that location on the front of the package was a factor that significantly enhanced attention to nutritional information. The finding that the FOP location increased attention to nutrition information, even when the traditional NFP appeared in the same plane, provides evidence that people prioritize information on the front of packages, and lends additional support for the belief that simplified nutrition labels that appear on the front of the package may be more effective than current labeling standards (Food and Drink Federation, 2015; Kennedy and Lowe, 2010; Harrison-Dun, 2014; US Food and Drug Administration, 2014).

It is worth noting, however, that the magnitude of this advantage was considerably smaller in Experiment 2 relative to Experiment 1 (Fig. 7a and b as compared with Fig. 5a and b). This suggests that at least part of the FOP benefit can be attributed to the visual characteristics of the FOP labels relative to that of the NFP. Policymakers from around the globe have increasingly focused on provision of nutrition information via optimized labels; this has led to arguments about what constitutes best practice (Food Information Council, 2013), and calls for objective data upon which policy can draw (Food Information Council, 2013; US White House Task Force on Childhood Obesity, 2010). The finding that the visual characteristics of a label impact attention to the information suggest that the considerations of the precise visual characteristics of the label are likely to impact the effectiveness of the label. As such, objective data of how these visual characteristics impact the efficacy of nutrition labels is key to developing best practices.

Within the debate about best practices, one of the most contentious issues has been whether the labels should be color-coded or not. Color-coded labels have been opposed by industry groups who indicate that simplified, qualitative cut-offs (e.g. color-coding) have the potential to elevate or demonize foods inappropriately. For instance, a diet beverage might be elevated while milk demonized. Trade organizations have also argued that what may be quite appropriate for one person's diet may be inappropriate for another, and that "standard" cutoffs are an over simplification. In late 2014, in response to complaints from industry groups and food companies that its traffic light labels would have a negative effect on product marketing, the European commission initiated legal proceedings against the Food Standards Association (FSA) in the UK. This was followed by the commission rejecting the EU-wide adoption of traffic-light labels (Harrison-Dun, 2014; Anonymous, 2015) In the US, independent of any FDA action, the Grocery Manufacturer's Association moved forward with its own, non-color coded FOP label (Kennedy and Lowe, 2010), citing concerns with the basis for color-coding in general. In Australia in mid-2014, despite strong positions favoring color-coding from several consumer groups and influential organizations (AMA, 2011; The Royal Australasian College of Physicians, 2015), the government health organization endorsed a color-free GDA style label (Commonwealth of Australia, 2015).

These attempts to limit color-coded FOPs have occurred despite a growing body of research which suggests that color-coding may increase label effectiveness (see review below). Our study adds to the body of research that favors color-coding; specifically providing evidence regarding attentional benefits. In Experiment 1, changes to color-coded FOP labels were found more consistently and more rapidly than changes to non-colored FOP labels (Fig. 6). Experiment 2 found the same pattern of results (Fig. 8), thereby extending the results to commercially available products. Thus, Experiment 2 demonstrated that the attentional benefit of FOP labels is maintained even when they compete for the consumer's attention with commercial branding information.

The fact that we find that color coded FOP labels are more effective than monochromatic FOP labels at drawing attention among those without an explicit nutrition relevant task dovetails nicely with work investigating the effectiveness of FOP labels in tasks with an explicit nutrition goal. Studies regarding the ability of colored FOPs (i.e. traffic lights) to catalyze nutritive comparisons have repeatedly suggested that they are effective. Researchers from the UK (Jones and Richardson, 2007), concluded that color-coded FOPs (traffic lighting) significantly enhanced participants' abilities to arrive at a judgement regarding product "healthfulness". This finding was echoed by a study conducted in Germany in which a color-coded FOP enhanced the chances of making a correct evaluation of the healthier choice of product during a binary force choice task compared to other types of nutrition labels (Borgmeier and Westenhoefer, 2009). Likewise, Australian researchers concluded that people were five times more likely to correctly identify a food as healthy when labeled with a traffic light FOP than a monochromatic FOP scheme (Kelly et al., 2009).

It is encouraging that the colored FOP format that has been shown to be particularly effective in the later stages of information processing (i.e. comparative tasks in the same format) also seem to be most effective at drawing attention to itself, an early stage of information processing. In short, the label that we find to garner the most attention, a color-coded FOP, is also the label that researchers who have focused on the late stages of cognitive processing (comprehension) have also found to be easiest to comprehend and use (Borgmeier and Westenhoefer, 2009; Hawley et al., 2013; Kelly et al., 2009; Roberto et al., 2012, 2010; Hersey et al., 2013). The combination of our results with those on comprehension suggests that color coded FOPs are more effectively processed at multiple stages of information processing (see Table 1), and thus is likely to be a more effective method of nutrition labeling.

It is worth noting, however, that the ultimate goal is to change people's choice in purchase scenario (Table 1; Step 4, compliance). Lab-based research on the ability of FOPs to alter the decision stage have yielded conflicting results, with some providing no evidence that FOPs influence choice (Borgmeier and Westenhoefer, 2009; Roberto et al., 2012; Hammond et al., 2013) and others reporting that they can (Koenigstorfer et al., 2013; Van Herpen and Trijp, 2011; Balcombe et al., 2010). Applied research conducted in the US has suggested that the use of a simple, self-developed, color-coded labeling system which distilled several nutrition factors into a single red, yellow or green label (Thorndike et al., 2012) did not merely assist in understanding of comparative healthfulness, but that it also positively impacted selection behavior. Levy et al. (2012) concluded that the presence of color-coded label for food and beverages positively impacted the sale of healthier products in a hospital cafeteria regardless of racial and socioeconomic backgrounds; a follow up study concluded that the encouraging selection pattern was sustained for a period of two years (Thorndike et al., 2014). In contrast to the US work, researchers from the UK (Sacks et al., 2009) reported that a study which compared sales before and after the implementation of the UK's traffic light system did not significantly influence the healthfulness of consumer choices when data from ready meals and sandwiches were compared. This was echoed in results collected in Hamburg, Germany; though a significant (positive) difference was found in the ability to identify healthier foods, there was no evidence for a difference in envisioned consumption when treatment conditions were compared (Borgmeier and Westenhoefer, 2009).

These mixed results likely contribute to the continuing policy debates regarding the value of requiring color-coded nutrition labels, and several factors possibly play a role in their disparity. The studies were conducted on different continents (North America and Europe), in different settings (hospital cafeteria vs grocery market vs laboratory) and took varied approaches to consumer education (hospital employees received specific information on label meaning and dieticians were available to answer questions for a period of time). Though all of the studies utilized FOP labels that employed color, the specific experimental designs differed. Several studies suggest that nutritional labeling is effective *when used* (Kim et al., 2001; Kreuter et al., 1997; Kristal et al., 2001). However, the only way that information can be used effectively in product selection is if all steps of the information processing model are accomplished (Steps 1–4 see Table 1). Design differences potentially impacted early stage information processing (i.e. people failed to be exposed, perceive or encode the information, barring comprehension and, ultimately selection, from occurring). As such, the effect of varied design factors (e.g. size, location, color, formatting) on early stage processing (attention) is in need further investigation so that solutions can be optimized and standardized through informed policy decisions.

Limitations

Although attention is a necessary prerequisite step to comprehension and consumption, it is not sufficient to ensure an effective nutritional label, future research is needed to determine whether (or not) the addition of these labels would aid other aspects of processing (i.e. comprehension and, ultimately, behavior). Indeed, that the ultimate goal is to change people's choice in purchase scenario, however data on whether colored FOP labels impact choice are conflicting.

In short, although we have strong evidence that color has significant influence on attention, and there is clear evidence that color-coding helps people make cross product comparisons when asked to do so (Sacks et al., 2009; Borgmeier and Westenhoefer, 2009; Kelly et al., 2009), it is less clear that proving this information would change the purchasing behavior of consumers (Sacks et al., 2009; Borgmeier and Westenhoefer, 2009; Thorndike et al., 2014). To achieve the desired goal of changing people's purchases may require a combination of an optimized method of providing nutrition information, which our research suggests would be a color coded FOP, and public education about the need to use that information to make more healthful food choices.

Conclusions

By applying a change detection method commonly used in visual cognition research, we were able to empirically evaluate attention to FOP labels and the traditional NFP label. Our results provide clear evidence that FOP labels are more effective at attracting attention than the traditional NFP labels, and that this advantage is attributable to both the location of the FOP on the front panel and to its design elements. In addition, our comparisons between different FOP designs demonstrate that color-coding FOP labels is an effective method for increasing attention to the FOP. These results hold whether one considers novel brands with sparse graphics (Fig. 3a) or more realistic, commercially-available products (Fig. 3b). Finally, we found no evidence that these findings depended on the health level of the product, and we found no evidence that coding the FOPs with facial expressions of emotion influenced attention to the labels. This latter finding is somewhat surprising given a considerable body of basic research which suggests that people show an attentional bias for face stimuli (Langton et al., 2008).

This work directly answers objective 4.3 of the FDA"s 2012–2016 Strategy, to "improve consumer access to and use of nutrition information" by investigating front-of-pack labeling using evidence-based approaches (Office of Foods, 2012). Further, it demonstrates that the application of an information processing approach can be combined with experimental methods from visual cognition to provide empirical evidence about effective labeling practices, thereby providing evidence which can be leveraged in informed policy making.

Authors' contributions

MWB, NMB, LB: designed research, analyzed data, wrote paper; RPS: designed research, performed research, analyzed data, wrote paper: CP; performed research, wrote paper.

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