Improving Food Labels for Health and Safety: Effects of Ingredients List Placement on Search Times

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Finding the ingredients on food product labels can be critical for safety and health. This study examines whether the amount of time it takes to locate an ingredients list on a food product label depends on its physical location, or its position relative to a conspicuous landmark, the nutrition facts panel (NFP). The position of the ingredients list was manipulated with respect to 6 potential label locations and its position relative to the NFP, yielding 30 possible combinations of locations for the ingredients list and NFP. Participants were shown the set of 30 layouts in random order, with instructions to find the ingredients list on each layout. Response time (ms) for finding the ingredients list was recorded. Analyses indicated a significant vertical position effect, with placement on the bottom producing longer response times than the top or middle positions. Other analyses examined the relative distance between the ingredients and the NFP, which showed that participants found the ingredients list faster when it were located near the NFP, as opposed to placements furthest away. Implications for the understanding search times on relatively complex labels are discussed. Benefits for health and safety through better food labeling are described.

INTRODUCTION

The ability to determine the ingredients contained in food products can be crucial for health and safety. Some consumers need to avoid certain ingredients because of allergies, dietary restrictions, or drug interactions. On the other hand, health conscious consumers may seek out certain ingredients for their beneficial qualities. For healthier dietary choices, the ingredients list serves as a foundation. Figure 1 shows an example ingredient list from a U.S. food label.

Given its importance to health and safety, consumers ought to be able to locate the ingredients list easily. But current U.S. regulations allow wide latitude for placement of components on food labels (U.S. Code of Federal Regulations, 2015), and the ingredients list often gets buried in complex labels that are dense with information. Some placements on a label might aid consumers in finding the ingredients more easily, whereas other placements might make the ingredients more difficult to find. A simple way to assess whether something is easy or difficult to find is to measure how much time a user takes to locate it. Shorter search times would indicate easier-to-find locations or placements. The current study examined whether different locations of the ingredient list on a food label affects the speed with which participants are able to find it.

Prior research suggests that standardized placement helps people locate information. For example, consistent placement of component information within nutrition facts panels helps people make healthy choices based on stated nutritional values (Wogalter & Kalsher, 1994; Wogalter, Shaver, & Chan, 2002). However, because food labels often have complicated layouts with numerous component sections (e.g., brand-related graphics, cooking suggestions, recipes, marketing information, etc.), it would probably be unfeasible to mandate a rigid, consistent placement of the ingredient list on food labels without permitting numerous exceptions.

In the U.S., the nutrition facts panel (NFP) has been required on food labels for processed foods since 1990 (NLEA, 1990). Figure 2 shows an example NFP. NFP labels have a relatively consistent format (although exceptions are allowed) and usually take up a substantial portion of the entire food label. The large size and distinctive appearance of the nutrition facts label would tend to make it stand out amongst other components on the label. Potentially, the NFP could serve as a conspicuous landmark that attracts immediate attention and if the ingredients list is nearby may reduce the time to find the list. An ingredient list placed adjacent to the NFP might therefore be easier to find than an ingredient list more distantly separated from the NFP. This is one of the issues addressed in the present research.

Specifically, two hypotheses were generated to help explain ingredient list search times as a function of its placement on the food label. The first hypothesis that might help to explain search times is based on reading order. Prior research indicates that people frequently scan information visually in the directions that corresponds to the reading direction of the language they use. For example, English-language users read from left to right and from top to bottom, and they tend to scan other informational displays in similar directions (e.g., Bzostek & Wogalter, 1999). Support for the reading order hypothesis has been found in label-search research showing that warnings on a complex medication labels are found faster when they are placed closer to the top and left relative to the bottom and right (Bzostek & Wogalter, 1999; see also Lim & Wogalter, 2000). Thus, the reading order hypothesis predicts that participants would locate an ingredient list faster if it were placed at the top of a food label than near the bottom.

However, search times may depend on other factors. An alternative pattern of search time results is predicted based on the notion of landmark adjacency (Grishin, Walkington, & Wogalter, 2015). If the relatively conspicuous NFP draws attention to itself, then an ingredients placed near it might aid search times compared to the ingredients list being placed more distantly (i.e., less versus greater separation between them). As a prominent, salient landmark the NFP would likely be one of the first components on the label that would capture attention at the beginning of the search. The landmark adjacency hypothesis predicts that faster search times would result by placing the ingredient list near the location of the

nutrition facts panel compared with more distant placements. Grishin et al. (2015) found some support for both the reading order and the landmark hypothesis, but the results did not definitively support either suggesting that both factors may play a role in search times for the ingredients. However, Grishin et al. was a preliminary study that placed the ingredients list in only four possible locations on the label. The limited number of label positions might have been insufficient to distinguish search time patterns between the reading order versus landmark adjacency hypotheses. In this follow-up study the number of ingredient-list positions were increased. There were 30 different conditions in which the ingredients list and the NFP appeared in every position relative to each other.
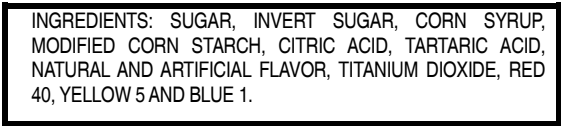
INGREDIENTS: SUGAR, INVERT SUGAR, CORN SYRUP, MODIFIED CORN STARCH, CITRIC ACID, TARTARIC ACID, NATURAL AND ARTIFICIAL FLAVOR, TITANIUM DIOXIDE, RED 40, YELLOW 5 AND BLUE 1.

Figure 1. An example ingredient list.

Figure 2. Example nutrition facts label.

METHOD

Participants

A web based polling site, Mechanical Turk, was used to recruit participants. Several studies have demonstrated that Mechanical Turk is a valid method of conducting behavioral research via the Internet (e.g., Paolacci, Chandler, & Ipeirotis, 2010; Goodman, Cryder, & Cheema, 2013). Mechanical Turk's built-in screening tools were used to limit participants to those only from the United States and to those that had a hit approval rate of at least 95%. The hit approval rating refers to the percentage of Mechanical Turk assignments for which a participant's results were reviewed and approved by a researcher. It is a measure of participant reliability. Forty-

seven participants with complete data were used in the analysis. Participants were paid $0.55 for their participation.

Materials

Thirty (30) two-dimensional layouts of a cough drop package were created based on an existing package design. The locations of the ingredients list and the NFP were systematically varied on each of the 30 layouts. The ingredients list and the NFP were rotated so that they appeared in every position of six-sector label. The U.S. Food and Drug Administration updated the NFP during the time this report was being prepared (U.S. Food & Drug Administration, 2016). The current research used the older version of the NFP (as in the example shown in Figure 2).

Figure 3 shows the position of the ingredients list and the nutrition facts label on the 30 layouts. The ingredients list is represented by green rectangles labeled "ING." The nutrition facts label (NFP) is represented by orange rectangles labeled "NFP." The gray circle, labeled as "other" was a bar code representing the UPC code commonly found on food packages. This component was not a focus of this report and is not described further.


Figure 3. A schematic representation of all 30 layouts. The ingredients lists are represented by green rectangles labeled "ING." The nutrition facts panels are represented by orange rectangles labeled "NFP." The gray circles for "other" were not analyzed.

The food label's layout or panel was divided into six sectors: two horizontal positions (left and right) and three vertical positions (top, middle and bottom). The ingredients list and NFP were systematically manipulated to appear in every possible position with respect to each other. Figure 3 illustrates how the systematic variation was implemented. In the first column for example, the ingredients list (designated as green rectangle) occupies the top left section, while the NFP is rotated through each of the remaining 5 sectors. Similarly in the second column, the ingredients list occupies the top right sector while the NFP is rotated through all of the 5 remaining sector positions. All the columns were laid out according to the same principle.

Moving the ingredient list necessitated displacing some of the other layout components (e.g., product name, warning label, etc.). In all cases, displaced components were kept as closely as possible to their original locations. Together the layouts reflect reasonable, ecologically valid placements of label components. Figure 4 shows two example labels of the 30 layouts. The layouts depicted correspond to schematic representations 6 and 21 in Figure 3.
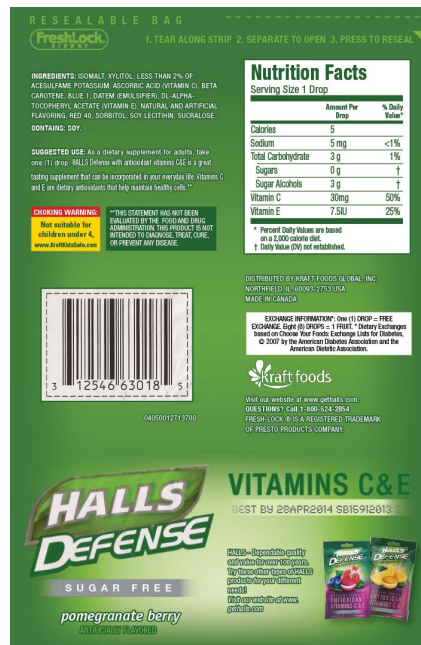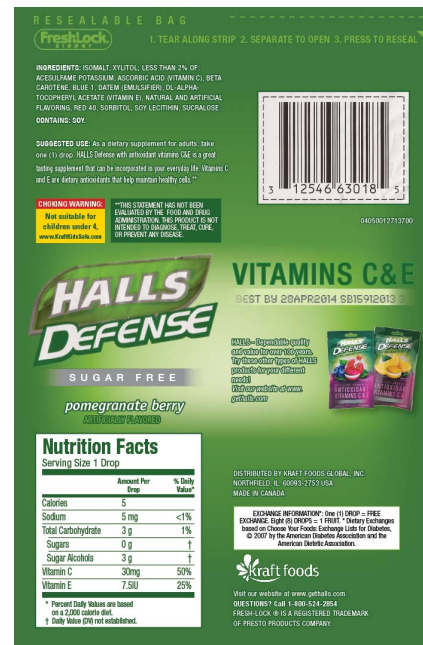
Layout 6   *Layout 21*

Figure 4. Two examples of the 30 layouts. Layouts 6 and 21 correspond to representations 6 and 21 in Figure 3. The ingredients list is located in the top left section in both layouts, while the NPF is located in the top right sections in Layout 6 and bottom left sections in Layout 21.

Procedure

The application programming interface for survey software, Qualtrics, was used to develop the online search task. It was programmed to test whether the 30 layouts differed in the amount of time that participants took to locate the ingredients list. A JavaScript sub-routine was written into the program that determined whether participants' screen and browser were large enough to view the entirety of each layout without having to scroll. If the screen was too small, a message appeared informing the participant that he/she could not continue, and the session was terminated.

After completing an informed consent form, participants were shown a screen with a gray box. Instructions on the gray box informed participants that the study would begin when they clicked on the box. At that point, they would be shown a food label. When the food label appeared on the screen, participants were to find the list of ingredients as quickly as possible and click on it with their mouse cursor. A timer was started at the moment the food label appeared, and was stopped at the moment the participant clicked on the list

of ingredients. This procedure was repeated for all 30 layouts. A different random order of layouts was used for each participant.

RESULTS

As is common is response time studies, the time data (ms) were converted to log 10 scores to reduce undue effects of a few outlier, long-duration scores. The means and standard deviations presented in the tables have been transformed back to milliseconds.

Several statistical analyses were used. In the first analysis, a one-way repeated-measures ANOVA with 6 levels was conducted. The ANOVA showed a significant effect of condition on response time, $F(3.4, 156.4) = 9.39$, $MSe = .111$, $p < .001$, $\eta = .17$. The six means are shown in the internal cells of Table 1. Post hoc comparisons using Fisher's LSD test at .05 showed that there were no significant differences among the means for the Top Left, Top Right, Middle Left, and Middle Right sector conditions. However, these four

sectors produced significantly faster response times than the Bottom Left and Bottom Right sectors.

Another analysis of these same data involved a factorial design, specifically using a 3 (Horizontal: top, middle, and bottom) X 2 (Vertical: left right) repeated measures analysis of variance (ANOVA). The means from this analysis are shown in Table 1. There was a significant main effect of vertical position on response time, $F(2, 92) = 14.1$, $MSe = .219$, $p < .001$, $\eta = .24$, but not for the horizontal factor, $F(1, 46) = .12$, $MSe = .001$, $p = .73$, $\eta = .003$. There was also no significant interaction between the vertical and horizontal factors, $F(2, 92) = 2.06$, $MSe = .010$, $p = .14$, $\eta = .043$.

Post hoc comparisons using Fisher's Least Significant Difference (LSD) test with a probability criterion of .05 on the vertical main effect means showed that participants were significantly faster in finding the ingredients list when it was in the top and middle sectors compared to the bottom sector. There was no significant difference between the top and middle sectors.

Table 1
Mean response time (in milliseconds) to find the ingredient list as a function of 3 (Vertical) X 2 (Horizontal) location of the food label. Standard deviations for conditions are shown in parentheses.

| Vertical | Horizontal | | |
	Left	Right	mean
Top	1983.75 (772.8)	1833.10 (531.4)	1908.43
Middle	1896.31 (1278.0)	1948.34 (1483.8)	1922.32
Bottom	2151.30 (848.1)	2365.91 (1157.5)	2258.61
mean	2010.45	2049.12	

Another analysis examined response times as a function of the distance between the ingredients list and food nutrition panel. The landmark adjacency hypothesis suggests that a salient landmark, in this case the NFP, might benefit the finding of the ingredients list if they are closer to each other. To test this hypothesis, all 30 layouts were categorized to reflect a measure of distance between the ingredients list and the NFP that roughly corresponded with their physical separation. In layouts where the ingredients list and the NFP are close together and orthogonally positioned (adjacent on a side), a code of 0 was assigned. In layouts, where the ingredients list and NFP are immediately adjacent but positioned diagonally from each other, a code of .5 was assigned. In layouts, where the ingredients list and NFP were far apart but oriented orthogonally (one space away but in either the same row or column), a code of 1 was assigned. In layouts where the ingredients list and NFP were far apart and placed diagonally (with one space between and in a different row or column) from each other, a code of 1.5 was assigned. Thus, the distance coding, while not a perfect linear measure, was indicative of an order of increasing distance. Table 2 summarizes the distance coding and the specific layouts reflecting those distances. Figure 5 graphically shows the layouts with respect to these four distance conditions.

Table 2
Mean search times (in ms) and standard deviations (SD) to find the ingredient list as a function of distance and orientation from the NFP. Table also shows distance codes for conditions and the layouts included in reference to those in Figure 3.

Distance & Orientation	Distance Code	Layouts	Mean	SD
Near Orthogonal	0	1, 2, 6, 8, 11, 13, 14, 17, 18, 20, 23, 25, 29, 30	2026.53	1037.66
Near Diagonal	.5	3, 7, 12, 15, 16, 19, 24, 28	1872.23	638.56
Far Orthogonal	1	4, 10, 21, 27	2088.16	849.60
Far Diagonal	1.5	5, 9, 22, 26	2298.06	1041.34

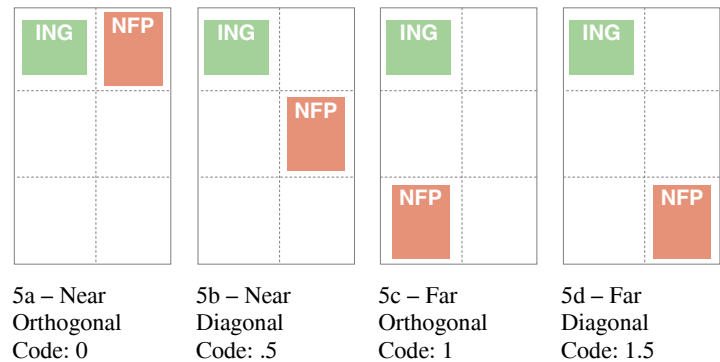| 5a – Near Orthogonal Code: 0 | 5b – Near Diagonal Code: .5 | 5c – Far Orthogonal Code: 1 | 5d – Far Diagonal Code: 1.5 |

Figure 5. Four illustrations of layouts reflecting the 4 distance codes.

A one-way repeated-measures ANOVA with 4 levels of distance conditions on ingredient list search time was conducted. The ANOVA indicated a significant effect, $F(2.6, 121.1) = 7.6$, $MSe = .048$, $p < .001$, $\eta = .14$. Table 3 shows the means and standard deviations for the four conditions. Post hoc comparisons using Fisher's LSD test at a probability level of .05 showed that the near orthogonal (coded 0) and near diagonal (coded .5) conditions yielded significantly faster search times than the far diagonal (coded 1.5) condition. The adjacent diagonal (coded .5) condition was significantly faster than the far orthogonal (coded 1) condition. Thus, the two near conditions were not significantly different from each other, and the two far conditions were not significantly different from each other. These findings suggest that shorter distance from the NFP reduced ingredients-list's search time.

With these same data, a factorial design was used, specifically a 2 (Near, Far) X 2 (Orthogonal, Diagonal) repeated measures analysis of variance (ANOVA). The means from this analysis are shown in Table 4.

Table 4
Mean response time (ms) to find the ingredient list as a function of 2 (Distance) X 2 (Orientation) location of the food label. Standard deviations for conditions are shown in parentheses.

| Distance | Orientation | | |
	Orthogonal (sd)	Diagonal (sd)	mean
Near	2026.53 (1037.7)	1872.22 (638.6)	1949.38
Far	2088.02 (849.6)	2298.06 (1041.3)	2193.04
mean	2057.27	2085.14	

The ANOVA showed a significant effect of near versus far placement on search times, $F(1, 46) = 14.5$, $MSe = .093$, $p < .001$, $\eta = .24$, but no significant main effect of orthogonal versus diagonal, $F(1, 46) = .59$, $MSe = .003$, p = .44, $\eta = .013$. However, there was a significant interaction, $F(1, 46) = 5.71$, $MSe = .031$, $p = .02$, $\eta = .110$. The interaction pattern displayed within the cells of Table 4 appears to show that when orthogonally positioned, it did not matter whether the ingredients list and the NFP were near versus far, but when they were positioned diagonally the far distance produced longer search times than the near position.

DISCUSSION

Being able to find the list of ingredients on food product labels can potentially benefit persons who may need to avoid certain components of a processed food product (e.g., allergy sufferers). It could also benefit persons seeking out certain desired ingredients as part of a healthy diet. This study examined whether the search time to find the ingredients list might be affected by its physical and relative position on a food label. Two hypotheses were investigated to describe the search time data. The reading order hypothesis predicts that the ingredients lists would be found faster if located closer to the top as opposed to the middle/bottom areas of a label. The second hypothesis was the landmark adjacency hypothesis, which predicts that placing the ingredients list near a salient landmark, such as the nutrition facts label (NFP), would result in faster search times. In an earlier study, Grishin et al. (2015) found partial support for both of these hypotheses, but also found results that did not fully support either hypothesis. The present study used a larger number of conditions in an attempt to uncover whether there would be clearer support for one hypothesis over the other. But again, the results provide some support for both hypotheses. Specifically, the results showed that placing the ingredients in top and middle sections of the label was significantly better than placing them near the bottom. This aspect of the findings supports the reading order hypothesis.

However, another analysis provided some support for the landmark adjacency hypothesis. According to this hypothesis, a highly salient feature (in this case the NFP) would attract the initial gaze, and then targets (in this case the ingredients list) that are closer to the landmark would be found faster than targets positioned farther away from it. The search time scores for the 30 layouts were categorized in terms of the distance between the ingredients list and the NFP. Results showed that when the list of ingredients was located closer to the NFP, search times were faster. Conversely, search times were slower when the two components were more distant from each other. This finding suggests that proximity with respect to a conspicuous landmark influences search time. The landmark attracts the initial gaze, and when the list of ingredients is close to the landmark, people find the list faster.

Overall this research support the idea that the ingredients list's positioning on a food label affects search time. Search times can be reduced by placing the ingredients list in the upper portions of the label, and near a conspicuous landmark, such as the NFP. Placing them together also makes

sense semantically as they both concern the food product's content.

These findings could serve as a basis for potential revisions of food labels in future regulations and manufacturers' labeling decisions. Since there are currently relatively few regulations on label-component placement, manufacturers determine how the packages are laid out, not always based on consumer feedback. Manufacturers (and distributors) could choose to use layouts that will make the ingredients easier to find (such as in cases where the ingredients are deemed healthy) or manufacturers could choose to place them so as to make them more difficult to find (so as to reduce the likelihood that unhealthy ingredients would be attended to). However, this game can be dangerous when the ingredients list includes items for which some people are allergic, etc. Making it difficult to find the ingredients list could lead to serious consequences.

In terms of basic visual performance, the results support the notion that a salient (landmark) object attracts visual attention initially and then moves outward from there to find the desired target. This finding could be confirmed by eye movement recording and may be useful in interpreting search times in other tasks.

Finally, these findings could be useful for other domains involving visual search apart from food labels. There are potential applications to labels of non-food products and various other complex displays in which certain information is looked for. For example, it might provide guidance for the placement of components on labels for other kinds of products, such as household chemicals.

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