

An Eye-tracking Study of People's Perception towards the Ingredient Section on Food Packages

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Abstract: *The ingredient section of food packages provides crucial insights into the product's components and health effects. However, only some consumers pay attention to the ingredient section. Many consumers tend to read other components of food packages. Previous studies about packaging focus more on improving visual design. Not much research has explored the ingredient section. This study investigates people's gaze distribution on the ingredient section when viewing food packages. The impacts of the following variables are studied: subjects' education level, different types of ingredients, and the length of the ingredient section. Moreover, an eye-tracking device is adopted in this study. An eye tracker could provide quantitative results of people's attention. This study sampled 22 participants in total. T-test results indicated that participants with a higher education level tended to focus more on the ingredient section than less educated ones. Additionally, people focused more on uncommon ingredients than common ones. When viewing lengthy ingredient sections, people looked at the middle area more than the top and bottom areas. These research findings could contribute to improving food packaging design and call for increasing awareness about nutrition-related knowledge.*

Keywords: *eye tracking, food package, ingredients, attention, gaze behavior*

1. Introduction

What we eat is essential to health. According to the World Health Organization, a healthy diet guarantees individuals' well-being and avoids potential illnesses ^[1]. As human society develops at a sky-high rate nowadays, a larger population tends to choose processed food for convenience. For instance, the consumption rate of ultra-processed food, such as snacks and soft drinks, has increased gradually since the late 1990s until the early 2010s worldwide ^[2]. Typically, processed food is required to add ingredient labels on the packages. For instance, processed food in the United States must be labeled with nutrition facts since 1990, according to The Nutrition Labeling and Education Act of 1990 ^[3]. By reading the nutrition facts and recognizing the ingredients, consumers are able to know what exactly and how much they are about to intake. Thus, obtaining the essential ingredient information from food packets is vital to a balanced diet. There has been a growing interest in improving food packaging design. Though it is essential to communicate the ingredient facts to consumers, only a little research has investigated this area. More studies focus on making packages more attractive, improving the visual design, or modifying packaging materials ^[4-9]. This research explores people's attention toward the ingredient section of food packages. Instead of using questionnaires or interviews, the present study leverages eye-tracking technology. Moreover, only some investigations have adopted eye-tracking technology to investigate people's attention distribution when buying food. By using eye trackers, researchers can objectively and quantitatively record the eyeball's movement, reflecting people's attention when looking at a product and their response to the perceived information. Some research using the eye tracking method on people's attention distribution is more on the visual aspects of food packets, such as product color, label sizes, and nutrition labels. Few studies have focused on the ingredient section ^[10-11].

This research aims to use an eye-tracking device to study how people's attention is distributed when viewing food packages with a focus on the ingredient section. There are three primary aims: (1) to examine the impact of people's education level on their focus on the ingredient section; (2) to explore how people's attention is distributed when viewing a long ingredient list; (3) to investigate how people's attention is distributed between common and uncommon ingredients. By analyzing the data generated by the eye tracker, such as total fixation duration and fixation count, a quantitative conclusion can be drawn on an individual's perception of the food ingredient section. This study aims to provide new insights into consumers' perceptions of food packages. The findings can help improve the effectiveness of current food packages in communicating health-related information.

2. Materials and Methods

2.1. Participants

The study sampled 22 participants, including 12 females and 10 males ($M=28.7$, $SD=10.7$). All participants were randomly recruited from a mall in Shanghai, China. Before the experiment, the participants were informed that they were part of a social study and would view several photos. All participants participated in the experiment voluntarily. Snacks were given as gifts to participants after the experiment was completed.

2.2. Stimuli

Five images of food packages were chosen as the stimuli for the experiment. The five types of food were chocolate chip cookies (P1), dried pork slices (P2), stick cookies (P3), cereal bars (P4), and chocolate bars (P5). These snacks are popular products in convenience stores and supermarkets, making them good samples to reflect how people view these products in daily consumption. The first two images (P1 and P2) showed the food packaging of two different snacks with both front (brand-related information) and back sides (ingredient-related information). The front and back sides of the packaging were at the same picture size. The last three images (P3, P4, and P5) showed a close-up view of the ingredient section on food packages so that people could view the ingredient section exclusively and that their eye movement within this section of the food packaging could be studied. These close-up views of the ingredient section varied in length, with P5 being the shortest and P4 being the longest.

To exclude impacts brought by backgrounds, all pictures were cropped to show the food packages or the ingredient section exclusively in a similar size; the pictures were shown on a white background. In addition, all pictures were enlarged to allow participants to process all texts and details.

2.3. Design and Procedure

The first part of the study (P1 and P2) aims to compare the gazing behavior of people with different education levels when viewing the front side (brand-related information) and the back side (ingredient-related information). Both sides are displayed on the same page. The second and third part of the study (with P3, P4, and P5) investigates people's attention distribution within the ingredient section exclusively.

The first part of the experiment adopted a between-subject design. The participants were divided based on their education level. The G1 group included participants with a bachelor's degree, and the G2 group included participants with a bachelor's degree or higher. The second and third parts of the experiment adopted a within-subject design comparing people's gazing behavior of the ingredient section.

The experiment was conducted in a café. Participants signed the consent form before experimenting. Then participants sat in front of a screen with an eye-tracker (Tobii 4C) placed at the bottom and connected to a laptop with the software Tobii Pro Lab. The laptop was connected to the eye tracker. Several slides with brief experiment instructions were shown on the screen first, asking the participants to look at the screen and not move during the experiment. Next, participants were asked to complete the nine-point calibration procedure to ensure the gaze would be captured. The experiment started after a successful calibration. The five stimuli images were displayed automatically on the screen in the assigned sequence for all participants. The duration of each image was 20 seconds. After the experiment, personal information, including education level and self-acknowledged attention to food ingredients, was collected using a survey.

In the first part of the experiment, the AOIs include the ingredient section in P1 and P2, respectively. In the second part of the experiment, the AOIs were drawn differently. In P3 and P5, AOIs were classified into two types, the Common Ingredients (including sugar, vegetable oil, and cocoa powder) and the Uncommon Ingredients. P4 was separated into three AOIs, the lower part (Lower), the middle part (Middle), and the upper part (Upper) of the ingredient section. Total fixation duration (TFD) and fixation count (FC) were used to analyze the participants' attention.

2.4. Data Analysis

T-tests of TFD and FC were carried out between the G1 group and G2 group for the first research question. For the second research question, T-tests on TFD and FC of the common and uncommon ingredients were conducted on P3 and P5. In addition, ANOVA was carried out to analyze participants'

attention distribution on P4 for the lower, middle, and upper parts.

3. Results

3.1. TFD and FC between G1 and G2

As shown in Table 1, the T-test results of TFD indicated that the participants in G1 ($M = 1.47$, $SD = 0.79$) concentrated on the food ingredient section significantly less than the participants in G2 did ($M = 2.64$, $SD = 2.30$; $t = -1.76$, $p < 0.05$). On the other hand, the T-tests results of FC showed no significant difference between participants in G1 ($M = 7.29$, $SD = 3.68$) and G2 ($M = 11.13$, $SD = 7.77$; $t = -1.61$, $p > 0.05$).

Table 1: Mean TFD and FC of G1 and G2 group on the ingredient section of the entire food packet.

	TFD (s)	FC
G1	1.47	7.29
G2	2.64	11.13

3.2. TFD and FC within P3 and P5 on common and uncommon ingredients

Table 2 shows TFD and FC of participants on common ingredients and uncommon ingredients in P3 and P5. After conducting the t-test analysis of TFD, the results revealed that participants paid significantly more attention to the uncommon and unknown ingredients ($M = 0.27$, $SD = 0.12$) compared to the common and familiar ingredients ($M = 0.19$, $SD = 0.14$; $t = -1.81$, $p < 0.05$). In addition, the T-test showed that FC on common ingredients ($M = 0.06$, $SD = 0.03$) was also significantly different from uncommon ingredients ($M = 0.27$, $SD = 0.09$; $t = -11.15$, $p < 0.05$).

Table 2: TFD and FC of participants on common and uncommon ingredients.

	TFD	FC
Common Ingredients	0.19	0.06
Uncommon Ingredients	0.27	0.27

3.3. TFD and FC in P4

As seen in Table 3, the single-factor ANOVA test indicated a significant difference among the TFD of the ingredient's lower, middle, and upper parts within P4 ($p < 0.05$, $F = 7.20$). Participants focus on the middle part ($M = 5.23$, $SD = 2.63$) of the ingredient significantly more than the upper ($M = 3.42$, $SD = 2.23$) and lower ($M = 2.59$, $SD = 2.19$) regions. Similarly, the results from FC of the single-factor ANOVA test also support this significant difference ($p < 0.05$, $F = 9.03$). Participants also paid significantly more attention to the middle area ($M = 25.95$, $SD = 10.90$) than the lower ($M = 13.36$, $SD = 9.87$) and upper ($M = 16.55$, $SD = 9.85$) areas.

Table 3: Mean TFD and FC of participants on lower, middle, and upper parts of P4.

	Lower	Middle	Upper
TFD (s)	2.59	5.23	3.42
FC	13.36	25.95	16.55

4. Discussion

This research investigates people's gazing behavior when viewing food packaging and nutrition labels. The first part of this investigation studies the distribution of attention among people with different education levels. The second and third parts of the study examined people's attention distribution within the area of the ingredient section.

For the first part of the study, the TFD results of participants from G1 and G2 show a significant difference. The results indicate that people with higher education tend to pay more attention to the ingredient section on food packages than those with lower education level. People with bachelor's degrees

or above may have more awareness and knowledge about health and nutrition. This result matches the finding that Nesbitt and Palomarez came up with about the relationship between health awareness and disease trends. They concluded that the chance of controlling diabetes is highly related to the level of education^[12]. When viewing food packages, people with higher education levels tend to choose healthier food, leading them to pay more attention to the ingredient section.

In the second part of the study, both TFD and FC results show that people pay more attention to uncommon ingredients. A possible explanation for more attention to uncommon ingredients is that people need to spend more time processing unfamiliar ingredient names and interpreting their meaning. This phenomenon indicates that unfamiliarity is a crucial factor that affects reading speed, which aligns with a previous study^[13]. In this research, Juphard mentioned that one's reading speed would increase as new phrases become familiar through proper practice.

When comparing the attention distribution within a long ingredient list, the present study shows that the middle part draws more attention than the top or the bottom. People's memory capacity could explain this phenomenon. Sanders concluded that when individuals process various cycles of information, memories of the previous cycles will be partly lost due to the limitation of memory capacity^[14]. When people read the upper part of the ingredient section, their working memory capacities were still abundant. However, when it came to the middle and the lower part, the memories were not enough, and they needed to go back to reread the last part.

Future studies could include more participants to increase the sample size. Moreover, despite education level, other factors may also influence people's gazing attention towards the ingredient section, such as cultural background, age, and gender. More factors could be explored to generate a more comprehensive result. This research uses snacks as stimuli. Other food or drinks (i.e., sandwiches, burgers, soft drinks, and alcohol) may have different results. More types of food could be included in future studies.

5. Conclusion

This study leverages eye-tracking to explore people's gazing behaviors when viewing the ingredient section on food packages. The results show that people with higher education levels focus more on the ingredient section. More corresponding education is needed to improve people's health and nutrition awareness, especially for people with comparatively low education levels. Compared to common ingredients, people tend to pay more attention to those uncommon ones. When the ingredient section is long, people concentrate more on the middle than the upper and lower parts. Brand owners may consider the above findings when designing food packages, i.e., change the textbox size to adjust some specific ingredients' position. These findings contribute to understanding consumers' perception of the ingredient section and will help improve food package design to communicate information better.

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