Expiration Date Legibility of Food Packaging in Terms of Position

Duyen (Tracy) Nguyen
Department of Computer Science
Clemson University
duyenn@g.clemson.edu

Li Zeng
Department of Computer Science
Clemson University
Zeng2@g.clemson.edu

Zhaoxin Deng
Department of Computer Science
Clemson University
zhaoxid@g.clemson.edu

ABSTRACT

Speed and eye movement measures were used to determine the average time it takes to locate expiration dates on images of food packages in the form of a can and a box. The two expiration date locations used were the top and bottom-front of the packages. In this study, we want to find the appropriate location for expiration dates, in which consumers take less time and effort in finding. A total of 10 participants of 1 female and 9 males with normal color vision and their age ranging from 18 to 50-years-old participated in the experiment. There were 6 participants who had corrected vision with glasses. Out of the 20 corrects trials, under each of 4 conditions performed by the 10 participants, all of the participants successfully found the expiration dates on their given packages. We found that participants spent less time to find expiration dates in Stimulus A (Box, Top) and Stimulus C (Can, Top) than Stimulus B (Box, Bottom-front) and Stimulus D (Can, Bottom-front). The information gathered might help producers to design more effective food packages for their food to be consumed in their appropriate time range.

INTRODUCTION

According to Dictionary.com, an expiration date is, “the last date that a product, as food, should be used before it is considered spoiled or ineffective, usually specified on the label or package” ("the definition of expiration date", 2016). This study explores the speed and time of finding expiration dates on either the top position or bottom-front position on food packaging.

Expiration dates on food packages are essential and could benefit consumers and producers if it were easier to identify. Consumers should not have to spend a lot of time on finding expiration dates on food products because it is important information prior to purchasing and consuming food items within the packaging. The goal of this study is to analyze eye movement data on food packaging to determine the expiration date legibility in terms of position. Experiments are conducted to study the amount of time participants take to find the target of expiration dates with either the date being positioned on the top or bottom-front of the packaging. The study is also aimed at discovering the location the participants look first to find the target.

When searching for expiration dates on food items, the task can be tedious regarding the various shapes and sizes that items are packaged in. Some package designs can be very busy with clutter and colors. We believe that placing expiration dates away from the main design of food packages could reduce the time it takes to find expiration dates.

In our attempt to research previous related studies, we discovered that there were not many published studies focusing on positions of expiration dates on food packaging. This study could potentially influence and encourage producers in considering more research on this topic for future food packing design. This eye tracking study was originally inspired by an unpublished eye tracking experiment by Holmes et al. (2013), “Pharmaceutical Packaging: Placement of Active Ingredient and Expiration Date on OTC medicine.” We found their study encouraging in the sense of usefulness for package design improvement.

The results of this experiment were determined using a velocity-based metric to compare the position, in which, participants have the most speed and accuracy in locating expiration dates between- and within-subjects.

Hypotheses

The following hypotheses were developed prior to conducting the experiment. The first hypotheses was created with observation of less clutter on the top of the food package designs. The second hypotheses was created with observation of less clutter on the front of the food package designs.

H1: Expiration dates at the top of food packages increases discovery by participants due to less clutter in the position of the package design.

H2: Expiration dates at the bottom-front of food packages decreases discovery by participants due to the clutter in the position in the package design.

BACKGROUND

In Duchowski's book *Eye Tracking Methodology* (2009), it helps explain the topic of visual attention and visual search to give us more background on how eyes function. It states that "attention is used to focus our mental capacities on selections of the sensory input so that the mind can successfully process the stimulus of interest" and "our capacity for information is limited" (Duchowski, 2009, pg. 4). Busy package designs could take up unnecessary mental capacity if the target is not discovered sooner. The book provided a two-stage process to describe visual search. Duchowski describes the two-stage process as: 1) "A time-consuming visual search for a target", and 2) "A decision process identifying the found item as either target or nontarget" (Duchowski, 2009, pg. 251).

Clement's study also looked into the visual attention of consumers and their limited capacity for perceptual stimuli. To further explain his study, he stated, "It is widely accepted that the human brain has limited capacity for perceptual stimuli and consumers' visual attention, when searching for a particular product or brand in a grocery store, should then be limited by the boundaries of their own perceptual capacity" (Clement et al. 2013). This information can be applied to a user at the grocery store purchasing an item. Not all foods get purchased, or consumed, before their expiration dates.

Expiration dates can go easily unnoticed if they are practically hidden within the package design. The risk of consuming over expired food items are just as important as having to waste food due to forgotten times of expiration dates. In Visschers study, it states that health-conscious consumers would purchase a variety of perishable foods, which were not all eaten and had to be discarded to avoid food risks (e.g. use-by dates or length of time the food had been kept in the refrigerator), were found to throw away more food (Visschers et. al, 2016).

In the "Eye Tracking the Visual Search of Click-Down Menus" study, they discussed the EPIC model. According to the study, "The EPIC model is made to predict latency, accuracy, and ease of learning for a wide variety of HCI-related tasks...2) In cases of serial top-to-bottom search, the users' eyes should move down to the menu a constant distance in each saccade, which is exhaustive in that every item of the menu from item 1 to the target item is examined" ("Eye Tracking the Visual Search of Click-Down Menus", 1999). Some consumers may have a natural tendency to search for expiration dates from top-to-bottom. This study helps us understand how users interact and perform tasks with their eyes.

Clutter in designs could be a big factor in the time it takes to locate expiration dates. In Ho's study "Visual Search for Traffic Signs: The Effects of Clutter, Luminance, and Aging," it compares the effects of clutter for traffic signs with older adults drivers versus younger drivers. With the use of Burton Trial Lenses, they found that errors were more common among the elderly and visual search efficiency declined with increased clutter and with aging (Ho et. al 2001). This brings up health concerns for older adults having difficulty finding expiration dates and potentially ingesting over expired products.

In O'Hanlon & Read's eye tracking study, it provides information on "blindness to background." Some food packing designs have a variety of objects and pictures, and it can be difficult engage visual attention on the language of numbers. The study explains, "The 'blindness to background' effect was abolished by the use of nouns, for example when asking children to point to 'water' rather than to 'blue' whilst eye movement patterns did not differ across adjective and noun conditions. This shows that the inability to switch attention from figure to ground depends on the nature of the linguistic

cue, providing robust, converging evidence of a powerful, inbuilt tendency to attend to objects when interpreting color language" (O'Hanlon & Read, 2016). The results of their study suggest that the predisposes humans to attend to figure not ground when interpreting language (O'Hanlon & Read, 2016). This discovery could be a contributing factor to the increased time it takes to find find the dates as well.

The time that you lose trying to find expiration dates on food items could lead up to important time-based decisions. The frustration of not being able to find the dates may discourage consumers in purchasing products all together. Clements found, "Rather than long explorations, deliberations and acts of choice, consumers are more likely to reach their decisions within a few seconds" (Clements et al. 2013). Discovering the most suited position for expiration dates in food packaging may help consumers make good choices.

METHODOLOGY

The experiment was conducted in the McAdams Eye Tracking Lab at Clemson University. A GazePoint GP3 Eye Tracker was used to track eye movements of the participants' gaze data during the experiment. The metrics is the time it took and the location to first glance at. The fixations were produced and recorded by the eye tracker after each participant completes the experiment. A pre-questionnaire and a post-questionnaire were issued prior to and following the study to provide demographic information and other study related questions for further processing.

Apparatus

The eye tracker that was used in the experiment is the Gazepoint GP3 Eye Tracker. The eye movements were detected by the GazePoint GP3 Eye Tracker, which is mounted in front towards the bottom of a DELL P2213 computer monitor with a resolution of 1680 x 1050. The eye tracker has eye cameras within the device for each eye. The tracker also uses red infrared LED sensor lights that is not harmful to participants. Participants were required to sit in front of the eye tracker and proceed to the calibration process before the start of the experiment. The sample rate of the Gazepoint GP3 Eye Tracker is 60Hz. It can track the user with a degree of accuracy of 0.5 to 1 degree, about 50 pixels. 5- or 9-point calibration.

Stimulus

Four food package design images were created for this study. The first set of images is two replicated images of originally designed cans, with expiration dates positioned one on the top and one on the bottom-front. The second set of images is of original designed boxes, with expiration dates positioned one on the top and one on the bottom-front, of the food packages. The packages of cans show a simpler front design compared to the boxes' busy design, and both packages contain a white background for contrast.

Package A: Boxed food with expiration date on top of package (refer to figure 1). Package B: Boxed food with expiration date in bottom-front of package (refer to figure 2). Package C: Canned food with expiration date on top of the package (refer to figure 3). Package D: Canned food with expiration date in bottom-front of the package (refer to figure 4).

Figure 1: Package A

Figure 2: Package B

Figure 3: Package C

Figure 4: Package D

Participants

The participants in the study were randomly selected in the Clemson University area. The experiment consists of a total of 10 participants of 1 female and 9 males with normal color vision and age ranging from 18 to 50 years old. Out of the 10, there were 6 participants were wearing glasses. Most of the participants are Computer Science students, and the rest will be randomly selected. There were no incentives given to participants for completing the study.

Experimental Design

A 2x2 mixed within- and between-subject experimental design was used in the study. The same group received treatment of expiration dates on the top and bottom-front, which makes it a within-subjects. Participants were tested between stimulus sets, which one group receives one can food stimulus and one box food stimulus. All participants will be given a set of 2 images (refer to Figure 6), one of a packaged can and one with a packaged box with expiration dates on different sides: one is on the top and one is on the bottom-front. There are four sets of stimuli. The first set is of the box package with the expiration date on the top and the can package with the expiration date on the bottom-front. The second set is the box package with the expiration date on the bottom-front and the can package with the expiration date on the top. The third set is the can package with the expiration date on the top and the box package with the expiration date on the bottom-front. The fourth set is the can package with the expiration date on the bottom-front and the box package with the expiration date on the top (refer to figures 5 and 6). Each participant were given one set and are required to find the expiration dates of the stimulus as fast as he/she can. The two images were displayed sequentially.

Food Package	
A	Box, top
B	Box, bottom-front
C	Can, top
D	Can, bottom-front

Figure 5: Packages identification

Stimulus Sets	
Set 1	A, D
Set 2	B, C
Set 3	C, B
Set 4	D, A

Figure 6: Sets tested per participant in experiment

Procedure

Participants were asked to participate in a 10 minute experiment separately through e-mail and word of mouth. The study consists of four steps: 1) pre-questionnaire, 2) calibration, 3) 2 tasks, and a 4) post-questionnaire. Prior to the experiment, participants were informed of the process of the study and shown applicable IRB forms. Participants were given a set of 2 images of stimuli and be required to find the expiration date on these stimuli.

Step 1: Pre-questionnaire

Before the experiment, participants were required to take a short pre-questionnaire that included simple questions about their personal information as an individual and also study related questions.

Step 2: Calibration

The Gazepoint GP3 Eye Tracker requires a calibration process for each participant. This requires participants to look at 5- to 9-points on the screen and follow each active point with their eyes to adjust the accuracy of the eye tracker. The participants were using Gazepoint software on the Windows 7 operating system..

Step 3: Finding Expiration Date

Participants were asked to find the expiration date on canned/boxed food products. The position of the expiration date is random, it can be either top or bottom-front. The order of canned/boxed package is also random, it can be canned product first or boxed product first, each type of product were shown exactly once. They were asked to press the space button on the keyboard to skip the image as soon as they find the exact expiration date.

The researchers used the output .csv files of Gazepoint Analysis software to find out the time used to find the expiration dates for boxes and cans.

Step 4: Post-questionnaire

Once all tasks were completed, participants were asked to complete a post-questionnaire. These questions include study-related questions, package design related questions, and their experience.

RESULTS

Data was collected from each participant's performance of two trials. Incorrect or Inaccurate trials were not used in time and fixation movement analysis. Out of the 20 corrects trials, under each of 4 conditions performed by the 10 participants, all of the participants successfully found the expiration dates on their given packages. However, according to Figure 12 (Table of how each participants were distributed to each set of stimulus.) and Figure 13 (Time series plot graph of the average time of each stimuli.), Participants spent less time to find the expiration dates in Stimulus A (Box, Top) and Stimulus C (Can, Top) than Stimulus B (Box, Bottom-front) and Stimulus D (Can, Bottom-front). The average time spent to find the expiration date on the Stimulus A package is 3.50 s , Stimulus C package is 2.31 s, Stimulus B package is 6.00s and Stimulus D package is 5.95s. The average time spent on Stimulus B is 1.71 (Time on Stimulus B/ Time on Stimulus A = 6.00s / 3.50s) times as long as time of Stimulus A. And Average time of Stimulus D is 2.58 (Time on Stimulus D/ Time on Stimulus C = 5.75s / 2.31s) times as long as time of Stimulus C. Also, from Figure 7 to Figure 11 (AOI Fixation and Sample Fixation movement), we made AOI areas on both the top area and the bottom-front area for the 4 stimuli. It is clear to track the movement of eye gaze through the orange circle and arrows. From these track, most of participants would look at the center of the picture and then move their eye gaze to the top of the package when looking for the expiration date on the package. From the AOI area created, most of the participants kept their eye gaze on the top of food package for most of the time. They rarely spent time on the bottom-front of the package when attempting to find the expiration date. However the p-value for both sets are higher than 0.05(p-value for box is 0.30 and p-value for can is 0.10). We cannot conclude that a significant difference exists. It may be caused by a small sample size (Only ten participants' data were analyzed). Further research may be needed.

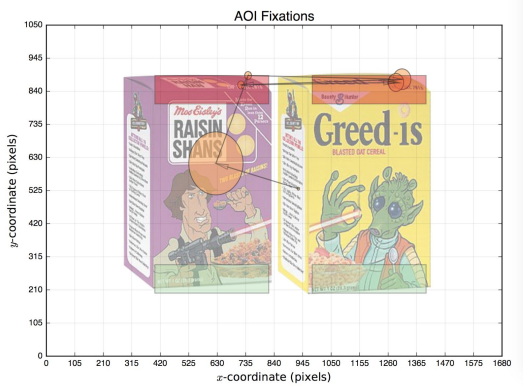

Figure 7: Sample Fixation movement (orange circles), the arrows show the order of the movement of eye gaze. The 4 rectangles are the designed AOIs (areas of interest).

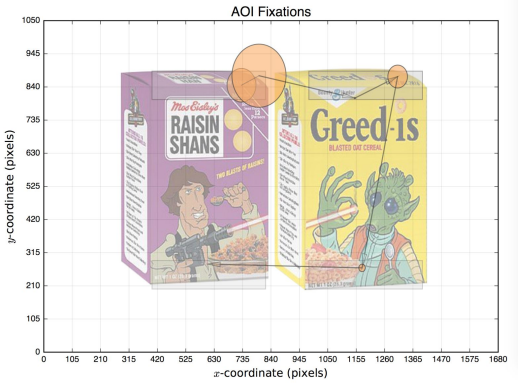

Figure 8: Sample Fixation movement (orange circles), the arrows show the order of the movement of eye gaze. The 4 rectangles are the designed AOIs (areas of interest).

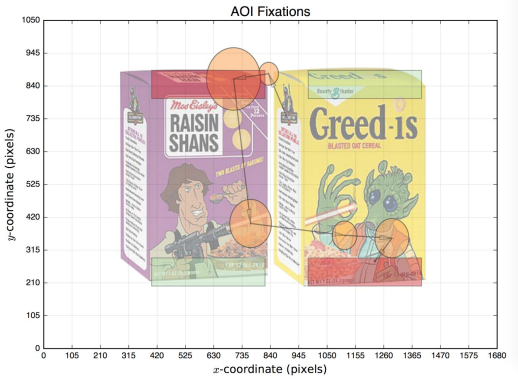

Figure 9: Sample Fixation movement (orange circles), the arrows show the order of the movement of eye gaze. The 4 rectangles are the designed AOIs (areas of interest).

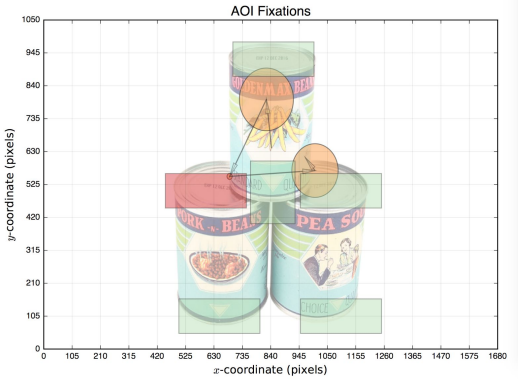

Figure 10: Sample Fixation movement (orange circles), the arrows show the order of the movement of eye gaze. The 5 rectangles are the designed AOIs (areas of interest).

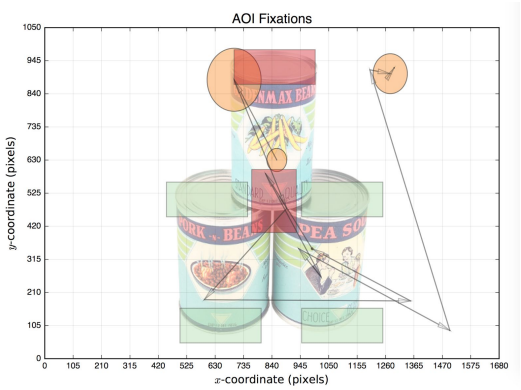

Figure 11: Sample Fixation movement (orange circles), the arrows show the order of the movement of eye gaze. The 5 rectangles are the designed AOIs (areas of interest). Due to some of the participants were wearing glasses and eye tracker may mistaken the reflection of lights as pupils, some of the fixation movements are inaccurate.

Distribution of Stimuli Sets on Participants and Average Time of Stimuli

participant no.	Stimulus A (box, top)	Stimulus B (box, bottom)	Stimulus C (can, top)	Stimulus D (can, bottom)
1	3.89333			3.47651
2		2.41512	0.98721	
3	4.39057			12.14042
4	2.41512			8.54268
5		5.58663	4.55037	
6		3.84601	2.41512	
7	3.18697			2.89141
8		14.85055	1.84601	
9	3.63044			2.67796
10		3.35136	1.74115	
Average time in seconds	3.503286	6.009934	2.307972	5.945796

Figure 12: Table of how each participants were distributed to each set of stimulus. Table also shows the average time in seconds of each stimulus.

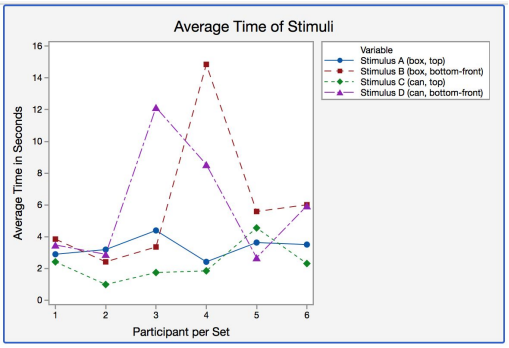

Figure 13: Time series plot graph of the average time of each stimuli.

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Stimulus A (box, top)	5	17.51643	3.503286	0.559934103
Stimulus B (box, bottom)	5	30.04967	6.009934	25.75223701

ANOVA

Source of variant	SS	df	MS	F	P-value	F crit
Between Group	15.70821049	1	15.70821049	1.193988168	0.30633594	5.317655072
Within Group	105.2486844	8	13.15608555			
Total	120.9568949	9				

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Stimulus C (can, top)	5	11.53986	2.307972	1.829734454
Stimulus D (can, bottom)	5	29.72898	5.945796	17.80564308

ANOVA

Source of variant	SS	df	MS	F	P-value	F crit
Between Group	33.08440864	1	33.08440864	3.369877516	0.10372339	5.317655072
Within Group	78.54151013	8	9.817688767			
Total	111.6259188	9				

Figure 14: Anova analysis of the data. P-value for boxes is 0.30633594 and p-value for cans is 0.10372339. Both of the p-values are well above 0.05 due to the small sample size (5 participants for each set of experiment).

DISCUSSION/CONCLUSIONS

From Figure 7 to 10, we can see the clear tendency that participants tended to check the top part of the boxes and cans first. And from Figure 11 to 12, we know that participants spent less time finding the expiration date at the top of food package rather than finding expiration date at the bottom-front of food package.

A hypotheses we made was expiration dates at the top of food packages increases discovery by participants due to less clutter in the position of the package design. It is likely to support this hypothesis since participants spent significantly less time to see the expiration date on the top of the package and participants are likely to keep their eye gaze on the top of the food package when they tried to find the expiration date.

The other hypothesis we made was expiration dates at the bottom-front of food packages decreases discovery by participants due to the clutter in the position in the package design. The result in this research supports this hypothesis. It is harder for participants to find the expiration date at the bottom-front of the food package since the average time spending on bottom-front designed package was longer and participants rarely spent time on the bottom-front of the food package when they looked for the expiration date according to the results.

It is likely to draw a conclusion that the expiration date on the top of food package is easier for customers to access due to less clutter in the position of the package design. A possible factor could also be that some consumers may have a natural tendency to search for expiration dates from top-to-bottom.

Further Research/Limitations

One problem to consider is that our amount of participants were fairly low. We were only able to experiment with 10 participants in this study, which gives a p-value that is well above 0.05. This rejects the null hypothesis. We predict that the N size of about 50 may provide more accurate results.

Also, 6 of the 10 participants were wearing glasses. This may increase the probability of inaccuracy of the eye tracker because the reflection of light on their glasses may cause the eye tracker to mistaken them as pupils.

Another thing to consider is that there are only two expiration date locations for participants to find. Depending on the type of food package, locations may vary in many different locations on it.

The last consideration is that participants are limited in movement when searching for their target. We were not able to obtain a head-mounted eye tracker for participants to have the real-world experience of finding the expiration dates on a physical stimulus. We used a static eye tracker and flat images that only provided one perceptual angle.

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