

Does the pop-out make an effect in the product selection of signage vending machine?

Mitsuki Hosoya¹, Hiroaki Yamaura¹, Satoshi Nakamura¹,
Makoto Nakamura², Eiji Takamatsu² and Yujiro Kitaide²

¹ Meiji University, Nakano 4-21-1, Nakano-ku, Tokyo, Japan

² Fuji Electric Co., Ltd., Fuji-cho 1-27, Yokkaichi, Mie, Japan
ev60523@meiji.ac.jp

Abstract. When people select a product, they often face problems that they spend too much time to make a choice or tend to pick only popular items. As a solution to this problem, we focused on visual characteristics called pop-out, assuming that presenting the pop-out can lead to shortening the selection time and a wider variety of choice. In this study, we implemented a signage vending machine which had a pop-out function and conducted a long-term experiment (half year) to investigate the effect of the pop-out method in a real environment. From 2826 sales, we revealed that the selection time was short when the purchased items were popped-out, and a popped-out product was more likely to be selected by 1.51 times than chance level during the cold-only period that sold cold products only. On the other hand, there was no effect of the pop-out during the hot/cold mixed period that sold both cold and hot products.

Keywords: Choice behavior, pop-out, visual stimuli, vending machine

1 Introduction

In everyday life, people encounter a lot of situations that require them to select something such as purchasing a drink at a vending machine, pick a lunchbox from a showcase, placing an order from a menu at a restaurant, and so on.

At the time of product selection, people often take time to consider which product to buy. However, there are several demerits in this behavior. For example, if a customer spends too much time to select items in a fast food restaurant, there would be a waiting line, the restaurant might get crowded, or other customers would become in a bad mood. So, it would be good for the providers if customers select items as fast as possible. In addition, spending a long time for selection is often considered to be a waste of time, so it is desirable to shorten the selection time. To solve these problems, we considered necessary to shorten the selection time by promoting the selection of products.

We then assumed that making a particular item stand out would be a way to encourage the selection of items. However, it is not desirable that only a particular item is highly likely to be selected when customers should have a wider variety of choice. For example, if people selected a particular product only in the vending machine, the product will be sold out, and others who want the item are no longer able to buy it. In

addition, it is disadvantageous to the providers since they hope to eliminate the hesitation over the selection as much as possible and encourage diverse selection.

Thus it is considered to be important to reduce the time required for selection and to promote selection with a wider variety. Here, there is a visual characteristic of human beings called pop-out. The pop-out is a visual characteristic to perceive the stimulus immediately when only one different visual stimuli is present in the same visual stimulation group (Fig. 1). Then, we considered using the pop-out during the selection action would lead to shortening the selection time and diverse selection. For example, when multiple products are sold in vending machines, by popping out a particular product, it becomes easier for the customers to perceive the item immediately. With this, it is possible to induce the customers to select the target item and reduce the time for selection.

In this study, we implemented a vending machine with touch display which users could buy a drink only by touching its image (Fig. 2) and carried out a long-term investigation (half year) on whether pop-out leads to shortening the selection time and whether the range of selection becomes wider by performing pop-out. In addition, we placed the vending machine at our university. Furthermore, we clarified the advantages and problems of pop-out based on the results of the experiment.



Fig. 1. Example of a pop-out



Fig. 2. The signage type vending machine for the experiment

2 Related Work

Many kinds of research have been carried out to study pop-out. Maljkovic et al. [1] revealed that whether a person anticipates what is popped-out does not affect the target of their attention, and that pop-out cannot be ignored consciously. In addition, there are many studies that analyzed the target stimulus of pop out, and they found that pop-out can be affected by factors such as word group relevance (Diliberto et al. [2]), difference in directions (Nothdurft [3]), and whether the target stimulus is a face (Hershler et al. [4]). Based on the findings of these studies, Baldassi et al. [5] suggested that pop-out is not peculiar to the luminance or color, but may occur due to subjective factors such as personal experience or knowledge. Our current study focuses on these characteristics

of pop-out introduced above and researches whether pop-out can reduce hesitation and time of selection.

Nudging is a term in behavioral economics that means a way to induce human behavior without restricting options. Specific examples and problems of nudging are summarized in Marteau et al. [6]. It is a nudging to induce selection by presenting pop-out before the action of selection, which is carried out in this study.

Digital signage is an information medium for transmitting information that displays images and characters with a display or projector. One of the examples is the digital signage guide interface in buildings or tourist spots, and the vending machine used in this study can also be an example. Digital signage has been becoming more and more common, and many studies have conducted along with it. For example, Muller et al. [7] pointed out a problem that digital signage is likely to be ignored when it shows advertising for which the viewers have no interest and proposed solutions for it. Digital signage is considered to match the technique introduced in the current study, which pops out a particular item because it is possible to control the information to present dynamically.

3 Experiment

The purpose of this study is to verify the usefulness of pop-out in solving the problems in product selection. Then, we implemented a signage type vending machine and investigated whether or not the pop-out is effective for reducing the selection time and promoting more variety of product selection by conducting an experiment using the machine.

Through the experiment, we collected data of the flow from when the research participants selected the item that is displayed on the screen of the vending machine to when they purchased it. We installed a function to present the effects of pop-out to highlight only one of the items in the vending machine at random for every purchase,



Fig. 3. An example of the product selection screen in the pop-out condition (bottom center of the product have been popped-out)

and we investigated whether the selection behavior can be affected by the presence or absence of the pop-out. In addition, the system changes a popped-out product randomly. Moreover, we fixed the position of the products during the experiment period except when we replaced the products with new ones.

Firstly, we investigated the selectivity of pop-out. Then, we compared the situations with the pop-out presentation (henceforth referred to as pop-out condition) and without the pop-out presentation (henceforth referred to as normal condition). Here, we investigated whether the presence of the pop-out by itself affects the reduction of selection time, regardless of whether the popped-out items were selected. In addition, we compared the selection times of when people selected the popped-out product and when they did not select it in the pop-out condition. Furthermore, to see if the pop-out influences the choice of the items, we compared the distributions of the purchased products with the pop-out presentation (pop-out condition) and without the pop-out presentation (normal condition).

In the experimental system, we used the same background color for all the products in the normal condition. Here, in the pop-out condition, we changed the background color of a product that was randomly selected and applied the pop-out to the product. An example of the product selection screen in the pop-out condition (see Fig. 3). In the experiment, the background color of the popped-out products was gray (RGB values that are specified in 0.0 and 1.0 are 0.9 respectively), and the background color of the products without the pop-out was white (RGB values are 1.0 respectively). By making only one background color stand out this way, it becomes easy for the target item to attract attention, which is expected to increase the product selectivity and shorten the selection time.

We placed the system on the sixth floor of Meiji University. The experimental contributors were an unspecified number of people who stopped by the vending machine and were notified about the experiment by a poster on the vending machine telling that the experiment was underway. The experimental implementation period was from August 29, 2018, to February 28, 2019, which resulted in collecting data of 2826 sales. In addition, from August 29, 2018, to 1:00 pm on October 31, 2018, the vending machine sold only cold products (henceforth referred to as cold-only period), and the number of sales of this period was 1090. Then, we replaced six cold products with hot products at 1:00 pm on October 31, 2018, and since then both the hot products and cold products were sold (henceforth referred to as hot/cold mixed period). The number of sales in this period was 1736.

4 Result

The total number of sales to be analyzed was 2826, in which the number of sales in the pop-out condition was 1384 (526 during the cold-only period, and 858 during the hot/cold mixed period) and the number of sales in the normal condition was 1442 items.

Table 1 shows the number of sales in the pop-out condition and the selectivity of the pop-out product in each period. Here, if people selected the products randomly at chance level, the number of the sold items with the pop-out will be 15.94 (526/33)

during the cold-only period, and 26.00 (858/33) during the hot/cold mixed period. The selection ratio of the popped out products becomes 1.51 in cold-only period and 1.04 during the hot/cold mixed period. These results suggest that the effect of pop-out was seen during cold-only period, but not during the hot/cold mixed period.

Table 1. The results of sales in the pop-out condition in each period

Period	The number of sales	The number of sales of the popped-out product	Expected value (Chance Level)	Ratio
cold-only	526	24	15.94	1.51
hot/cold mixed	858	27	26.00	1.04

Fig. 4 shows a comparison between the average selection time of when the customers selected the popped-out product and that of when they did not select the popped-out product in each period. In this figure, the average selection time of the user who selected the popped-out product was shorter than that of those who did not select the popped-out products. However, there was little difference in selecting time whether the products popped-out or not during the hot/cold mixed period. The result suggests that by presenting the pop-out during the cold-only period, it was possible to shorten the selection time of the user when they selected the pop-out product.

Fig. 5 shows a comparison of the average selection time in the pop-out condition and the normal condition. From this result, there is no difference in the average selection time between in the pop-out condition and the normal condition.

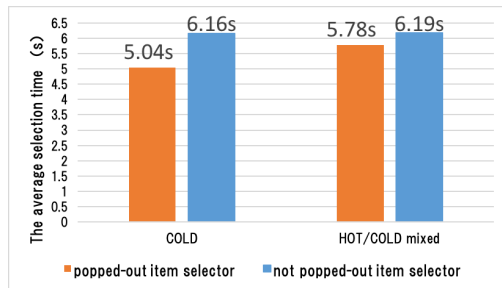


Fig. 4. Comparison of the average selection time between popped-out items and others

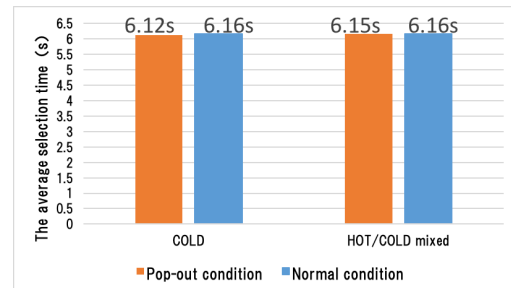


Fig. 5. Comparison of the average selection time between the pop-out condition and the normal condition

The products sold in the vending machine used in this experiment were placed in the 33 positions (see Fig. 6). The arrangement of the products during the hot/cold mixed period and the arrangement was the same during cold-only period. We made a comparison of the distribution of the sold products in the pop-out condition and in the normal condition to investigate whether the pop-out changed the distribution. In addition, we conducted two different investigations for the cold-only period and hot/cold mixed period respectively because of the difference in types of products sold in each period.

Fig. 7 shows the distribution of sold products with the pop-out presentation and that with no pop-out presentation during the cold-only period, and Fig. 8 shows those distributions during the hot/cold mixed period. The horizontal axis of these figures represents the position number of the product shown in Fig. 6, and the vertical axis represents the number of sold products. The result shows that, regardless of whether or not there is a presentation of the pop-out, the distribution of products was mostly not changed. In addition, the most purchased products were products placed in No. 9 in both conditions with and without the presence of the pop-out. Based on these observations, we found that the distributions of sold products were similar in the pop-out condition, and the normal condition.

1	2	3	4	5	6	7	8	9	10	11
12	13	14	15	16	17	18	19	20	21	22
23	24	25	26	27	28	29	30	31	32	33

□ COLD product ■ HOT product

Fig. 6. Product placement during the HOT/COLD mixed period in signage vending machine.

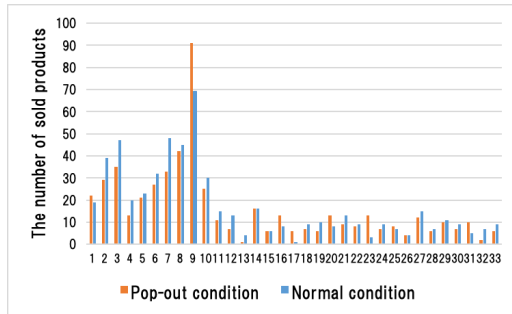


Fig. 7. Distribution of product sales in the pop-out condition and the normal condition during the cold-only period

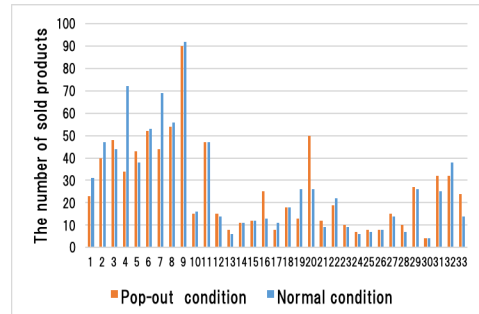


Fig. 8. Distribution of product sales in the pop-out condition and the normal condition during the hot/cold mixed period

Fig. 9 showed the distribution of the sold products in the pop-out condition in each period. The result shows that the products placed in No. 9, which was the most purchased products among all the products, had the biggest number of sales when they were with pop-out during the cold-only period. In addition, the products placed in No. 1 to 3 and No. 5 to 9 had a relatively large number of sales in each condition during the cold-only period, and they also tended to be sold well when they were popped-out. Moreover, the number of purchase of the products placed in No. 29 to 33 was extremely small, but it improved when they were popped-out. Therefore, we found that pop-out products were widely purchased during the cold-only period.

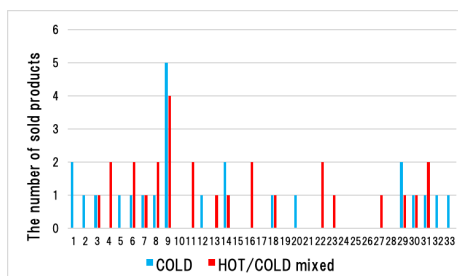


Fig. 9. Distribution of purchased popped-out products

5 Analysis

We found that the selectivity of popped-out products was high during the cold-only period. On the other hand, there is no difference in selectivity of the popped-out products during the hot/cold mixed period. The result would be because while cold products were displayed with blue text, hot products were displayed with red text (see Fig. 3), which resulted in popping out the hot products. In addition, the effect of the pop-out was not observed during the hot/cold mixed period because the customers were highly likely to know whether they would buy a cold drink or hot drink before starting the purchase.

As for shortening the selection time by pop-out, the average selection time of the users who selected the pop-out products was shorter than that of those who did not select the pop-out products. Thus, we could say that the pop-out contributed to shortening the selection time. On the other hand, there was no significant difference in the average selection times in the pop-out condition and the normal condition. This result would suggest that the presentation of the pop-out is less likely to cause negative effects, such as extending the selection time by increasing hesitation and confusion.

Here, the products placed in No.1 to 3, and No.5 through 9 had a large number of sales throughout the entire experiment, and they also held the high number of sales when they were popped-out during the cold-only period. From these results, we can say that a popped-out product that is originally popular would lead to increasing their sales. On the other hand, the products placed in No. 29-33 were observed to have a small number of sales throughout the entire experiment, but the number of their sales increased when they were popped-out during the cold-only period. The result would suggest a possibility that the pop-out can increase the sales of unpopular products as well.

During the hot/cold mixed period, there was a bias in the types of the purchased products when the user purchased the popped-out products. For example, the arrangement of the products in which hot items and cold items were mixed. To solve this problem, we will re-arrange the positions of cold products and hot products during the hot/cold mixed period.

The current study observed that the number of sales of the products placed on No.1-9 was high while that of the products placed on No. 29 - 33 was small, and this result of the sales can be considered to be due to not only the users' preferences on the products but also the arrangement of the products (see Fig. 6). It is known that when people

search for something, they generally start looking at the upper left, then move to the lower right. The result could account for the fact about the sales of the products that the products placed in No.1 to 9, which were placed in the upper left of the vending machine and therefore are seen at first, recorded a large number of sales. On the other hand, the sales of products placed in No.29 to 33, which were placed in the lower right of the vending machine and therefore are seen last, had only the small number of sales. However, it was also true that the products placed in No. 29 to 33 had been sold in the pop-out condition, so it can be said that the pop-out improved the negative effect of the position of the products to their sales.

Based on the observations above, we can say that the pop-out gives positive effect to the selection behavior. In addition, seriousness toward the selection was guaranteed in this experiment as it was conducted in the real environment in which the participants had actually to pay for the products. It is considered that we can apply the method to pop out to digital signage in general. Digital signage for selective actions has been widely used now and is suitable for this study, such as improving selection and selecting various products. In addition, we believe that the method used in the current study is applicable for any types of selective actions by touching the options on the display.

6 Conclusion

In this paper, we implemented a system which had a pop-out function and conducted a long-term experiment in the real environment. Then, we found that the products were more likely to be selected when they were popped-out than when they were not, and that the selection time was shorter when the users selected the popped-out products during the cold-only period. However, the result also suggested that the effect of the pop-out was not valid in the hot/cold mixed period. In addition, we found the possibilities that a wider range of selection would be available by popping out products randomly, and that the selection time can be shortened when users select the popped-out product.

In future work, we will analyze the behavior such as the number of human in front of the vending machine, and their gender, and age, and so on. In addition, since this research did not consider the possibility of the product package and popout competing, we believe that it is necessary to cluster and analyze the elements such as color, font, impression, and so on which related to package design. Additionally, since Gutwin et al. [8] shows that that popout effects away from a user's central vision are harder to notice, we will analyze the relationship between popped-out locations and purchased products. By doing this, it will be possible to make recommendations suitable for the situations, and the pop-out will be used more effectively.

Acknowledgments. This work was supported in part by JST ACCEL Grant Number JPMJAC1602, Japan.

References

1. Maljkovic, V., Nakayama, K. : Priming of pop-out-I. Role of features. *Memory&Cognition*, vol.22, p.657-672 (1994).
2. Diliberto, K. A., Altarriba, J. and Neill, W. T.: Novel popout without novelty. *Memory&Cognition*, vol. 26, p. 429-434 (1998).
3. Nothdurft, H. C.: Texture segmentation and pop-out from orientation contrast. *Vision Research*, vol. 31, no. 6, p. 1073- 1078 (1991).
4. Hershler, O., Hochstein, S.: At first sight: A high-level pop out effect for faces. *Vision Research* 45, p. 1707-1724 (2005).
5. Baldassi, S., Burr, D. C.: “Pop-out” of targets modulated in luminance or colour: the effect of intrinsic and extrinsic uncertainty. *Vision Research* 44 , p. 1227-1233 (2004).
6. Marteau, T. M., Ogilvie, D., Roland, M., Suhrcke, M., & Kelly, M. P.: Judging nudging: Can nudging improve population health? . *British Medical Journal*, 342, d228.
7. Muller, J., Wilmsmann, D., Exeler, J., Buzeck, M., Schmidt,A., Jay,T. and Kruger, A.: Display Blindness-The Effect of Expectations on Attention towards Digital Signage. *Pervasive Computing* , p.1-8 (2009).
8. Gutwin, C., Cockburn, A., Coveney A.: Peripheral Popout: The Influence of Visual Angle and Stimulus Intensity on Popout Effects. In: *SIGHCI Conference on Human Factors in Computing Systems (CHI2017)*, New York (2017).