

Aroma Nudges: Exploring the Effects on Shopping Behavior in a Supermarket

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Abstract. Due to the pandemic of COVID-19, product sampling at supermarkets has been restricted, and the disposal of unsold vegetables and other perishable foods has become a problem. To explore alternatives to product sampling, this study focuses on the “aroma” generated during product sampling and explores the effect of aroma nudges on purchasing behavior. Specifically, we focused on the scenario of promoting the purchase of Yamato-maru eggplant, a traditional vegetable of Nara Prefecture in Japan. We conducted an experiment in a supermarket for two months, from June to July of 2021, the season of the Yamato-maru eggplant. We compared the number of visits to the sales booth, the time spent in the booth, and the sales volume under four conditions: (1) no presentation, (2) presentation of paper media, (3) presentation of the paper and video media, and (4) presentation of a paper, video, and olfactory media. The experiment results suggest that the inclusion of aroma nudges has a positive potential to attract consumer interest and positively influence their purchasing decisions.

Keywords: Nudging · Olfactory Interfaces · Purchasing Analysis · Behavior Change.

1 Introduction

Demonstration sales such as product sampling in supermarkets are known to be an effective way to motivate consumers to buy [14, 15]. However, due to the pandemic of COVID-19, sales promotion activities such as product sampling had to be discontinued in order to prevent the spread of infection. As a result, a decrease in sales and an increase in the amount of waste of fresh foods such as vegetables have become a problem. Against this background, there is a need to explore alternatives to product sampling while taking infection prevention into consideration.

In this study, we focus on the existence of olfactory stimuli that have been lost due to the restriction of product sampling and explore the possibility of aroma nudges on purchasing behavior. As a first step, we have developed a prototype of an aroma nudges system that sprays a scent appropriate for the scene on the cooking video to stimulate the consumer’s desire to “look delicious” and “want to try it” and to improve their purchasing motivation. Our system is equipped with a sensing mechanism to infer the flow of consumers using a depth camera. And the system has a feedback mechanism to encourage consumers’ purchase motivation by presenting visual, auditory, and olfactory information.

We conducted an experiment in an actual store over a period of two months from June to July of 2021, the season of Yamato-maru eggplant. In the experiment, we compared the number of visits to the sales booth of Yamato-maru eggplant, the time spent there, and the sales volume under four conditions: (1) no presentation, (2) presentation of paper media, (3) presentation of paper and video media, and (4) presentation of paper, video, and olfactory media. As a result of the experiment, it was confirmed that the number of visits to the booth and the time spent at the booth were improved by the aroma nudges. The experiment results suggest that the inclusion of aroma nudges has a positive potential to attract consumer interest and positively influence their purchasing decisions.

2 Related Work

Aroma is considered to be one of the most important components of the physical environment of a service [4]. The effectiveness of ambient scents in influencing consumer behavior has been supported by academic research. For example, it is known that olfactory cues can enhance consumer behavior when they are related to product attribute information [2]. In a study that investigated the effect of vanilla scent on shopper behavior by installing aroma diffusers in fashion stores, it was found to have a significant positive effect on shopper behavior (time spent in the store, purchase amount, and intention to return to the place of purchase) [8].

In addition, it is known that warm scents like vanilla and cinnamon produce a powerful drive to buy things in a social environment, while cold scents like peppermint and eucalyptus have the opposite effect. Warm scents have been found to increase preference for and purchase of premium and luxury brands [7]. Spangenberg et al. [12] showed that when there are pleasant smells around, consumers have the feel of spending less time in the store and that prices were lower. Therefore, it can be inferred that smells influence behavior and perception.

In recent years, various types of olfactory interfaces and interactions using them have been proposed. Wang et al. [16] proposed piercing-type, necklace-type, and face-worn on-face olfactory devices and evaluated their social acceptability, comfort, and the intensity of the odor perceived by both the wearer and the observer. Amores et al. [6] proposed a necklace-type scent device that can be controlled remotely from a smartphone and can change the intensity and frequency of scents based on biometric and contextual information. Dobbstein

et al. [1] have developed a wearable scent device that can be used in daily life, allowing the user to receive notifications of personal scents. However, to the best of our knowledge, there have been no efforts to empirically verify the effects of behavior change using olfactory devices.

3 Designing The Aroma Nudges System

Nudges are small cues set up by the environment to gently push people’s decisions and actions towards a desired direction. Thaler and Sunstein, the proponents of nudges, defined nudges as any aspect of choice architecture that changes people’s behavior in a predictable way, without forbidding choices or significantly changing economic incentives [13]. Recently, sensory nudges [11], which act on various sensory systems such as vision, hearing, and smell, have been attracting attention. Based on the concept of “IoT Nudge [10],” in which sensory nudges are intelligently controlled by an IoT system equipped with sensing and actuation functions, in this study, we aim to realize a nudge system that acts on the senses of sight, hearing, and smell according to the store conditions in order to promote purchasing behavior.

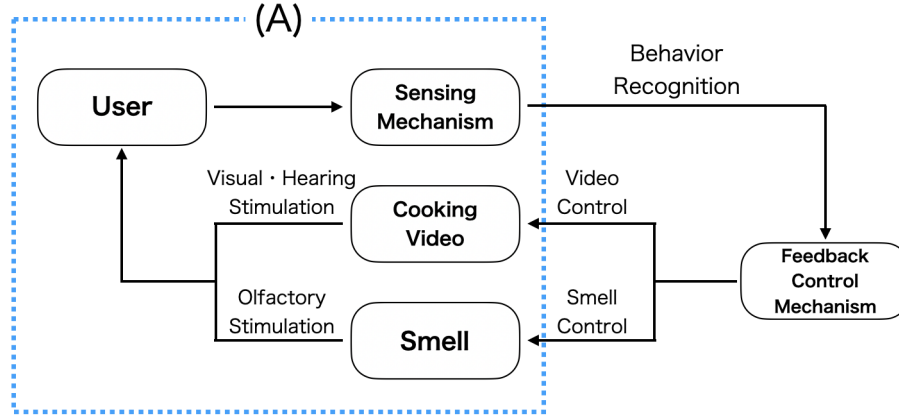


Fig. 1. Overview diagram of the proposed system

We propose an IoT-based nudges system called “Aroma Nudges System” which has sensing and actuation functions including olfactory stimulation. An overview of the Aroma Nudges System to replace product sampling is shown in Figure 1. The system is equipped with a sensing function to understand the flow of consumers and a feedback function to encourage consumers’ purchasing behavior. Our system aims to make people think the food in the video is delicious and increase their purchasing motivation by providing timely feedback of cooking images and aromas based on sensing results.

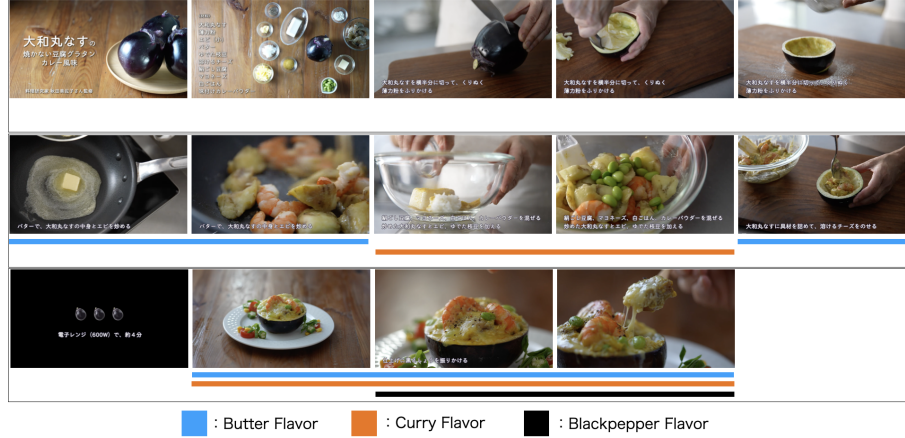


Fig. 2. Timing of aroma injection connected to cooking videos

In this study, we implement a prototype of the proposed system and investigate the effect of aroma nudges on purchase intention in a real environment. The overview of the proposed system is shown in the blue frame (A) of the Figure 1. The sensing mechanism is responsible for detecting the consumer’s purchasing behavior. In this study, we detect consumer behavior through skeletal detection. In the feedback mechanism, the cooking video provides visual and auditory stimulation, and the smell provides olfactory stimulation to encourage consumers’ purchasing behavior.

The sensing mechanism plays a role in detecting the purchasing behavior of consumers. By sensing the consumer’s behavior, the system detects buying behaviors such as reaching for a product display shelf or gazing at the shelf. In this study, we constructed a system that uses skeletal detection for consumer behavior recognition and detects purchasing behavior based on the positional coordinates of joints. We used Intel’s RealSense as a camera and Cubemos’ Skeleton Tracking SDK⁴ for skeleton detection. To protect the privacy of consumers, we use a program that removes the RGB information including the background in the image and obtains only the skeleton information.

The feedback mechanism provides visual and auditory interventions through cooking videos and aroma interventions linked to the cooking videos, and plays a role in stimulating the consumer’s purchasing motivation. Unlike fruits, the smell of Yamato-maru eggplant itself is almost imperceptible, so we adopt an approach in which the smell of the seasoning of the dish is in during the cooking process is injected at the right time in conjunction with the video of delicious cooking of Yamato-maru eggplant. In the cooking video, we visualize the cooking process of “Curry flavored tofu au gratin without baking,” which can be easily

⁴ <https://www.intelrealsense.com/skeleton-tracking/>



Fig. 3. Setting up the experiment

prepared using Yamato-maru eggplant, and use it as a cooking video to promote purchase motivation.

We used Aroma Shooter⁵ provided by AromaJoin Corp. as the olfactory device that sprays smells in conjunction with the cooking video, and prepare the smells of curry, butter, and black pepper. The Aroma Shooter can spray up to six aroma, and the distance is about 60 cm (the distance varies depending on air conditioning). Figure 2 shows the aroma control performed by this system. The butter aroma represents the savory aroma of frying food. The curry scent is used to enhance the flavor of the curry in the ingredients. Finally, the three different aroma are sprayed to convey the overall flavor of the raw tofu gratin: butter, curry, and black pepper. In this study, we used “Aroma Player Offline,” an iOS application provided by AromaJoin, to control the timing of the aroma spray. In this process, we controlled the arrival of the scent to the customer, so it matches the food in video presentation. We took into account error from the point of odor injection to the consumer’s sense of smell.

4 Experiment

4.1 Overview

The evaluation experiment was conducted at the AEON Mall Yamatokoriyama store (supermarket) located in Yamatokoriyama City, Nara Prefecture in Japan, for two months from June to July 2021, the season of Yamato-maru eggplant. This study was conducted with the approval of the Research Ethics Committee of Kio University (Approval No. R3-03). The experimental setup is shown in Figure 3. In this experiment, four conditions shown in Table 1 were compared to investigate the impact of presenting information with different modalities on consumers’ purchasing behavior.

The experiments were conducted on Saturdays, Sundays, and national holidays, when there was no bias from special sales or point reductions at the store.

⁵ <https://aromajoin.com/products/aroma-shooter>

Table 1. Experiment Design (Date of experiment and medium of presentation)

	Date	Intervention	Presentation media
Exp. 1	Jun. 12, Sat.	-	-
	Jun. 13, Sun.	-	-
Exp. 2	Jun. 26, Sat.	✓	Paper media ²
	Jun. 27, Sun.	✓	Paper media ²
Exp. 3	Jul. 3, Sat.	✓	Paper media ² , Video media (touch play)
	Jul. 4, Sun.	✓	Paper media ² , Video media (continuous play)
Exp. 4	Jul. 22, Thu. ¹	✓	Paper media ² , Video & olfactory media (touch play)
	Jul. 23, Fri. ¹	✓	Paper media ² , Video & olfactory media (continuous play)
	Jul. 24, Sat.	✓	Paper media ² , Video & olfactory media (touch play)
	Jul. 25, Sun.	✓	Paper media ² , Video & olfactory media (continuous play)

¹ These dates are a national holidays in Japan.

² Handouts of recipes and pop-ups are prepared.

In the experiment, we did not conduct direct sales promotions such as handing out flyers, talking to customers, or tasting the products, so as to avoid the influence of prior publicity. In order to eliminate bias in purchasing due to price changes, we sold the products at the same price on all days. In Experiment 4, which used the olfactory device, we manually started the olfactory media by touching the tablet on Thursday and Saturday. We played it continuously on Friday and Sunday to confirm the effect of the olfactory media on the booth.

The evaluation items were the number of visits to the booth, the time spent in the booth, the sales of Yamato-maru eggplant, and the results of post-interviews with consumers. The number of visits and the time spent in the booth were evaluated based on the skeletal information in front of the booth using a depth camera attached to the booth, excluding information on consumers who were assumed to have passed by the booth for less than five seconds.

For sales, we compared the sales data for the same week and day of the previous year (FY2020). The number of booth visits, the time spent at the booth, and the sales data were used to evaluate whether they significantly influence sales in sales promotion. At the time of distribution of the questionnaires, the purpose and method of this study and ethical considerations for the survey participants were explained orally and in questionnaires' sheet. In addition, the participants were informed of the purpose and methods of this study and of ethical considerations for survey participants both orally and in writing when the questionnaires were distributed.

4.2 Result and Discussion

Comparison of the number of booth visits The Figure 4 shows the results of the number of booth visits for each day of the experiment. The number of visits to the booth was highest in Experiment 4 (paper media, video media, and smell media) shown in red. In Experiment 3, shown in green, there was a

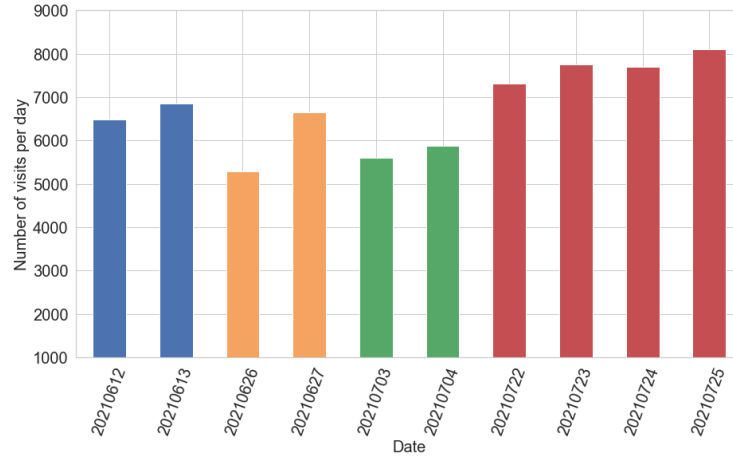


Fig. 4. Number of booth visits per experimental day (*touch play, **continuous play)

difference in the number of booth visits compared to Experiment 4, although the difference was only in the presence or absence of the smell media.

The results of the comparison of visits to the booth in a day are shown in Figure 6. The number of visits increased from 3:00 p.m. to 5:00 p.m. in each experiment. In other words, it is thought that shoppers who are preparing for dinner were visiting in the store. The number of visitors to the booth after 5:00 p.m. in Experiment 4 (paper media, video media, and olfactory media), shown in red, tended to increase compared to the other experiments.

Comparison of time spent at the booth Next, the results of the comparison of the percentage of time spent in the booth for each experiment are shown in the Figure 5. Experiment 4 (paper media, video media, and olfactory media), shown on the far right, had the highest percentage of time spent per consumer of 10 seconds or more compared to the other experiments. Similarly, in Experiment 3 (shown in green), compared to Experiment 4, there was a difference in the time spent in the booth only with and without the scent device.

The Kruskal-Wallis test, a nonparametric test equivalent to a one-way ANOVA, was used to quantitatively compare the time spent in the booth in each experiment. As a result of the test, a significant difference was found between each experiment (p-value: $5.57 \times 10^{-17} < 0.05$), confirming that there was a difference in the time spent at the booth in at least one of the four evaluation experiments. The Mann-Whitney U test, which is used as a significance test for two independent sets of samples, was then used to quantitatively compare the time spent in the booth between each experiment. The results of the test between each experiment are shown in Table 2. As a result of the test, significant differences were found between all experiments.

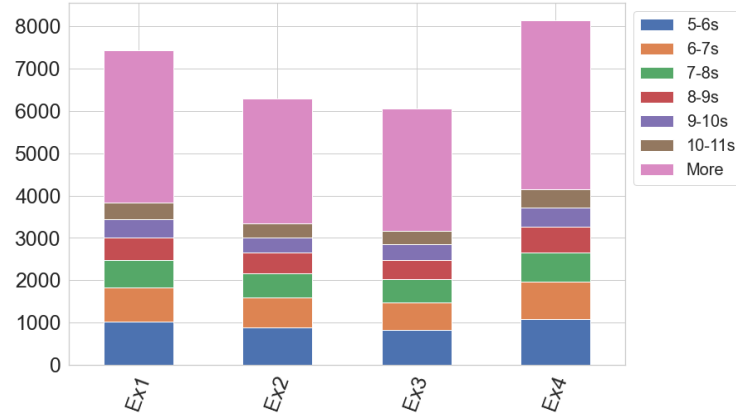


Fig. 5. Average time spent in booth per day

Table 2. Test results for time spent in the booth between each experiment

Two pairs to compare	P-value	presence of significant difference
Experiment 1,2	4.615×10^{-2}	significant difference exists
Experiment 1,3	1.109×10^{-5}	significant difference exists
Experiment 1,4	2.596×10^{-17}	significant difference exists
Experiment 2,3	3.849×10^{-2}	significant difference exists
Experiment 2,4	9.834×10^{-8}	significant difference exists
Experiment 3,4	1.121×10^{-3}	significant difference exists

Comparison of sales volume by intervention The Figure 7 below shows the results of the comparison of sales for each type of intervention in this experiment with the previous year (2020). The comparison was also made for the same holidays as last year. In Experiment 1, where no intervention was conducted, sales were 1.00 times higher than in the previous year, indicating no change. Experiment 2, in which we intervened with paper media such as pop-ups and recipes, produced the greatest difference, with sales 1.47 times higher than last year, with cooking videos 1.34 times higher than last year, and with smells 1.83 times higher than last year.

As shown above, sales tended to increase in all experiments in which interventions were conducted, and sales increased the most in the intervention using smells. In addition, the intervention of paper media such as product pops and recipes, and the intervention of cooking videos, which have been commonly used as methods to promote purchasing, are also considered to contribute to the increase in sales.

4.3 Results of the interview survey

In order to investigate the opinions and impressions of consumers regarding the booths in this experiment, a questionnaire was conducted on a different day from

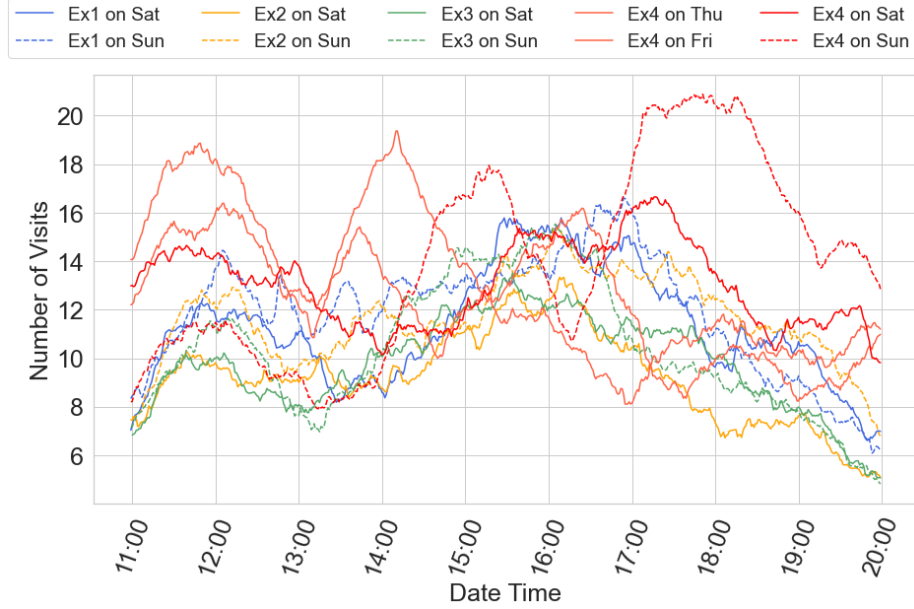


Fig. 6. Average number of booth visits per minute

the day of the experiment. The interview survey was conducted over two days, with a total of 298 people completing the questionnaire. The following is a list of the opinions about the olfactory media, pop-ups and recipes.

Positive comments on the olfactory media included, “I was impressed by the fact that it produced an aroma. I wanted to make and eat it,” “It smelled good,” and “It was interesting and stimulated my interest.” As for the recipes and pop-up displays, we received comments such as, “The pop-up display of Yamato-maru eggplants hanging above was very impressive and easy to see,” “The variety of recipes was helpful,” “I don’t like elaborate recipes and can only think of denraku at home,” and “I thought I want to try it since I received the recipe.”

Negative comments included “more visible area would be better”, “inconspicuous”, and “make the booth more visible.” As for the cooking videos, we received the opinion that “it would be good if the recipes were changed every 30 minutes.” From the results of the interviews, we had the impression that many consumers were interested in the olfactory media, which was a device that they had never seen before. There were no negative comments about the smell from the consumers, and they said that the aroma was effective in making them believe the dish was delicious. In addition, there were opinions that consumers wanted to actually cook the food and that they wanted to purchase the seasonings used in the aroma, such as black pepper and curry, which led to change in consumer

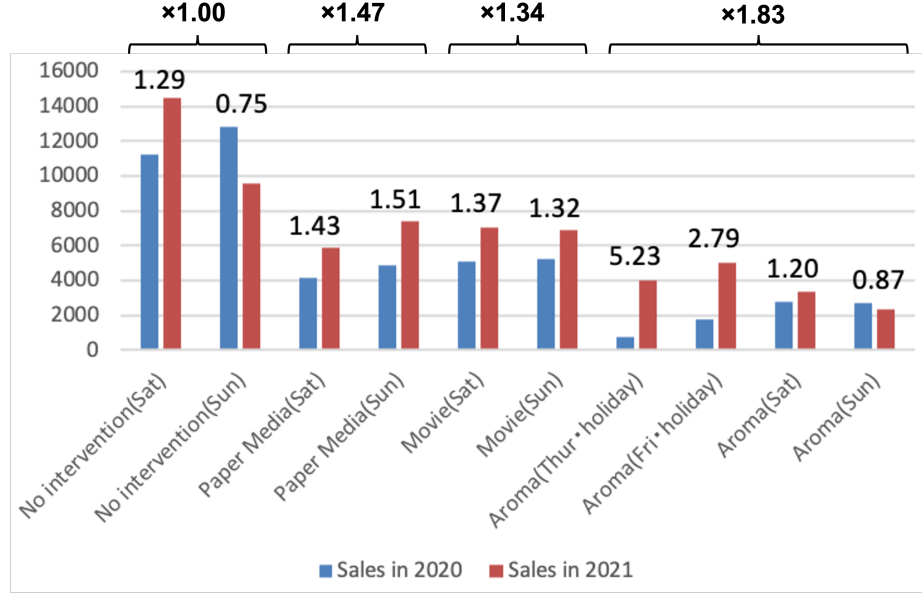


Fig. 7. Comparison of sales volume by intervention (2020, 2021)

behavior. This means that aroma nudges have the potential to encourage chain shopping behavior, such as impulse buying.

5 Conclusion

In this paper, we explored the possibility of aroma nudges on purchasing behavior. In the experiment, we compared the number of visits to the sales booth of Yamato-maru eggplant, the time spent there, and the sales volume under four conditions: (1) no presentation, (2) presentation of paper media, (3) presentation of paper and video media, and (4) presentation of paper, video, and olfactory media. The results suggested that the number of visits to the booth and the time spent in the booth increased when olfactory stimulation was provided by the aroma of the ingredients in addition to visual and auditory stimulation, and that this tended to increase sales. The influence of aroma on purchasing behavior like sales amount and time spent has been shown in previous studies [3, 5, 9], and similar results were obtained in this experiment. In the future, we plan to extend the duration of the experiment and increase the number of stores to investigate the more general effects of aroma nudges on purchasing behavior. We will also study the timing of the scent spray and the use of airflow to create a natural aroma smelling away. Our experimental results suggest that aroma nudges may positively impact purchase promotion. However, the use of aroma nudges should be carefully considered. For example, sweet smells may contribute

to the purchase promotion of sweets that contain a lot of sugar, but from a health promotion perspective, such nudges may be undesirable. Therefore, future studies will need to discuss the potential and application of aroma nudges from an ethical perspective.

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