System for Inducing Acceptance of Unconsidered Information by Connecting Current Interests

Proof of Concept in Snack Purchasing Scenarios

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Abstract. We propose a purchasing support system for offline stores that can present information to users without being evasive by interactively displaying small amounts of product information according to their interest, as estimated by the system. Accordingly, we designed and implemented a proof-of-concept system for an actual use case scenario: a snack purchasing area in an office. Furthermore, we evaluated the effectiveness of the proposed system via a snack purchasing experiment with 11 participants. The obtained experimental results suggest that the proposed method can induce user interest and encourage viewing, and that some users may receive and consider the information presented while making a purchase.

Keywords: interactive display · purchasing support system · information acceptance.

1 Introduction

People make decisions in various daily situations; however, they sometimes make decisions without examining each option meticulously and without clear criteria for judgment. This human tendency could trigger the vicious circle of repeatedly making choices that are good in the short term with negative long-term consequences. For example, in purchasing lunch and snacks, people often decide what to buy based on whether or not they like the taste or if the product suits their mood. Continuing to make such decisions may make the consumer happy in the short term because they get to eat what they like. However, in the long term, this could lead to an unbalanced diet and cause lifestyle-related diseases, such as obesity and diabetes, owing to nutritional imbalance.

Therefore, in such situations, it is ideal if the information system can support a convincing choice that considers other information (including nutrients) that

can lead to long-term benefits, in addition to the consumer's taste and mood. Currently, several offline stores place display screens near product shelves from which commercials are broadcast in a marketing-like effort to draw attention and interest to their products. Via this approach, presenting nutrient information from a display near the product shelf may influence attitudes and purchasing behavior at the time of purchase.

However, the one-way presentation of information from displays in offline stores can adversely affect the purchasing experience [1–3]. One of its adverse effects is advertising avoidance, which is defined as any behavior exhibited by the audience to reduce the level of contact with the advertisement [4]. There are three types of advertisement avoidance: "cognitive avoidance" (intentional disregard for information), "emotional avoidance" (negative feelings and emotional reactions to information), and "behavioral avoidance" (avoidance behaviors other than lack of attention) [5]. Hence, in designing an information system to support behavior change at the time of purchase, it is important to consider information presentation methods that reduce these avoidance behaviors and increase the acceptability of the presented content.

Here, we attempt to design a purchasing support system for offline stores that can present information to users without being evasive by interactively displaying small amounts of the product information according to their interest in the product, as estimated by the system. Accordingly, we designed and implemented a proof-of-concept model of the system for an actual use case scenario: a snack purchasing area in an office. The design of the proposed system was based on the results of previous studies [6] that demonstrate that people are receptive to varying quality and quantity of information, depending on their interests. In addition, we evaluated the effectiveness of the proposed system based on our hypotheses via a purchasing experiment with 11 participants. The obtained experimental results suggest that the proposed method can induce user interest and encourage viewing, and that some users may receive and consider the information presented while making a purchase. Our research will contribute to providing novel insights into the design of information presentation methods for offline stores and expanding the design space for interactive purchasing support systems.

2 Related Works

2.1 Interest estimation method

Several methods have been proposed to estimate internal mental states, such as interest during purchase. Li et al. utilized the camera of a mobile phone to estimate the eye gaze and compared the user's gaze on the Google Play Store screen with the areas of interest reported by the user [7]. The obtained results demonstrated that users looked significantly longer at areas in which they reported interest than at other areas. Jacob et al. adopted a spectacle eye tracker to obtain gaze information and estimate the newspaper articles in which users were interested [8]. In addition, Karolus et al. performed interest estimation for displayed

images using multiple gaze estimation and gazing information metrics, and inferred that they achieved better accuracy than random in all estimations [9]. Several studies on offline store purchases that investigate the relationship between the position of purchased products on the shelf and eye gaze [10, 11] also suggest that eye gaze information at the time of purchase is a crucial feature in expressing the interest of users. Following the findings of these previous studies, we developed a method for estimating the level of interest in information in products displayed on snack shelves based on the user's gaze and position during offline purchases.

2.2 Interactive display and purchasing support system

Previous studies have demonstrated that presenting calorie information [12], altering the price of healthy products, suggesting healthy alternatives [13, 14], and presenting information on the purchase of healthy products to less healthy users [15], can influence consumer behavior and choices. However, these studies primarily focused on investigating analog approaches that do not utilize information systems and they do not investigate whether users positively receive presentations via information systems when making offline purchases. Hence, this study focuses on how to display information such as nutrients for the buyer's consideration via interactive displays installed in offline stores.

Several interactive information presentation systems for offline environments have been proposed. Schiavo et al. proposed a presentation method that calculates the level of interest in information in a public display based on the user's face, body orientation, and position, and alters the content progressively, according to the user's level of interest in information [16]. In addition, Kim et al. proposed a method for switching detailed and comparative information on two products in an experimental environment according to the user's line of sight [17]. However, in an offline environment with multiple candidate products displayed on shelves in front of them, it may be difficult to attract users by simply switching information according to their behavior. Therefore, designing an information system that can present information in a way acceptable to users remains a crucial challenge.

3 Proposed system

3.1 Design of an information presentation model

This study attempts to develop a presentation method that increases the likelihood that users will view information even if they are not interested in it, including a system that changes their purchasing behavior. The model for determining whether a person will view information is considered to be significantly similar to the technology acceptance model (TAM) [18], which determines whether a person will use a system. Based on TAM, our study focused on the level of interest in information and information amount as parameters that can be identified and estimated in the targeted purchasing scenario. They have the following

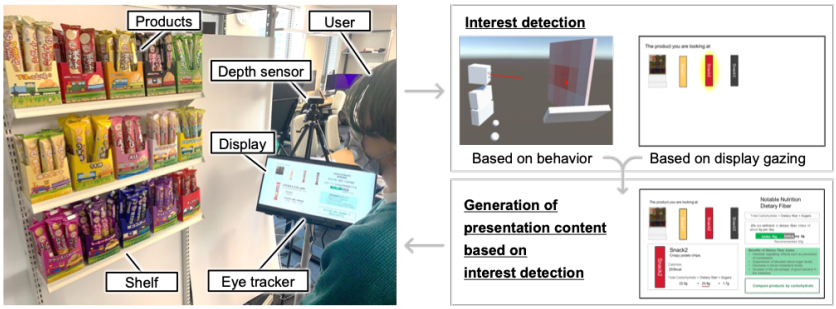

Fig. 1. System overview

characteristics: (1) People do not view information when their interest in the information is low; (2) If the amount of information is too large, people are less likely to view the information because of the burden. To get users to positively receive information, it is considered effective to make them interested in the information or reduce the amount of information.

Here, we assume that the item of interest (hereafter referred to as Focused Item) is the product. During the purchasing behavior, the user obtains information as needed from products (hereafter referred to as Gazed Information). At this point, by presenting unseen information to users, for example, nutritional information on the back of the package, a change in behavior based on new decision criteria can be expected.

3.2 System configuration

This system was designed for one person as a first step. The system comprises a computer (windows10, intel corei9-11900K, 128GB), a depth sensor (Azure Kinect DK), an eye tracker (Tobii Eye Tracker 5), a display (21.5-inch, 1920 × 1080 Pixels), and a shelf for placing the products (Figure 1). The depth sensor captures users and calculates three-dimensional postures. The eye tracker calculates the gaze of users looking at the display, and the system that generates the display using the data from sensors was implemented using Unity. The size of the entire product area is H90 cm × W74.5 cm, and the size of each product is approximately H25 cm × W14 cm. Purchasing users look at the products in front of the shelf, and while selecting items, these users can view information on displays placed next to the shelf. In this scenario, 15 products were placed in boxes on the shelf.

3.3 Implemented features

To verify the effectiveness of the proposed approach, we set the following three hypotheses.

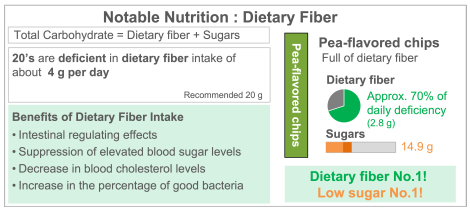

Fig. 2. Information to be presented to users (actual system is in Japanese and shows the actual images of the products.) In Japan, starch is also included in the nutritional component of sugar

H1 Interactive display presenting small amounts of relevant information triggers the users' interest in the system and encourages them to look at the information.
H2 Encouraging users to view the display longer leads them to receive and consider the information presented.
H3 The user's consideration of the presented information changes the purchase outcome.

In this study, we chose commercial snacks that offer various flavors and allow for uniformity in package size and price. The content of the presentation was determined based on a questionnaire presented to users beforehand. Based on the results of the questionnaire, "Pea-flavored chips" was categorized as an uninteresting product, and "dietary fiber (fiber) information" and " Pea-flavored chips information" were categorized as uninteresting information. (Figure 2)

Two-stage interest detection We implemented a two-stage detection method that stably acquires the head position and posture with the depth sensor, and then narrows down the user's target of interest with the eye tracker and the display UI for stable detection.

Stage 1: Interest detection using head position/posture from the depth sensor The system calculates the user's head position and orientation vector from the skeletal information estimated using the depth sensor. It also calculates a vector from the head to the product position. By determining the angle between these two vectors and the distance from the user for each product, the level of interest in information in the product is calculated in the range of 0.0–1.0. The smaller the angle and distance, the higher the level of interest in information. The level of interest in information calculation was achieved with a guaranteed speed of 60 fps or higher.

Stage 2: Narrowing down interests using the eye tracker and display UI Products within the top 3 level of interest in information and above the threshold are considered "Candidate Items." Candidate Items are presented on a display, and the products whose gazing is detected by the eye tracker are considered "Focused Item." This method displays information at the timing when the user's interests

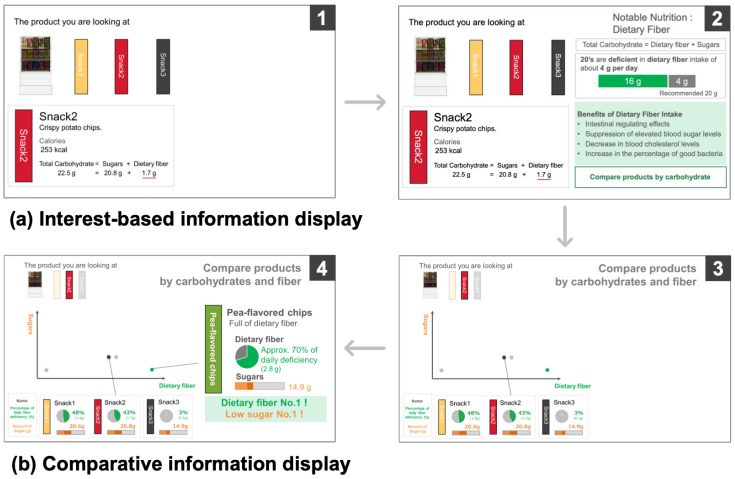

Fig. 3. Screen transition of proposed UI

are determined. The system updates the level of interest in information when a facial stillness decision or gaze stillness occurs. The system notifies the users of this phenomenon with a notification tone. This feature allows information to be presented interactively in response to non-explicit user input.

Presentation content design The presentation content design based on the detection results is described below.

Presentation of interest-based summary information The system displays nutritional information for the product as summary information when it determines the Focused Item (Figure 3 (a) left). By displaying less information at the beginning of the presentation and displaying new information, the user views the content more, and the system ultimately presents information corresponding to the user's level of interest in information and facilitates the information's acceptance by the user.

Presentation of summary information outside the user's interest Even after the information on Focus Item is presented, other products set as Candidate Products continue to be presented on the display. When the user looks at these images, summary information is presented on the products that differ from the Focused Item.

Presentation of detailed information outside the user's interest Once the system detects that the summary presentation is being gazed at, it presents additional detailed information on the Focused Item (Figure 3 (a) right). This system presents detailed dietary fiber information. After including the effect of highlighting fiber data in the nutritional information, the system presents detailed information on fiber. A button for transition is displayed in the lower right

corner of the screen, and when gazing at this button is detected, the presentation proceeds to the next step.

Presentation of comparative information The system utilizes the 2 axes of sugar and fiber to present information that encourages comparison between the Focused Item and other products (Figure 3 (b)). A product with low sugar and high fiber content ("Pea-flavored chips" in this case) was selected for comparison with the Focused Item.

4 Experiment

The objective of this experiment is to determine how interactions with the proposed system lead to changes in users' attitudes and awareness during purchasing and to test the hypotheses (H1, H2, H3). To achieve this objective, we conducted a simulated purchasing experiment in the snack purchasing area in an office. In total, 11 students (10 males, 1 female, age: M = 22.5, SD = 0.934) participated in the experiment. None of the participants had any background information about the experiment prior to participating in the study.

4.1 Settings

We adopted a within-participant design and observed the outcomes of two conditions: presenting Figure 2 from the display with the existing method and presenting Figure 3 according to the user's interest using the proposed method (The detailed process of the proposed method is described in the previous section). The experimental environment is presented on the left of the Figure 1. A display is installed next to the snack shelf, and information is presented from the display. Participants were asked to select 1 of the 15 types of snacks displayed on the shelf that they would like to buy. Here, participants did not actually pay and received a snack as a reward. Participants experienced each condition once, in the order of the existing and proposed methods. We set a one-week washout period to reduce the influence of order effects. Furthermore, the participants were instructed not to share the contents of the experiment with each other during the period. Before the experiment, participants were informed that some information would be presented from the display, and that there would be a questionnaire and an interview after the experiment. In addition, a calibration was performed to improve the accuracy of the eye tracker. The experimental description and questionnaire were the same for the existing and proposed methods. After each experiment, the participants were asked to complete a questionnaire about their buying experience and the system. The questionnaire included the following questions answered by the five-case method: "Did you pay attention to the information presented in the display?" "Did you pay interest on the information presented in the display?" "Did you confirm or agree with the nutritional information before purchasing the product?" "Would you consider purchasing food with nutrients in mind in the future?" After all experiments, participants were interviewed on their individual purchasing experience.

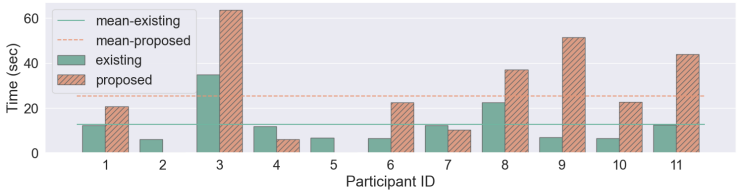

Fig. 4. Viewing time by participants

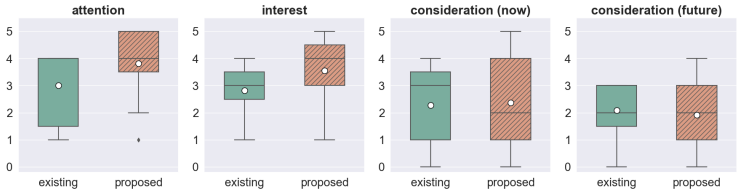

Fig. 5. Results of survey responses

4.2 Results

Results for Hypothesis 1 Figure 4 and Figure 5 present the results of the display viewing time and attention/interest questionnaires obtained from the system, respectively.

Figure 4 presents the viewing time graph on the vertical axis and each participant's ID on the horizontal axis. The green bar and dotted line represent the participant's viewing time and its average for the existing method, while the orange bar and dotted line represent the participant's viewing time and its average for the proposed method, respectively. Figure 5 presents a boxplot with the results of each questionnaire on the vertical axis and the methods on the horizontal axis. The green box, orange box, and white dots represent the results of the existing method, proposed method, and mean values, respectively. Here, each response is on a 5-point Likert scale, with the addition of the option "did not see the presentation" (corresponding to 0). Note that the vertical scale is a 6-point scale from 0 to 5. The results presented in Figure 4 demonstrate that the average viewing time for the proposed method was 25.3 s, while the average time for the existing method was 12.6 s, thus indicating that the viewing time increased. The attention and interest results in Figure 5 demonstrate that the distribution of responses is biased toward the upper side of the graph, thereby indicating an upward trend in responses for the proposed method. These results suggest that our proposed method may tend to attract buyers' attention and arouse interest better than the existing method.

Results for Hypothesis 2 The results of "consideration(now)" and "consideration(future)" in the Figure 5 demonstrate that the proposed method does not exhibit an upward trend compared to the existing method. The distributions in the Figure 5 demonstrate that the interquartile range keeps widening and the dispersion keeps increasing in both cases. The results in the Figure 4 indicate a

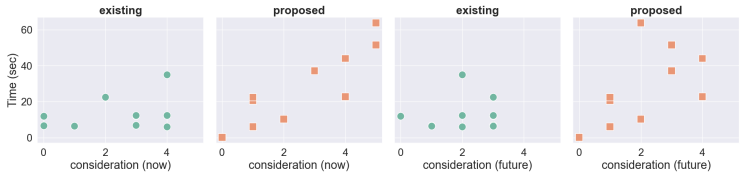

Fig. 6. Relationship between time and survey responses. From left to right, the correlation ratios are 0.37, 0.90, 0.20, and 0.58.

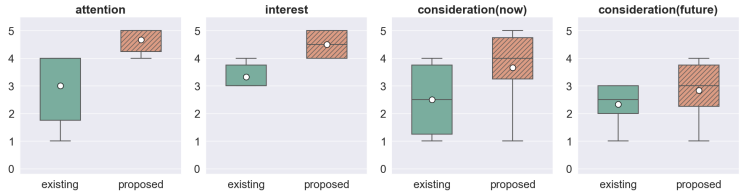

Fig. 7. Results of survey responses (top6)

large variation in viewing time among participants, and the difference is particularly significant for the proposed method, thereby indicating that the response results are expected to vary depending on viewing time. To investigate the relationship between viewing time and responses Figure 6 presents a scatter plot of viewing time and responses. The results in the figure demonstrate that the proposed method (orange) exhibits a stronger correlation between viewing time and responses than the existing method (green).The results indicate that the longer viewing of the presentation based on our proposed method, compared to the existing method, may lead to decision making with favorable reception and conviction of the presented information. In Hypothesis 2, we focus on users who viewed the system for more extended periods. Hence, we split the participants into two groups, one that interacted with the display more(6/11) and the other that did not(5/11), and then we examined the results of the group that viewed the display more.

The results of the survey responses from the top 6 viewers relative viewing time (6 people) are presented in the Figure 7. Here, the two results of "consideration(now)" and "consideration(future)" exhibit an upward trend in the responses, thus indicating that the respondents are considering presented information when making decisions. In addition, the items of attention and interest also exhibit an upward trend for these groups.

Results for Hypothesis 3 The top 6 viewers were surveyed to determine how the reasons for purchase and products purchased, obtained via questionnaires and interviews, changed compared to their initial mood at the time of purchase. The results are presented in Table 1. These results indicate that the number of respondents who cited some nutrients as the reason for purchase was three in the proposed system, compared to one in the existing method. Regarding the behavioral change in the choice of snacks, only one person in the proposed

Table 1. Participant's pre-purchase mood, reasons for purchase, and products purchased

Participant ID	System	Mood	Reason	Purchased product (target : Pea-flavored chips)
P3	existing	something sweet	fiber	other
	proposed	something sweet	taste, fiber	other
P6	existing	something salty	taste	other
	proposed	something sweet	taste	other
P8	existing	something sweet	taste	other
	proposed	something high in calories	taste, calories	other
P9	existing	nothing	taste	other
	proposed	something like chips	taste, fiber	target
P10	existing	something like chips	taste, mood	other
	proposed	something light	taste	other
P11	existing	something salty	taste	other
	proposed	something salty	taste	other

method bought the snacks that were the target of the inducement. In an interview, the person revealed that they had initially wanted to try a different type of chips; however, they were persuaded by the system to opt for the pea-flavored chips. The other participants chose the one that suited their initial mood. The interviews revealed that a certain number of participants did not want to be conscious of nutrients when purchasing snacks in the first place. This suggests that purchasing snacks may have been a more difficult scenario to make people aware of nutrients than decisions such as meal menu choices. Because previous research [19] has clearly demonstrated that it is challenging to design information systems that have sufficient impact on altering consumer behavior in short-term decision-making, the fact that 1 out of 11 people changed can be considered a positive starting point. In addition, given the results of partial support for Hypotheses 1 and 2, there could be a possibility that continued presentation over a long period could induce behavioral change. This underscores the need for further research.

5 Discussion

Acceptance difficulty of information As demonstrated in the experimental results, the total viewing time was longer for the presentation of the proposed method than that of the existing method. However, the proposed method did not increase the viewing time for all content, which varied depending on the information category. For example, for the proposed method, the average viewing time for the product summary information was 7.1 s, while that for the fiber information was shorter, at 4 s on average, which was less likely to be viewed. In the interview, the participants mentioned the category of information and the amount of information as reasons for not viewing the fiber information, including factors such as not considering fiber when purchasing snacks and not wanting to read too much information. As these comments suggest, the summary information, which was viewed for a longer period of time, was indeed the type of information often used for selecting snacks, and the amount of information was approximately 1/4 of the fiber information in terms of the number of words. This

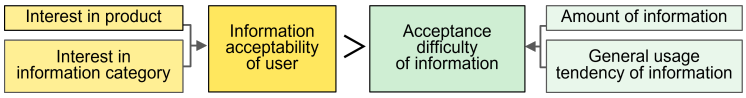

Fig. 8. Information acceptability model derived from the experimental results. It represents the conditions under which a user can favorably receive certain information. When the information acceptability of the user exceeds the acceptance difficulty of the information, the user can favorably receive the information.

suggests that the acceptability of certain information for a given product can be estimated from the amount of information and whether that information tends to be used in general when the product is purchased. Therefore, we define the difficulty of accepting certain information as a characteristic of that information, as "Acceptance difficulty of information," derived from the two aforementioned variables.

Using this acceptance difficulty, the experimental results can be explained as follows. In the proposed method, the participant's level of interest in information was increased by viewing the information of the product of interest, and participants were willing to view the summary information. However, the level of interest in information may not have been high enough to make the participants consider viewing the fiber information, which has a higher level of acceptance difficulty.

Level of interest in information categories However, in the experiment, there were individual differences in the amount of time the same information was viewed. For example, when presenting the fiber information in the proposed method, 4 participants watched for only 1 s or less, 5 participants watched for 3–4 s, 1 participant watched for 7.7 s, and the participant who watched the longest watched for 14.6 s. In the interview, the participant stated that they were usually health-conscious and interested in fiber information. Another participant who watched the presentation for 8 s stated that the presentation triggered a fiber-conscious purchase. Hence, it can be inferred that the level of interest in the information category also affects the viewing time, and this interest may be inherent in users or aroused by the presentation. Combined with the model we described in Section 3, it can be inferred that the interests in information categories and products have similar characteristics and influence the user's information acceptance.

In the proposed system, by increasing the level of interest in information in products, we attempted to increase the acceptability of various types of information outside of the interest, without distinction. From the above discussion, the model in Section 3 can be improved by considering the acceptance difficulty and the interest in the information category.

Information acceptability model Based on the above discussion, the model in Section 3 is modified, considering the acceptance difficulty of information

and level of interest in information category (Figure 8). First, from the amount of information and the extent to how much the information tends to be used when the product is purchased (General usage tendency of information), the acceptance difficulty can be defined as a constant that is unique to each piece of information. In contrast, the user's acceptability of information can be derived from the user's level of interest in information in the product and information category at that time. These variables change momentarily depending on the user's internal state during purchase. When the information acceptability of the user exceeds the acceptance difficulty of information, the information is accepted and viewed by the user.

If the model is reliable, it is possible to estimate the user's level of acceptability and acceptance difficulty for each piece of information, as well as select information that is likely to be viewed. In addition, it is also possible to present information that increases the level of acceptance of other information categories and adjust the amount of information according to the general usage tendency of information.

limitations and future work In this section, we discuss the limitations of this study. First, we are yet to verify the validity and accuracy of the interest detection method. In the post-experiment interviews, several participants favorably received the information containing products of their interest; however, there were a few comments that products of no interest were displayed. Therefore, the accuracy of the interest estimation method needs to be evaluated and improved. Furthermore, there were cases in which the estimation of the interest changed while the participants were still comparing the shelf and the presented information, thereby altering the content of the presentation and ultimately confusing the participants. We need to explore how to realize context-sensitive interest estimation.

Moreover, the effectiveness of the proposed presentation method was only verified in a single scenario, i.e., the scenario with a one-time purchase of snacks. Although our experiment included a one-week washout period, it is possible that the order effect may not have been completely removed. In addition, since our experiment was a simulated purchase without payment, the behavior may be slightly different from the actual purchase. We plan to study the long-term impact of the proposed approach in actual purchasing situations, examining its effectiveness not only for low-cost, high-frequency purchases, but also for expensive, infrequent purchases. In general, people tend to be more cautious and spend more time buying expensive, infrequently purchased items than inexpensive, regularly purchased items. For such situations, we also consider a hybrid intervention approach that integrates more persuasive techniques in addition to the current inducemental approach.

In addition, the model proposed in the previous section only considers the parameters identified from the results of this experiment, and it is possible that various parameters are involved. We infer that by evaluating the validity of the model and improving it via further experiments, we can possibly develop a

presentation method that uses small amounts of interest-related information to increase the acceptance of information outside the user's interests, including a behavior change system that adopts this method.

6 Conclusion

In this paper, we proposed a purchasing support system for offline stores that can present information to users without being evasive by interactively presenting small amounts of product information according to their interest in the product, as estimated by the system. Accordingly, we designed and implemented a proof-of-concept system for an actual use case scenario: a snack purchasing area in an office. Furthermore, we evaluated the effectiveness of the proposed system based on our hypotheses via a purchasing experiment with 11 participants. The obtained experimental results suggest that the proposed method can induce user's interest in the system and encourage them to view the information, and that users may positively receive the information presented and make a purchase, even if partially considered.

Acknowledgment

This work was supported by JST, PRESTO Grant Number JPMJPR21P7, Japan.

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