Effect of products’ startup sound on repurchase intention

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Abstract

Sound design can enhance industrial products’ emotional value because sound plays a functional role and also provides an emotional experience. Nevertheless, limited research has been conducted on product sound, especially startup sounds—the first sounds heard when a product is touched. This study focused on the possibility that attachment to a product could be created through startup sounds, which could consequently create loyalty. We verified the hypothesis that strength of the startup sound’s impression affects repurchase intention by using personal computer (PC), robot vacuum cleaner (VC), and car (CA) as research objects. To prevent the subject from being overly conscious of startup sounds, we focused research in an actual consumer environment, not an experimental environment. Thus, PC and VC’s odds ratios were $\geq 1.7$, supporting the hypothesis, but CA showed no significant difference. We conclude that through proper startup sound design, loyalty to a product can be increased.

Keywords: durable consumer goods, emotional value, startup sound, loyalty, repurchase intention, propensity score

1. Introduction

As technological development progresses in industrial products, the products’ performance exceeds the level of consumers’ demand; however, thereafter, it becomes difficult to continue contributing to consumer value improvement. From the consumers’ perspective, even if the performance is excellent, they perceive that the product or service has not improved. Consequently, commoditization occurs, and the profit margin decreases due to price competition. Therefore, it is important for industries to focus on emotional value to acquire high consumer loyalty. Emotional value is an effective means to satisfy human senses such as sight and smell. This study focuses on hearing, that is, sound. Sound has various effects such as on consumers’ memory, evaluation, and purchasing behavior [1].

In the past, products’ sound design was often aimed at noise reduction; however, recently, its purpose has changed to convey the product’s concept and provide comfort [2]. This is because sound generated by the product performs a functional role and also provides a sensual experience [3]. Moreover, it produces various emotions such as comfort, friendliness, and relief [4]. For example, sound of a car engine not only serves as a criterion for judging performance but also provides sensory comfort [5,6]. In electric vehicles, the engine is changed to a motor and is silent, but a functional sound is required to warn pedestrians [7].

Currently, there is a movement to design sounds that enhance not only the function but also emotional value of products. BMW announced an engine sound that changes depending on the driving mode in the i4 concept model scheduled to be released in 2021 [8]. The E-10 concept of Chevrolet has the latest electrification technology, but it also has a retro exterior design and intentionally generated engine sound [9].

Sound is used in not only cars but also products such as microwave ovens, vacuum cleaners, and smartphones. However, despite its importance, research on product sound is still limited [10]. Most studies have long examined in-use sounds and notification sounds that play a functional role; however, products’ startup sounds are rarely studied. The startup sound is the first sound heard when the product is touched without being disturbed by other tasks’ sounds.

Therefore, we focused on the possibility that attachment to a product could be created through startup sounds, which could be a factor in creating consumer loyalty. In this study, we verified the hypothesis that the strength of a startup sound’s impression affects consumers’ repurchase intention by using personal computers (PC), robot vacuum cleaners (VC), and car (CA) as study objects. To prevent the respondents from being overly conscious of the startup sounds, we conducted the analysis in an actual consumer environment, not in an experimental environment. It is important to design product sound by understanding how consumers perceive sound for its success [11].

If the hypothesis is supported, it would suggest to the industry the importance of this asset of startup sound, which is less costly compared with new technology. Nowadays, it is becoming difficult to differentiate by technology and performance, so such value creation that attaches great importance to emotional value contributes to competitiveness more and more.
2. Effect of Sound on Consumer Behavior

Many studies have been conducted on this topic, because sound has various effects such as on consumers’ memory, evaluation, and purchasing behavior [1]. When categorized, the following three viewpoints are central.

The first is the effect of sound symbolism. Sound is an effective way to convey product characteristics independent of language. For example, an experiment was performed in which a curved non-cornered figure and a linear angular figure were presented, and the participants were asked to select which figures corresponded to the pronunciation of the words /takete/ and /maluma/. Most participants selected the former figure as corresponding to /maluma/ and the latter to /takete/ [12]. Similarly, the pronunciation of /a/ gives a big impression and that of /i/ gives a small impression [13]. Thus, by using sound symbolism, it becomes possible to convey the size, weight, speed, and strength of a product through the brand name [14]. The brand name accounts for 34% of the attitude toward a product [15], and its effect enhances brand equity by having distinctiveness and meaning [16,17]. Even if consumers do not understand the product, their choice behavior changes depending on the brand name [18].

The second is the effect of music. In retail stores, music encourages purchases [19,20], boosts consumers’ purchase price amount [21], and ensures higher evaluation of the sales staff and store [22]. Besides, it can extend consumers’ waiting time [23] and reduce anxiety [24]. Moreover, sound in advertisements also attracts visual attention [25] and conveys product characteristics [26].

The third is the effect of product-generated sound. Especially, as the perception of food depends on not only the flavor but also the sound generated by chewing, this topic has been studied actively. For example, auditory cues are essential for the accurate judgment of crispness [27]. Studies on potato chips revealed that the sound of mastication contributed to perceived crispness and freshness [28]. For industrial products, noise reduction is often the target. Through addition of vibration as well as sound, a product is perceived as more powerful, but annoyance also increases [29]. Fan noise also causes customer dissatisfaction [30]. Recently, the purpose of sound has changed to convey the concept of products and provide comfort [2]. To this end, research is needed to support designers and engineers responsible for the complex task of sound design [31]. In the automobile industry, a consortium of European automobile manufacturers and universities has developed a vehicle interior sound database and a psychoacoustic dictionary to devise an objective evaluation method for in-vehicle sound [32]. Various studies have also been conducted, such as on a system for sensuously evaluating sound [33] and on the process for managing products’ sound information [34]. However, although the importance of sound has been recognized for a long time, there are still few studies that match the purpose of this study.

3. Research Method

3.1 Survey

In this study, we hypothesized that the strength of a startup sound’s impression affects the repurchase intention of PC, VC, and CA. The target brands and products are Apple’s MacBook for PC and iRobot’s Roomba for VC; detailed models are not considered. In both cases, a sound is generated from the product when activated. The CA brand is Lexus, but the product name was not defined. This is because the brand is not restricted to only one product but includes several products under its ambit. For Lexus, a startup sound is generated from the manufacturer’s car navigation.

An online survey was conducted in Japan from February 1 to 8, 2020. The sample size was 500 for each product, with a total of 1,500 respondents. Regarding the conditions, the respondents needed to (a) be in their 20s to 60s, (b) have purchased the target product as a new product, and (c) have used it more than once a month. The survey comprised a screening survey and main survey. Both surveys were conducted online, and after the screening survey, main survey was started immediately. The answering device could be either a smartphone or PC.

The screening survey’s purpose was to select respondents who met the above conditions (a)-(c). Respondents who did not meet the conditions ended the survey here. We asked questions on 12 items: (1) gender, (2) age, (3) living area, (4) household annual income, (5) owned brands and products (PC, VC, and CA), (6) frequency of use, (7) information on target categories, (8) existence of decision-making rights for target products, (9) emphasis on purchase of target products, (10) purchase time, (11) planned next purchase time, and (12) number of times they had purchase experience of the target brand. In (5), for each category, the top 10 brands sold in Japan were listed. Only those who answered Lexus for CA were additionally asked whether their car’s navigation was from the manufacturer or not; they were excluded if it was not. When the respondents owned the target brands in multiple categories of PC, VC, and CA, they were randomly assigned to one category. Among the respondents who met the conditions, we randomly selected 500 people in each category as the subjects of the main survey. Table 1 shows representative values for each subject, which were then converted into dummy variables.

In the main survey, the following items were asked: (13) repurchase intention, “Do you want to purchase from the [brand] you currently own next time?”; (14) strength of the startup sound’s impression, “How impressive is the sound you hear when you start up your [brand-product], or does it not make any sound?”; (15) PC/VC/CA startup sound mode setting, “Do you usually use [brand-product] in silent mode?”; (16) impression of the startup sound, “What is the impression of [brand-product] startup sound?” The brand and products obtained from the screening survey were inserted in the square brackets.

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### Table 1 List of variables and representative values

| No | Variable | Description | PC mean sd | VC mean sd | CA mean sd |
|----|----------|-------------|------------|------------|------------|
| 1  | RepurchaseIntention | Repurchase Intention dummy | 0.666 0.472 | 0.434 0.496 | 0.595 0.491 |
| 2  | Impression | Impression dummy | 0.338 0.474 | 0.498 0.500 | 0.290 0.454 |
| 3  | Female | Gender dummy | 0.500 0.501 | 0.500 0.501 | 0.397 0.490 |
| 4  | 20s* | Age dummy | 0.200 0.400 | 0.200 0.400 | 0.081 0.273 |
| 5  | 30s | | 0.200 0.400 | 0.200 0.400 | 0.128 0.334 |
| 6  | 40s | | 0.200 0.400 | 0.200 0.400 | 0.258 0.438 |
| 7  | 50s | | 0.200 0.400 | 0.200 0.400 | 0.298 0.458 |
| 8  | 60s | | 0.200 0.400 | 0.200 0.400 | 0.235 0.425 |
| 9  | Hokkaido | Area dummy | 0.040 0.196 | 0.030 0.171 | 0.044 0.206 |
| 10 | Tohoku | | 0.038 0.191 | 0.038 0.191 | 0.057 0.233 |
| 11 | Hokuriku | | 0.044 0.205 | 0.044 0.205 | 0.047 0.212 |
| 12 | Kanto* | | 0.482 0.500 | 0.374 0.484 | 0.433 0.496 |
| 13 | Chugoku | | 0.112 0.371 | 0.128 0.381 | 0.149 0.356 |
| 14 | Kinki | | 0.164 0.371 | 0.164 0.371 | 0.172 0.378 |
| 15 | Shikoku | | 0.014 0.118 | 0.014 0.118 | 0.016 0.124 |
| 16 | Kyusyu | | 0.068 0.252 | 0.068 0.252 | 0.060 0.238 |
| 17 | Income_20_39* | Annual household income dummy | 0.204 0.403 | 0.114 0.318 | 0.065 0.247 |
| 18 | Income_40_59 (thousand dollars) | | 0.258 0.438 | 0.218 0.413 | 0.102 0.303 |
| 19 | Income_60_79 | | 0.232 0.423 | 0.206 0.405 | 0.185 0.389 |
| 20 | Income_80_99 | | 0.118 0.323 | 0.156 0.363 | 0.204 0.403 |
| 21 | Income_100_149 | | 0.140 0.347 | 0.214 0.411 | 0.219 0.414 |
| 22 | Income_150 | | 0.048 0.214 | 0.092 0.289 | 0.225 0.418 |
| 23 | DailyUse | Frequently used dummy | 0.672 0.470 | 0.240 0.428 | 0.373 0.484 |
| 24 | Decision | Purchase decision dummy | 0.772 0.420 | 0.616 0.487 | 0.556 0.497 |
| 25 | Info | Information gathering dummy | 0.448 0.498 | 0.150 0.357 | 0.264 0.441 |
| 26 | Function | Emphasis point dummy | 0.208 0.406 | 0.096 0.295 | 0.232 0.423 |
| 27 | Design | | 0.082 0.275 | 0.034 0.181 | 0.162 0.369 |
| 28 | Usability | | 0.278 0.448 | 0.326 0.469 | 0.300 0.459 |
| 29 | Price* | | 0.096 0.295 | 0.130 0.337 | 0.063 0.243 |
| 30 | Eco | | 0.012 0.109 | 0.014 0.118 | 0.031 0.174 |
| 31 | Wom | | 0.042 0.201 | 0.066 0.249 | 0.026 0.160 |
| 32 | Others | | 0.004 0.063 | 0.000 0.000 | 0.003 0.051 |
| 33 | Purchased_within3years | Purchased period dummy | 0.466 0.499 | 0.596 0.491 | 0.356 0.497 |
| 34 | Purchased_over4years | | 0.500 0.501 | 0.376 0.485 | 0.436 0.497 |
| 35 | Purchase_within3years | Next purchase plan dummy | 0.230 0.421 | 0.178 0.385 | 0.232 0.423 |
| 36 | PurchaseMultiple | Multiple purchase experience dummy | 0.604 0.490 | 0.174 0.379 | 0.475 0.500 |
| 37 | NonSilent | Non silent mode dummy | 0.488 0.500 | 0.678 0.468 | 0.734 0.443 |
| 38 | SP | Answer on smartphone dummy | 0.464 0.499 | 0.514 0.500 | 0.507 0.501 |

Note: *Criteria for dummy variables. PC=personal computer; VC=robot vacuum cleaner; CA=car; sd=standard deviation; SP=smartphone.

### Table 2 Estimated result of logistic regression model

| Variable | PC | VC | CA |
|----------|----|----|----|
| (Intercept) | 0.196 0.277 0.000 *** | 0.436 0.236 0.000 *** | 0.254 0.348 0.000 *** |
| Female | 0.727 0.203 0.118 | 0.385 0.276 0.001 ** | 0.347 0.345 0.002 ** |
| 40s | 0.702 0.261 0.175 | 0.475 0.277 0.007 ** | 0.281 0.346 0.000 *** |
| 50s | 0.473 0.276 0.007 ** | 0.324 0.278 0.000 *** | 0.242 0.375 0.000 *** |
| 60s | 1.827 0.348 0.083 | 1.78 0.385 0.232 0.423 |
| 70s | 0.676 0.289 0.074 | 2.638 0.264 0.000 *** |
| Function | 0.716 0.232 0.150 | 1.427 0.210 0.090 | 0.281 0.346 0.000 *** |
| Purchased_over4years | 1.700 0.203 0.009 ** | 0.854 0.209 0.451 | 0.242 0.375 0.000 *** |
| Purchase_within3years | 1.596 0.231 0.045 * | 5.664 0.228 0.000 *** | 4.242 0.337 0.000 *** |
| PurchaseMultiple | 2.599 0.222 0.000 *** | 0.699 (0.651-0.747) | 0.744 (0.700-0.787) | 0.731 (0.687-0.774) |

Note: ***p<0.001; **p<0.01; *p<0.05. PC=personal computer; VC=robot vacuum cleaner; CA=car; se=standard error; CI=confidence interval.

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Objective variable (13) was gathered first to collect data before the consumers were biased due to treatment variable (14). In (13) and (14), we asked questions on seven-point scales: the top two answers defined as “have a repurchase intention” and “have an impression” were made into dummy variables. At this time, we also asked “Or does it not make any sound?” because the specifications differed depending on model type. For MacBook, the model released before early 2016 made a startup sound, but this sound did not appear on models manufactured in late 2016 and thereafter, except for MacBook Air (13-inch, 2017) [35]. Because of the complicated conditions, we judged that it was difficult to obtain an accurate answer for detailed model types. Therefore, without distinction, if the products were turned on in silent mode or the model type had no sound, we treated the answer as “no impression.” In (15), we asked questions on seven-point scales, ranging from “always in silent mode” to “always in normal mode and sound always comes out.” We made the top two answers on the normal mode side into dummy variables for non-silent. Excluding those who answered that no sound was heard in (14), (16) asked for a free answer.

3.2 Analysis

When random allocation of the treatment is possible, it is desirable to use a randomized controlled trial as the most reliable scientific basis. However, random allocation makes it difficult to verify the hypothesis in this study through actual consumer behavior. This is because two homogeneous groups that have no experience of using the target brand/product would be prepared, and the treatment group would be set to the normal mode and the control group to the silent mode. Then, it would be required for mode change to be prohibited and the user to continue to use the product for a certain period. Since the sound’s impression is unconsciously created [3], long-term observation is required and the burden on the subject is heavy. In addition, there would be a concern that unnatural instructions (e.g., “Do not change the mode”) may lead the consumers to be confused or become conscious of the sound, which may bias the result.

Therefore, we used the propensity score proposed by Rosenbaum and Rubin [36], a typical method for estimating causal effects when random allocation is difficult. Covariates were adjusted by aggregating multiple covariates into one variable, the propensity score. There is high possibility that there are biases in the characteristics of people with and without impressions of startup sounds collected in the survey. Therefore, the causal effect was estimated by matching respondents with similar propensity scores and homogenizing both groups. Since the propensity score’s true value is unknown, it is common to estimate it from data using a logistic regression model. Based on the consumer attribute data in rows (3)-(39) of Table 1, we constructed a logistic regression model that estimates the presence or absence of the startup sound’s impression. The stepwise method was used for variable selection. The criteria for the dummy variables were not entered. As shown in Table 2, in PCs, the experience of multiple purchases has the highest odds ratio, followed by the use of normal mode and experience of 4 years or more. In each category, c-statistics are about 0.7, and the condition for using the propensity score is satisfied.

As a result of matching using the estimated propensity scores, there were 152 people in each group for PC, 156 people in each group for VC, and 97 people in each group for CA. As Table 3 shows, the covariates in each group are almost homogenized. The standardized mean difference was 0.177 at the maximum, and it was judged that there was no concern about a bias affecting the repurchase intention, which is the objective variable.

Then, for each category, the difference in the distribution of repurchase intention between the treatment and control groups was verified by the chi-square test. The null hypothesis is that there is no difference in the repurchase intentions of the two groups. If the null hypothesis is rejected at the 5% significance level, this study’s hypothesis, “The strength of the startup sounds’ impression affects the repurchase intention,” is supported.

Finally, we grasped how consumers perceive the sound, by natural language processing, from the sentences in which the impression of each startup sound was asked in the free answers.
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4. Results and Discussion

Table 4 shows the results of crosstabulation and chi-square test after propensity score matching regarding the following values for the PC, VC, and CA: presence or absence of the impression × presence or absence of repurchase intention.

First, regarding PC, of the 152 people who have the impression of a startup sound, 115 have repurchase intention (positive rate: 75.7%). On the other hand, of the 152 people with no impression, 98 have repurchase intention (positive rate: 64.5%). The p-value is 0.045 as a result of the chi-square test, and so there is a significant difference. The odds ratio is 1.713. Second, regarding VC, the p-value is 0.008, and a significant difference is present, resulting in an odds ratio of 1.894. Finally, regarding CA, the p-value is 0.464, and there is no significant difference. In CA, the positive rate of those who have an impression is 62.9%, and that of those who have no impression is 56.7%. The difference between the two groups is 11.2% for PC and 15.4% for VC, but only 6.2% for CA.

The characteristics of each startup sound were analyzed from the free answer about the impression. The characteristics of each product were found by morphological analysis of the sentence data provided freely and extraction of adjectives. For PC, “dignified,” “cool,” and “simple” were the top three adjectives in terms of frequency. For VC, “cute,” “mechanical,” and “bright” were the top three. For CA, “dark,” “calm,” and “elegance” were the top three. The respondents shared “dignified” and “bright” were the top three. For CA, “dark,” “calm,” and “elegance” were the top three adjectives in terms of frequency. The respondents shared that the MacBook has a dignified sound, the Roomba has a mechanical and pop sound, and the Lexus has a soft, piano-like sound. However, it cannot be generally concluded from this result that “dignified” and “bright” are effective, and “elegance” is ineffective. Further research is needed to understand effective sounds.

Therefore, the hypothesis that “the startup sounds’ impression affects the repurchase intention” was supported for PC and VC, but rejected for CA. This is because PC and VC, the odds ratios were 1.7 or higher, confirming a high degree of contribution to repurchase intention. Thus, by unconsciously hearing the startup sound each time a product is used, it is possible for consumers to increase their attachment to the product, thus increasing their loyalty.

The results showed that the odds ratios of PC and VC intention of the PC, VC, and CA in the real environment. The startup sounds’ impression influences the repurchase intention of the PC, VC, and CA in the real environment. The results showed that the odds ratios of PC and VC were 1.7 or higher, supporting the hypothesis. Therefore, by properly designing startup sounds, one can expect to increase consumers’ loyalty toward the product.

5. Conclusion

It is difficult to differentiate between industrial products based on performance. Therefore, creating emotional value that appeals to the consumers’ five senses is important for ensuring high brand loyalty. In this study, we focused on sound. In the past, products’ sound design was often aimed at noise reduction, but nowadays it is designed to convey the products’ concept and provide comfort. This is because sound generated by the product not only plays a functional role but also provides an emotional experience. However, research on product sound is still insufficient, and startup sounds are rarely studied. Therefore, this study verified the hypothesis that the startup sounds’ impression influences the repurchase intention of the PC, VC, and CA in the real environment. The results showed that the odds ratios of PC and VC were 1.7 or higher, supporting the hypothesis. Therefore, by properly designing startup sounds, one can expect to increase consumers’ loyalty toward the product.

Table 4 Result of treatment effect by Chi-square test

| Impression | RepurchaseIntention | Total | odds ratio | p-value |
|------------|---------------------|-------|------------|---------|
| 0          | 1                   | 54    | 98         | 152     | 1.713  | 0.045* |
| 1          |                     | 37    | 115        | 152     |         |        |
| PC         |                     |       |            |         |        |
| 0          | 1                   | 103   | 53         | 156     | 1.894  | 0.008**|
| 1          |                     | 79    | 77         | 156     |         |        |
| VC         |                     |       |            |         |        |
| 0          | 1                   | 42    | 55         | 97      | 1.294  | 0.464  |
| 1          |                     | 36    | 61         | 97      |         |        |
| CA         |                     |       |            |         |        |

Note: ***p<0.001; **p<0.01; *p<0.05. PC=personal computer; VC=robot vacuum cleaner; CA=car.

However, this study has four limitations. First, we dealt with three product categories—PC, VC, and CA—but it is difficult to generalize the results because the study focused on only one brand from each category. This study only shows that startup sounds could contribute to the repurchase intention. Therefore, even for CA, it is possible that they will have an effect if appropriate startup sounds are designed. Second, it is impossible to know the range of the effect size. In the study’s results, the sounds’ impressions were identified as dignified and bright, but other sounds with the same impression could have a different effect size. Therefore, to estimate the effect range, it is useful to define multiple impressions for each target brand or product and prepare and analyze multiple startup sounds for each impression. By involving multiple brands, it may be possible to grasp the effect size of the startup sound compared with the effects of the brands. Third, there is a concern that the results may deviate from the actual repurchase behavior because the evaluation is based on recognition of the repurchase intention. Since durable consumer goods have long replacement periods, a long-term follow-up survey is required to verify the results with the actual behavior. Fourth, regarding the matching by consumer characteristics, including purchase emphasis points, there is a slight possibility that the distribution of reasons for purchase intention differs between the treatment group and the control group. These are subjects for future research.

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