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Shimizu, Tomoyuki
Futami, Kyosuke
Terada, Tsutomu
Tsukamoto, Masahiko

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Article

Selection Interface for Promoting User Selection Diversity by Presenting Positive/Negative Review Text and Video to Evoke Product Impression and User Emotion

Tomoyuki Shimizu ¹, Kyosuke Futami ^{2,3,*}, Tsutomu Terada ¹ and Masahiko Tsukamoto ¹

¹ Graduate School of Engineering, Kobe University, Kobe 657-8501, Hyogo, Japan; shimizu_tomoyuki@stu.kobe-u.ac.jp (T.S.); tsutomu@eedept.kobe-u.ac.jp (T.T.); tuka@kobe-u.ac.jp (M.T.)

² Graduate School of Information Science and Engineering, Ritsumeikan University, Kusatsu 525-8577, Shiga, Japan

³ Digital Spirits Teck., Kusatsu 525-8577, Shiga, Japan

* Correspondence: futami@fc.ritsumei.ac.jp

Abstract: In recent years, unintentional bias in user selection has hindered the growth of information device interfaces and algorithms. To address this problem, it is essential to clarify the factors that influence a user's selection bias and to design methods that diversify the user selection without bias. This study focused on the positivity and negativity of reviews and videos as factors that influence a user's selection bias and investigated whether viewing them increases or decreases a user's selection diversity. Based on the results, we aimed to show effective methods for improving a user's selection diversity by evoking a user's product impression through a review presentation and by evoking a user's emotion through a video presentation. This study drew inspiration from the broaden-and-build theory, which suggests that exposure to positive or negative information can impact an individual's selection diversity. In this study, we implemented a smartphone application for online product purchase for an experimental task in which individuals repeatedly selected one of five different drinks. Two experiments were conducted to investigate the effect of reviews and videos on user selection. Experiment 1 showed that viewing positive reviews promoted diversity in a user selection and that both positive and negative reviews promoted brand switching (i.e., selecting different products in a consecutive selection). Experiment 2 indicated that watching a negative video potentially decreased a user's selection diversity. Our study is helpful for understanding the effect of viewing reviews and videos on user selection and for designing interfaces that promote diverse user selection.

Keywords: information presentation; decision making; diversity; cognitive bias; behavior change; persuasive technology; recommendation system; user interface; emotion; entropy



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1. Introduction

In recent years, unintentional bias in user selection has hindered the growth of information device interfaces and algorithms. For example, ranked lists, which are widely used on shopping sites and search engines, tend to bias a user's selection toward more highly rated items on individual or group selection [1,2]. Many studies have also shown that online information-seeking promotes confirmation bias, in which people only collect information that supports their ideas [3–5]. In addition, research on tourism has shown that online information sources make biased tourist routes toward metropolitan areas more than offline sources (e.g., guidebooks, travel agencies, and friends) and that this bias may constrict the healthy growth of local economies [6].

To address this problem of biased selection, it is important to clarify the factors that influence biased selection in information interfaces and to understand the design that diversifies user selection. Additionally, there are situations where users browse reviews

(referred to as word-of-mouth in this paper) or videos before selecting content using information devices. For example, many e-commerce sites show customers' reviews of products on selection screens. In addition, the user often shops after watching videos on video-sharing platforms by clicking a hyperlink. To avoid inadvertently causing biased selection in such situations, it is essential to investigate how a user selection is affected by viewing reviews and videos.

Psychological research has indicated the possibility that diverse selection is promoted after viewing positive information and biased selection is promoted after viewing negative information. For example, the listed number of activities that an individual wants to perform now can increase after viewing positive videos and decrease after viewing negative videos [7]. According to the broaden-and-build theory [8], this result indicates that positive emotions make people more likely to recall or accept a wider range of actions and options. In light of these findings, it can be assumed that if a user's positive or negative impression of options or a user's emotion is evoked by viewing positive or negative reviews or a video, the user selection will be unconsciously diverse or biased. If such effects are revealed, they would be helpful in designing an interface that prevents the phenomenon of biased selections and promotes selection diversity.

Therefore, this study investigated reviews and videos that increase or decrease selection diversity in terms of positive or negative information. Based on the experimental results, we showed effective methods to increase a user's selection diversity by evoking the user's product impression through a presentation of the reviews and by evoking the user's emotion through a video presentation. In this study, "diverse selection" refers to the behavior of an individual selecting a wide range of options, and "biased selection" refers to the tendency of an individual to narrowly select partial options from many options. In this study, we implemented a smartphone application for online product purchase for an experimental task in which individuals repeatedly selected one of five types of drinks and conducted the following two experiments. Experiment 1 investigated the effect on user selection caused by product impression manipulation through review viewing. Experiment 2 investigated the effect on user selection caused by emotional evocation through video viewing. Our results help us to understand the effect of review and video viewing on user selection and to design interfaces that promote selection diversity.

The remainder of this paper is organized as follows. Section 2 presents related work. Section 3 describes Experiment 1 for review viewing and discusses the results. Section 4 describes Experiment 2 for video viewing and discusses the results. Section 5 discusses the limitations of our study, and we finally present our conclusion in Section 6.

2. Related Work

In this section, we present previous studies on the approaches to selection diversity, the interplay between emotion and decision-making, the influence of reviews and videos, and the indicators used to measure diversity. These studies present the importance and potential of, and the method for evaluating, increasing selection diversity through emotional reviews and videos.

2.1. Selection Diversity

Although repeating the same selections can reduce decision-making costs and unknown risks, it may be better to make various selections in a changing or uncertain environment. Making an unusual selection can result in new insights and thus reduce uncertainty in such an environment. The dilemma of risk aversion through the same selection versus knowledge acquisition through an unusual selection has been explored in various research fields, including medicine [9], economics [10,11], business administration [12], psychology [13,14], and biology [15,16]. Many of them recommend using the two decision-making strategies in a balanced manner [17].

Previous studies have confirmed that interfaces and algorithms cause biased selections. Users tend to select items whose reviews are more posted or higher rated on shopping

sites [1,2]. Tourists' routes using online information sources are biased more toward metropolitan areas than those using offline sources (e.g., guidebooks, travel agencies, and friends) [6]. In addition, previous studies have pointed out that online information-seeking promotes user confirmation bias, in which people only collect information that supports their ideas [3–5]. As a similar problem in recent years, some researchers and activists have pointed out the “filter bubble”, whereby excessive information personalization algorithms allow users to retrieve only the information they want [18,19].

To tackle this problem, many studies have attempted to improve interfaces and information-recommendation algorithms to promote diverse decision-making. For example, Tsai et al. [20] proposed an interface that makes understanding the differences between options easier by arranging the options in two dimensions instead of a one-dimensional ranking. In their study, they asked participants to select as many different options as possible from options. They found that participants selected more diverse options with the proposed interface than with a simple, one-dimensional ranked list. Similarly, there are selection interfaces for products [21] and music [22] that focus on the easiness of capturing the differences between options. In addition, many studies on recommendation systems have evaluated the recommendation results using indicators of serendipity and novelty so that users do not get bored with similar information [23–25].

2.2. Positive/Negative Emotion and Decision-Making

Many studies have investigated the relationship between emotions and decision-making, including risk selection [26,27], willingness to purchase [28], and decision-making time [29].

In particular, Fredrickson proposed the broaden-and-build theory [7,8], which is the psychological effect of positive emotions, such as joy, interest, and satisfaction. According to this theory, positive emotions broaden one's repertoire of thoughts and actions, such as “want to do something,” and negative emotions narrow them. For example, Fredrickson et al. asked subjects to list what they wanted to do after watching a video that evoked a particular emotion. They found that the group feeling joy and satisfaction listed more actions compared to those feeling fear and anger. In addition, some theories suggest that positive emotions expand visual attention. For example, Fredrickson et al. asked subjects to find a difference in two images that differ in terms of global and local parts. The results indicated that the positive group easily found entire changes, while the negative group easily found detailed changes.

In their broaden-and-build theory paper, Fredrickson et al. cited research showing that positive emotions increase variety-seeking (the behavior of consumers who purchase a variety of products). Kahn et al. [30] conducted an experiment in which subjects repeatedly selected the crackers they wanted to eat after evoking their emotions. The results indicated that the brand-switching behavior increased in the positive emotion group. Brand switching is selecting a different product from the previous one and is one of the behaviors by which customers pursue a variety of products. However, they did not evaluate the degree of the biased selection.

There are also many studies on the effect of the positivity and negativity of options on selection tendencies. In particular, the framing effect [31,32] is a well-known effect in which people's preferences reverse between negative and positive descriptions of the same meaning. For example, research has shown that patients are more inclined to undergo surgery when presented with a statement, such as “your surgery has an 80% chance of success” compared to “your surgery has a 20% chance of failure. However, the framing effect basically focuses on preference reversal and does not cover cases where more than three options exist, such as in selection diversity.

2.3. Influence of Reviews and Videos on Users

A study by Zhang et al. [33] investigated the effects of user emotions contained in reviews on shopping sites and found that users who experience enjoyment and pleasure

from reading online reviews are more likely to engage in impulse buying. Furthermore, some studies have examined how the positivity or negativity of review texts impacts users' cognition of the review's usefulness. Huang et al. [34] investigated the effect of emotion on emojis in reviews. Yin et al. [35] compared anxious and angry reviews.

In addition, studies used videos and music to evoke subjects' emotions and investigated the risk preferences in their selection. For example, watching videos of a happy mood increased gambling compared to sad or neutral moods [36]. Another study showed that a group preferred riskier selections by listening to music that made them happy [37]. Conversely, videos evoking sad moods increase risk aversion [38]. There are indications that the susceptibility to emotional impact from videos varies based on personality traits [39]. In emotion research, watching film clips is one of the most effective methods to evoke emotion [40]. Schaefer et al. [41] created a database of French or English short film clips to evoke fear, anger, sadness, disgust, amusement, tenderness, and a neutral state. They asked participants to subjectively assess many videos using two emotional scales of many adjectives.

Although the above indicates that elements, such as reviews and videos, can influence user selection in the interface, there is still a need to investigate the effect of positive/negative information on biased selection.

2.4. Diversity Indicators

There are several ways to measure the diversity of selection. Kahn et al. [30] evaluated brand switching and decision-making time as indicators of consumer's variety-seeking behavior in their research. Brand switching indicates the frequency with which people switched options, and decision-making time indicates the time people spent selecting. In addition, Shannon entropy can represent the tendency for people to select options evenly. Entropy is used in many fields as a diversity indicator of the user's engagement diversity in the interface [20] or algorithm [42], biological diversity [43], urban diversity [44], and economic disparity [45].

3. Experiment 1: Effect of Viewing Review on Selection Diversity

This experiment evaluated how a user's selection diversity is affected after viewing review texts that evoke positive or negative impression of different options. The subjects were 28 university students (26 males and two females in their early 20s), all of whom agreed in advance to the possibility of evoking negative emotions.

3.1. Method: Presenting Reviews to Evoke Product Impressions

This experiment used a method to evoke positive or negative product impressions in participants by presenting them with corresponding positive or negative reviews. A review refers to the user's word of mouth about the product.

3.2. Hypothesis

Figure 1 shows our hypothesis. Our hypothesis assumes that viewing positive reviews increases the selection diversity and viewing negative reviews decreases the selection diversity. This is based on the hypothesis that when positive impressions of products are evoked, people will want to try products that they were not initially attracted to. Conversely, when a negative impression is evoked, they will not want to select the products that they were initially attracted to.

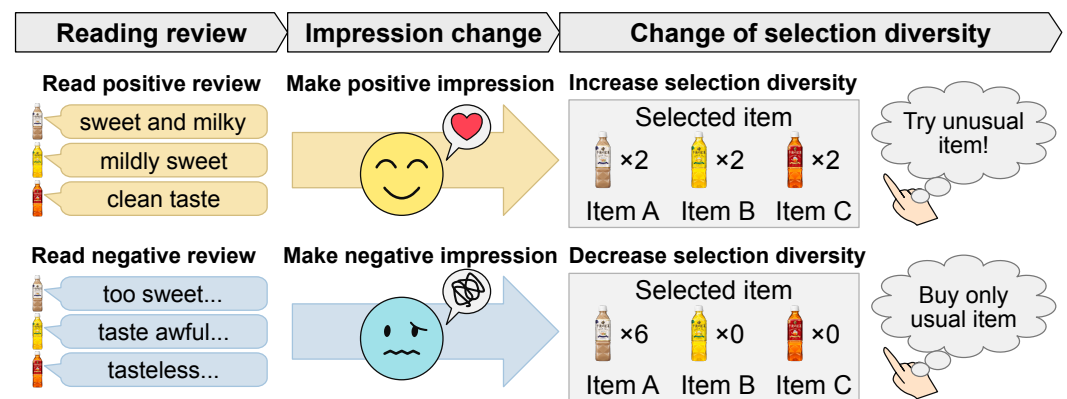


Figure 1. Hypothesis for Experiment 1. The effect on selection diversity of presenting positive and negative reviews in selection. Positive impressions encourage diverse choices. Negative impressions encourage biased choices.

Therefore, this experiment tested the following hypotheses. Because it is unknown which positive or negative reviews promote selection diversity, we will discuss the appropriate method of presenting reviews after testing the following points.

Hypothesis 1. *Selection diversity increases (i.e., selection bias decreases) after viewing positive reviews.*

Hypothesis 2. *Selection diversity decreases (i.e., selection bias increases) after viewing negative reviews.*

3.3. Evaluation Indicators

This experiment evaluated the selection diversity using the following three indicators. Previous studies adopted these indicators.

3.3.1. Entropy

Shannon's entropy is an indicator that evaluates the selection diversity; a higher entropy value indicates more even distribution of selections across the available options. For example, the value of entropy is one when the subject selects each option the same number of times in the case of repeatedly selecting any one of the five options. Conversely, the entropy value is zero when the subject repeatedly selects only one option. This indicator is calculated from the entropy Equation (A1) described in Appendix A.

3.3.2. Brand Switching

Brand switching is an indicator that evaluates selection bias; a higher value of brand switching indicates that a subject did not select the same option in consecutive selections (i.e., the subject attempted a different selection from the previous one). Specifically, this indicator counts the number of times a selection differs from the previous one in multiple consecutive selections. This indicator has a high value if a user switches more frequently to other options different from the previous one. Conversely, it becomes a lower value by more repeats of selecting the same option as the previous one. For example, assume the following two users when selecting menus a total of six times. (1) User 1 selects Menu A three times consecutively and then selects Menu B three times consecutively. (2) User 2 selects Menu A and Menu B alternately one by one so that the total number of times is six. In this case, User 2 has a higher value of brand switching, which can be interpreted as an unbiased selection. However, a higher value of brand switching does not necessarily represent increased selection diversity, although it can indicate that the subject did not continuously select the same option.

3.3.3. Decision-Making Time

Decision-making time is an indicator that measures total selection time per trial and is not directly related to selection diversity. Kahn's study [30] did not find a consistent trend

in the relationship between selection diversity and decision-making time. However, we also used this indicator in this experiment to investigate this relationship. For example, if both decision-making time and selection diversity increase because of information presentation, it suggests that interfaces may cause biased selection by design to reduce the time users spend making a selection.

3.4. Experimental Procedure

In this experiment, subjects repeatedly selected one of five bottled tea types one by one, 30 times in total. In detail, we gave subjects the following instructions at the beginning of the experiment. This experimental procedure and the instruction text were based on a previous study that evaluated the effects on selection [30]. The previous study used crackers, soup, and snacks as options in their experiment, and we also used tea, a product related to foods, and beverages. In addition, we could get statistical information on the domestic consumption of tea. In addition, making multiple selections at once is possible in actual life (e.g., when making monthly orders in a meal-kit delivery service). Practically, this instruction is described in Japanese. Subjects all read this instruction before beginning the first trial.

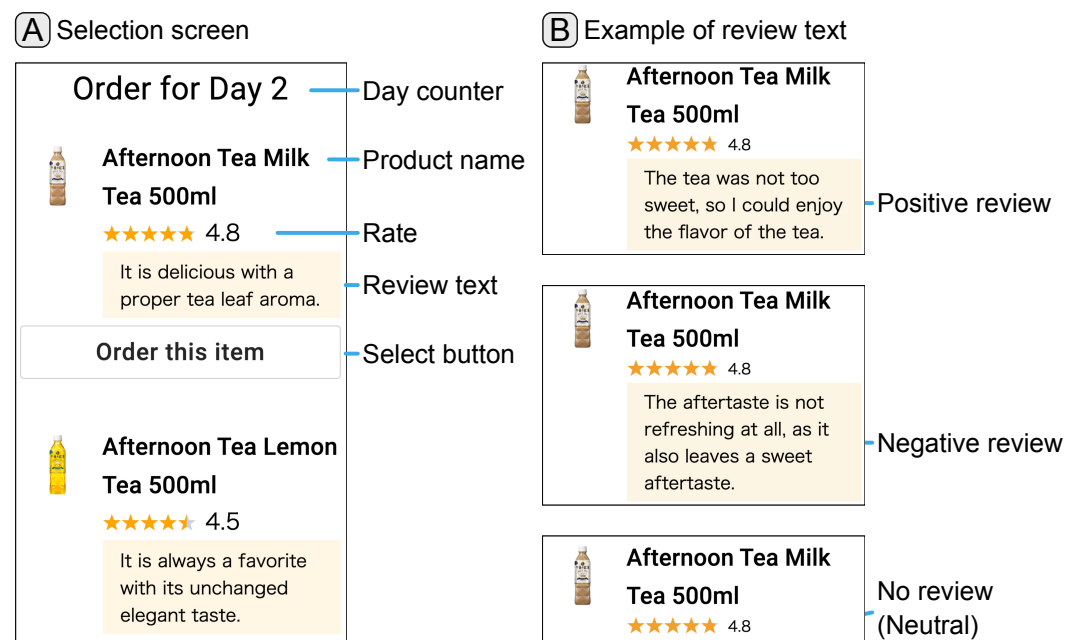
Instruction: With a new subscription service, you can get a bottle of tea every day for your break. However, you must submit a month's order at one time. So, please make the order plan for next month.

One trial consisted of viewing reviews, selecting products, and taking a break. First, subjects viewed the five teas and the reviews for each product on the screen shown in Figure 2A. The reviews were classified into positive reviews, negative reviews, or no reviews, as shown in Figure 2B. Next, subjects repeatedly selected a tea product of five types one by one until they selected a total of a 30-day supply. After completing the 30-day selection, the subjects took a 10-min break until the subsequent trial. This sequence procedure of one trial was performed for each of the three review presentation conditions described in Section 3.6 (positive-, negative-, and no-review conditions). Subjects completed the experiment after a total of three trials. The order of review presentation conditions was randomized with a counterbalanced order. The experiment was also conducted in a quiet, private room using the subject's smartphone.

The tea products used in this experiment are listed in Table 1. Table 1 shows the product name, flavor, and user rating score. The user rating score represents the product's popularity score. We set the popularity of each tea based on the statistical data of the beverage production volume in Japan [46]. The teas were ranked in popularity order as follows: milk, lemon, sugarless, sugared, and sesame. Because an actual shopping site makes a user's biased selection by the difference in rating scores, this experiment made differences in the ratings to reproduce such a situation.

Table 1. Tea products used in Experiment 1 and Experiment 2.

Product Name	Flavor	Rating
Afternoon Tea Milk Tea 500 mL	milk	4.8
Afternoon Tea Lemon Tea 500 mL	lemon	4.5
Afternoon Tea Unsweetened 500 mL	sugarless	4.2
Afternoon Tea Black Tea 500 mL	sugared	3.9
Sesame Barley Tea 350 mL	sesame	3.6



* Each element of the actual screen was shown in Japanese.

Figure 2. Implemented screens of the review presentation interface in Experiment 1. (A) Selection screen, (B) Examples of review texts.

3.5. Experimental Interface

Figure 2 shows the information screen used in the experiment. This screen worked with JavaScript in the Chrome and Safari browsers of the subject's smartphone. The product selection screen placed a day counter at the top and products in the fixed order of popularity below the counter, as shown in Figure 2A. The day counter counted up to 30 days each time a subject selected a product. When subjects pressed the selection button, the screen scrolled to the top of the screen, and the day count increased. Information about each product included name, image, user rating score, and reviews. As shown in Figure 2B, although the screen showed reviews in the positive- and negative-review conditions described in Section 3.6, it showed no review in the no-review condition.

3.6. Review Presentation Conditions

This experiment used the following three review presentation conditions.

3.6.1. Positive-Review Condition

In this condition, positive reviews were presented for each product. Review examples included: "I find it enhances the flavor of the aromatic tea!"; "My blood pressure has been bothering me lately, so this could be good"; or "It was nice to drink it during breaks from work, as it seemed to take away some of the fatigue". Table A1 in the Appendix shows the actual positive reviews used in the experiment. In the experiment, each time a subject selected one tea, each review was updated to randomly present a review from five positive reviews about each product.

3.6.2. Negative-Review Condition

In this condition, negative reviews were presented for each product. Review examples included: "It is not very good"; "I don't like the unique taste..."; or "I would prefer it to be a little less sweet." Table A2 in the Appendix shows the actual negative reviews used in the experiment. In the experiment, each time a subject selected one tea, each review was updated to randomly present a review from five negative reviews about each product.

3.6.3. Neutral Review Condition

No reviews were presented in this condition.

3.7. Procedure of Review Collection

The reviews mentioned above used in the experiment were collected from actual review-posting sites and confirmed that they could evoke positive and negative impressions by Google Natural Language API. We selected these reviews by the following procedure. First, we collected product reviews from Kakaku.com, which is one of Japan's most popular review posting sites.

We then manually removed invalid words and unintelligible lines. The following shows three examples. (1) Unnecessary conjunctions: For example, "By the way, this taste is too sweet". (2) Comparisons with other teas: For example, we removed all sentences, such as, "This tea smells better than the same brand of tea with lemon". (3) Statements unrelated to the product: For example, we removed all sentences, such as, "It is hot today, so I posted this".

After data cleaning, the number of review candidates was decreased to a total of 185. We then analyzed the sentiment scores of the reviews using Google Natural Language API. This API outputs a sentiment score between 1 and −1 in increments of 0.1 for each input text. Finally, we selected the five positive reviews with the highest sentiment score in order from the top and the five negative reviews with the lowest sentiment score for each product in order from the bottom. When the scores of six or more review candidates were equal and the most positive/negative, we randomly selected five reviews from them. Table 2 shows the mean and standard deviation (S.D.) of the sentiment score of the reviews for each product. Each mean of the positive-reviews score was 0.9, which means the upper limit score of the API, and S.D. was 0. S.D. being 0 is correct by considering our method and the API specification. Because our procedure was to select the most positive/negative five reviews in order from the top, the mean and S.D. must become such values if five or more reviews indicated the upper limit score of the API.

Table 2. Mean sentiment scores of positive and negative reviews for each product used in Experiment 1.

Flavor	Review Type	Mean of Sentiment Score	S.D.
milk	positive review	0.90	0.00
milk	negative review	−0.66	0.15
lemon	positive review	0.90	0.00
lemon	negative review	−0.72	0.13
sugarless	positive review	0.90	0.00
sugarless	negative review	−0.60	0.20
sugared	positive review	0.90	0.00
sugared	negative review	−0.76	0.11
sesame	positive review	0.90	0.00
sesame	negative review	−0.50	0.27

3.8. Results

Figure 3 and Table 3 show the entropy, brand switching, and decision time. The box plots in Figure 3 represent the quartiles and the jitter plots represent the actual values of all subjects. Table 3 shows each condition's mean and S.D. Each subject's entropy was calculated from 30 within-individual selections using Equation (A1) with the base five, and the overall mean of the entropies was calculated in each condition.

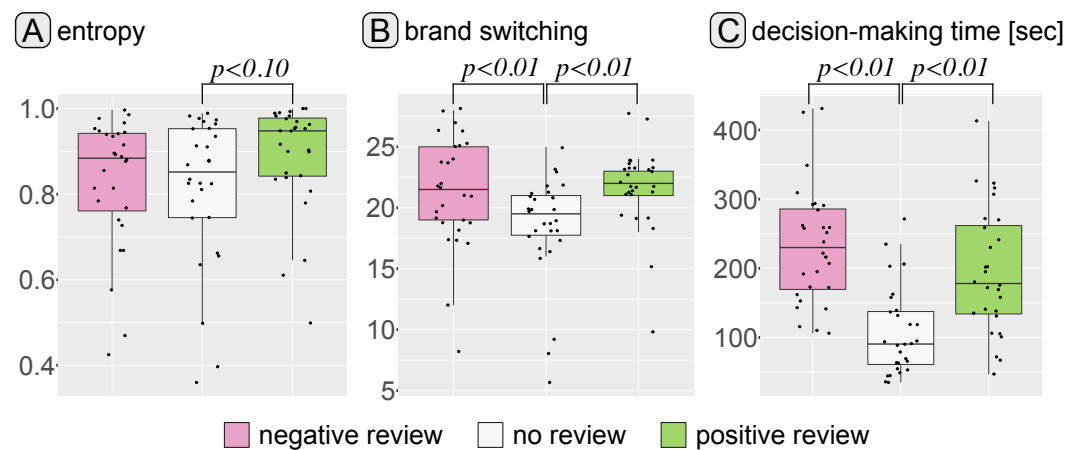


Figure 3. Results for each review presentation condition in Experiment 1. (A) Entropy, (B) Brand switching, (C) Decision-making time.

Table 3. Mean entropy, brand switching, and decision-making time for each review presentation condition in Experiment 1.

Indicator	Negative	Mean(S.D.) Neutral	Positive
entropy	0.830 (0.023)	0.812 (0.030)	0.890 (0.016)
brand switching	21.25 (4.66)	18.50 (4.40)	21.61 (3.45)
decision-making time [sec]	232.6 (85.3)	107.1 (62.9)	194.8 (90.8)

In this calculation, one represents the most diverse selection and zero represents the least diverse selection. Brand switching represents the number of times subjects selected a different option than the previous one. Decision-making time represents the seconds it takes subjects to complete one trial. We used R for the following statistical analysis. In addition, we tested the normality of all data using the Shapiro–Wilk test. In particular, because entropy is calculated by Equation (A1), the data were not normally distributed. In all indicators, the test results of one or more conditions rejected the normality hypothesis ($p < 0.05$). Therefore, we used a non-parametric test for the analysis.

We performed the Friedman and post-hoc Nemenyi tests with the Holm correction on the entropy results. The results of the Friedman test showed that the difference between conditions was marginally significant ($p < 0.10$). Although the results of the post-hoc test showed no significance, the positive- and no-review conditions showed a marginally significant difference ($p < 0.10$). In addition, the entropy in the positive-review condition was greater than that in the no-review condition.

We performed the Friedman and post-hoc Nemenyi tests with the Holm correction on the brand-switching results. The results of the Friedman test showed significant differences between the conditions ($p < 0.01$). The results of the post-hoc test showed that the brand switching was significantly high in both the positive- and negative-review conditions than in the no-review condition ($p < 0.01$).

We performed the Friedman and post-hoc Nemenyi tests with the Holm correction on the decision-making time results. The results of the Friedman test showed a significant difference between conditions ($p < 0.01$). The results of the post-hoc test showed that the decision-making times were significantly longer in both the positive- and negative-review conditions than in the no-review condition ($p < 0.01$).

3.9. Discussions

We describe the findings from the results and present the review presentation method.

3.9.1. Can Positive Reviews Diversify User Selection?

The experimental results supported Hypothesis 1, which suggests that positive reviews promote selection diversity. Compared to the no-review condition, the positive-review condition increased entropy, which evaluates selection diversity, with a marginally significant difference ($p < 0.10$), and significantly increased brand switching, which evaluates selection-change frequency ($p < 0.01$). These results indicate that viewing positive reviews broadened the range of selections and increased the frequency of switching products.

3.9.2. Do Negative Reviews Make a User's Biased Selection?

The experimental results did not support Hypothesis 2, which states that negative reviews promote biased selection. The entropy results were not significantly different between the negative review and no review conditions. However, brand switching was significantly more ($p < 0.01$) in the negative-review condition than in the no-review condition. These results indicate that, although viewing negative reviews did not affect selection diversity, more subjects selected different teas instead of the same tea each time. The results can be interpreted as decreasing consecutive biased selections by negative reviews without reducing selection diversity.

3.9.3. The Effect of Review Viewing on Decision-Making Time

Increased decision-making time by viewing positive and negative reviews was a natural consequence. The positive and negative reviews can be interpreted as an increase in decision-making time due to subjects becoming more unsure of their selections. In this experiment, selection diversity did not necessarily increase as the decision-making time increased.

3.9.4. What Is a Review Presentation Method to Promote Selection Diversity?

Our results suggest that presenting positive reviews is most recommended when users or system designers want to promote selection diversity. In addition, negative reviews may be used to promote selection diversity (i.e., prevention of biased selection) compared with the case of no reviews and can be presented when it is impossible to present positive reviews.

4. Experiment 2: Effect of Watching Video on Selection Diversity

This experiment evaluated how a user's selection diversity is affected after watching a video that evokes a user's positive or negative emotion. The subjects were 28 university students (26 males and two females in their early 20s), all of whom agreed in advance on the possibility of evoking negative emotions.

4.1. Method: Presenting Videos to Evoke User's Emotion

This experiment used a method to evoke a user's emotions positively/negatively by presenting positive/negative videos. Many studies used the method of presenting emotional videos to evoke specific emotions.

4.2. Hypothesis

Figure 4 illustrates our hypothesis. We assumed that watching a positive video increases the selection diversity whereas watching a negative video decreases the selection diversity. This is based on the hypothesis that people want to try various products when a positive emotion is evoked. Conversely, when a negative emotion is evoked, people will want to avoid products other than their favorite item.

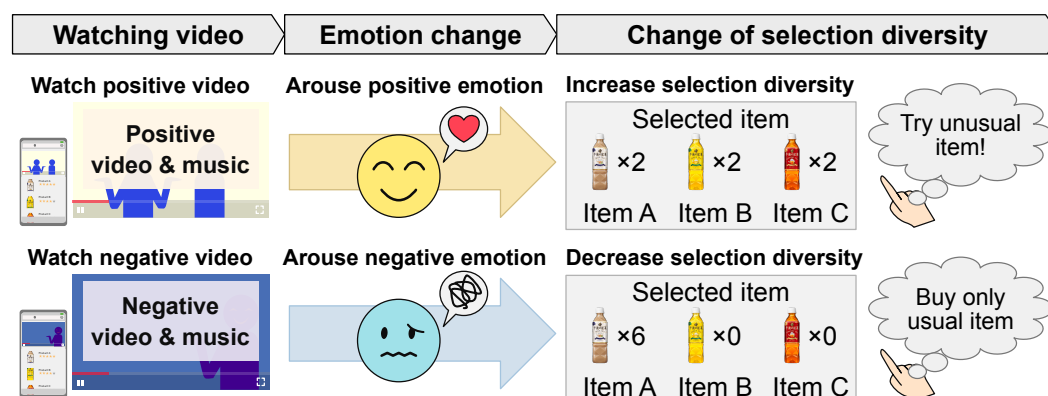


Figure 4. Hypothesis for Experiment 2. The effect on selection diversity of presenting a positive/negative video before selection. Positive emotions encourage diverse choices. Negative emotions encourage biased choices.

Therefore, this experiment tested the following hypothesis. Since it is unknown which positive or negative videos promote selection diversity, we discuss the appropriate method of presenting videos after testing the following points.

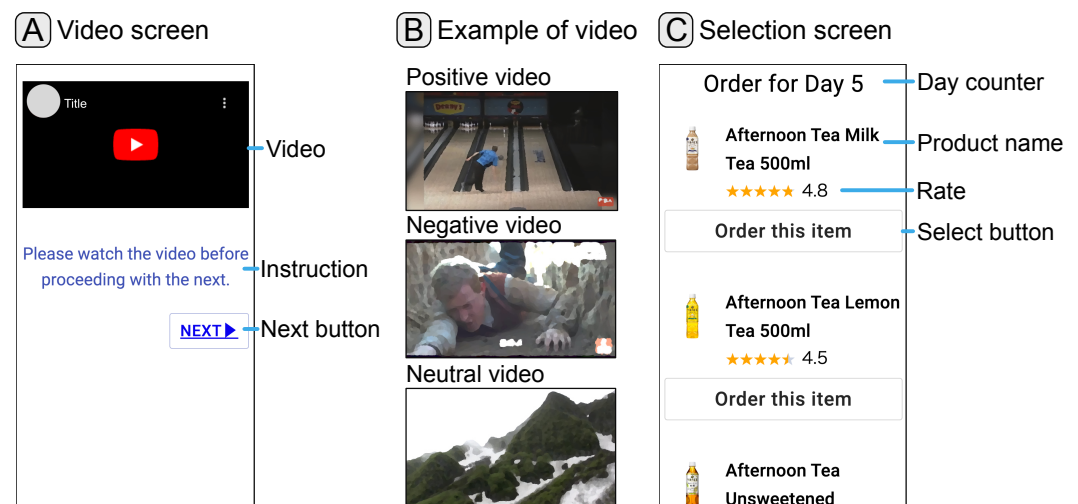
Hypothesis 3. *Selection diversity increases (i.e., selection bias decreases) after watching positive videos.*

Hypothesis 4. *Selection diversity decreases (i.e., selection bias increases) after watching negative videos.*

4.3. Evaluation Indicators and Experimental Procedure

This experiment also used the same three evaluation indicators as Experiment 1: entropy, brand switching, and decision-making time.

The experimental methodology followed Experiment 1, in which subjects repeatedly selected one of the same five bottled tea types one by one, 30 times in total. Although the experimental procedure was almost the same as in Experiment 1, this experiment differed from Experiment 1 in two points: (1) subjects viewed no review, and (2) the subjects watched a video before selecting a product. One trial consisted of watching a video, selecting products, and taking a break. First, the subjects watched the video on the screen shown in Figure 5A. The screen presented one of the positive, negative, or neutral videos, as shown in Figure 5B. Next, on the screen shown in Figure 5C, subjects repeatedly selected a tea product of five types one by one until they selected a total of a 30-day supply. Finally, the subjects took a 10-min break until the subsequent trial. This sequence procedure of one trial was performed for each of the three video presentation conditions described in Section 4.5 (positive video condition, negative video condition, and neutral video condition). Subjects completed the experiment after a total of three trials. The order of video presentation conditions was randomized with a counterbalanced order.



* Each element of the actual screen was shown in Japanese.

* Video examples were processed, and the actual videos were not illustrations.

Figure 5. Implemented screens of the video presentation interface in Experiment 2. (A) Video screen; (B) Examples of video content; (C) Selection screen. The video examples show a scene of trick shots in bowling as a positive video, a scene of an abused man in a movie trailer as a negative video, and a scene of a foggy mountain as a neutral video.

4.4. Experimental Interface

Figure 5 shows the information screen used for the experiment. This screen worked with JavaScript in the Chrome and Safari browsers of a subject's smartphone. The Interface consisted of two types of screens: one for watching a video and the other for the selection task. As shown in Figure 5A, the watching video screen embedded a video and placed the transition button to proceed to the selection task. The selection screen, as shown in Figure 5C, was the same screen structure as in Experiment 1, except it was without review presentations.

4.5. Video Presentation Conditions

This experiment used the following three video presentation conditions. Table A3 in the Appendix shows the actual videos used in the experiment.

4.5.1. Positive Video Condition

In this condition, positive videos were presented at the beginning of a trial. We used three positive videos: sports, news, and film promotion video. The video shown to each subject was selected randomly among one of the following three videos. The sports video showed a clip of a collection of acrobatic trick shots of bowling. The news video showed a clip of a baby seal saved from a life-threatening situation. The film promotion video showed a trailer for "Saving Mr. Banks."

4.5.2. Negative Video Condition

In this condition, negative videos were presented at the beginning of a trial. We used three negative videos: film promotion, accident, and news video. The video shown to each subject was selected randomly within one of the three videos. The film promotion video showed a trailer for the film "Betrayed." The accident video showed a clip inside a car when a couple was involved in a tailgating driver (i.e., a driver harasses other drivers by driving dangerously). The news video showed an interview of a Hiroshima bomb survivor telling their war experience.

4.5.3. Neutral Video Condition

In this condition, neutral videos were presented at the beginning of a trial. We used three neutral videos: financial news, weather forecasts, and scenery videos. The video shown to each subject was selected randomly among one of the three videos. The financial news video showed market news from the past on a day when price movements were moderate. The weather forecast video showed a past weather report on a calm day. The scenery video showed a scene of a mountain shrouded in a fog called the Japanese Alps.

4.6. Video Collection Procedure

The videos in the experiment were collected from an online video-sharing platform and we confirmed them to evoke positive, negative, and neutral emotions. We selected these videos by following the following procedure.

Collection step: We collected 24 candidate videos consisting of eight videos in each emotion from YouTube. All videos were shared on the official channels of public organizations and companies, such as professional sports associations and television companies. The positive candidates consisted of three film promotion videos, four daily news videos, and two sports videos. Furthermore, the negative candidates consisted of two film promotion videos, five news videos, and one accident video. Finally, the neutral candidates consisted of two financial news videos, three weather forecast videos, and two scenery videos.

Evaluation step for evoked emotions: We recruited eight male and two female students. We then asked participants to subjectively evaluate one arousal scale and two emotional scales using a questionnaire. A previous study used these three scales to create a database of emotion-evoking movies [41]. The arousal scale measures how much emotion heightens regardless of the type of emotion using the 5-point Likert scale (1: feel no emotion–5: feel extreme emotion). As the two emotional scales, we used the Japanese versions of the Positive and Negative Affect Schedule (PANAS) [47] and the Differential Emotions Scale (DES) [48]. The PANAS measures how much the respondent's emotion fits the 20 emotional adjectives using the 5-point Likert scale (1: not fit–5: very fit). We obtained two total scores of ten positive and ten negative adjectives from this scale. The DES measures how much the respondent's emotion fits 16 adjective groups consisting of 43 emotional adjectives using the 7-point Likert scale (1: not fit–7: very well fit). We obtained two total scores of eight positive and eight negative adjective groups from this scale.

Video selection step: Based on the questionnaire results, we selected three videos for each emotion, as shown in Table 4. The positive videos had high positive and low negative emotion scores. The negative videos had low positive and high negative emotion scores. We performed a Wilcoxon signed-rank test on each candidate video's PANAS and DES results. We then picked only videos that showed a significant difference ($p < 0.01$) between the positive and negative emotion scores on both scales and showed the highest arousal score in each video category. For the neutral videos, we selected the lowest arousal score in each video category. Finally, we selected nine videos for the experiment.

Table 4. Means of the arousal scale and the emotion scales used PANAS and DES for the videos used in Experiment 2.

	Emotion	Category	Arousal	PANAS		DES	
				Positive	Negative	Positive	Negative
1	positive	sports	2.8 (0.79)	21.5 (4.86)	10.4 (0.70)	25.6 (8.26)	8.2 (0.63)
2	positive	news	3.0 (1.25)	16.4 (5.83)	11.2 (1.93)	30.3 (10.90)	10.4 (3.53)
3	positive	movie	3.2 (1.03)	20.6 (6.64)	10.3 (0.67)	25.1 (13.36)	8.6 (1.07)
4	negative	movie	3.9 (0.99)	14.1 (4.31)	24.4 (8.10)	11.0 (3.77)	25.5 (11.72)
5	negative	accident	4.4 (0.70)	15.7 (4.66)	30.6 (8.72)	12.4 (3.17)	30.8 (7.22)
6	negative	news	3.5 (0.71)	11.3 (1.25)	18.5 (5.74)	9.2 (1.03)	20.8 (9.76)
7	neutral	market	1.3 (0.48)	11.8 (1.81)	11.1 (1.10)	10.2 (2.48)	9.8 (3.55)
8	neutral	weather	1.4 (0.70)	11.8 (2.57)	10.5 (1.01)	10.0 (1.83)	8.8 (1.32)
9	neutral	scenery	1.4 (0.97)	11.7 (1.70)	10.7 (1.06)	11.7 (5.56)	8.6 (1.07)

4.7. Results

Figure 6 and Table 5 show the entropy, brand switching, and decision-making time. The box plots in Figure 6 represent the quartiles and the jitter plots represent the actual values of all subjects. Table 5 shows the mean and S.D. of each condition. The calculation methods for the three indicators were the same as in Experiment 1. We used R to perform the following statistical analysis. In common with Experiment 1, because the Shapiro–Wilk tests rejected the normality hypothesis ($p < 0.05$), we used a non-parametric test for the analysis.

We performed the Friedman and post-hoc Nemenyi tests with the Holm correction on the experimental results. The results of the Friedman test showed that the difference between conditions was marginally significant ($p < 0.10$). Although the post-hoc test results showed no significant difference, the p-value was close to a marginally significant level between negative and positive videos ($p = 0.11$). In addition, negative videos had less entropy than positive videos. We performed the Friedman tests for brand switching and decision-making time results. The results showed that brand switching and decision-making time had no significant difference between conditions ($p > 0.10$ and $p > 0.10$, respectively).

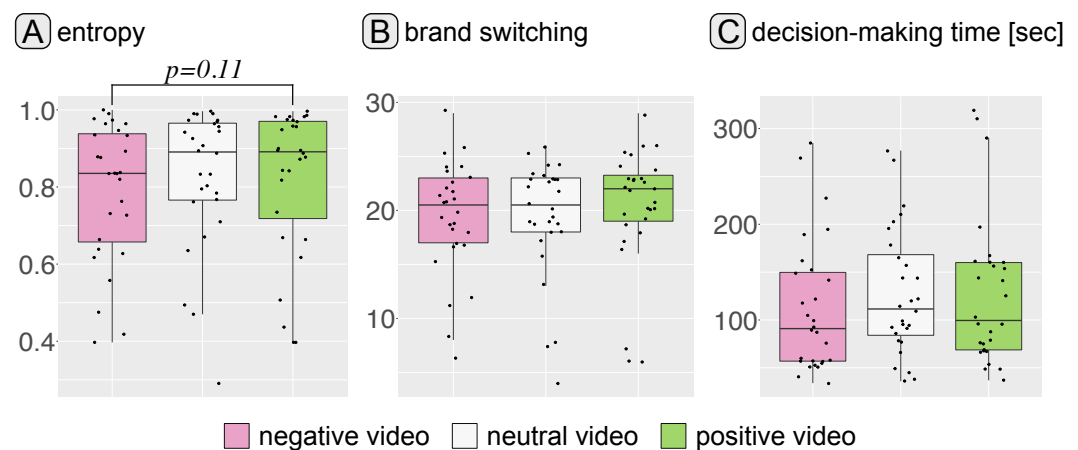


Figure 6. Results for each video presentation condition in Experiment 2. (A) Entropy, (B) Brand switching, (C) Decision-making time.

Table 5. Mean entropy, brand switching, and decision-making time for each video presentation condition in Experiment 2.

Indicator	Mean (S.D.)		
	Negative	Neutral	Positive
entropy	0.790 (0.032)	0.827 (0.032)	0.820 (0.037)
brand switching	19.36 (5.29)	19.32 (5.47)	20.32 (5.72)
decision-making time [sec]	111.9 (69.4)	127.5 (66.3)	127.0 (77.0)

4.8. Discussions

We describe the findings from the results and present the video presentation method.

4.8.1. Does a Negative Video Make a User's Biased Selection?

The experimental results tended to support Hypothesis 4, which suggests that negative videos decrease selection diversity. The Friedman test for entropy showed a marginally significant difference ($p < 0.10$). This result indicates that subject's selection tends to be influenced by watching a video. The entropy of negative videos tended to be smaller than that of positive videos ($p = 0.11$), and the entropies of neutral and positive videos had comparable degrees. It is more reasonable to assume that entropy decreases as a result of negative videos rather than increasing because of positive videos. Thus, this result can

be interpreted as showing that negative videos may decrease selection diversity when compared with positive and neutral videos.

4.8.2. Can a Positive Video Diversify User Selection?

The experimental results did not support Hypothesis 3, which suggests that positive videos increase selection diversity. As described in the previous paragraph, although the entropy of positive and negative videos showed a marginally significant difference, it can be interpreted as a decrease in entropy by negative videos. Therefore, the results indicate that the positive videos do not affect selection diversity.

4.8.3. What Is a Video Presentation Method to Promote Selection Diversity?

Based on the experimental results, avoiding negative videos is recommended when users or system designers want to promote selection diversity because presenting negative videos may decrease selection diversity.

5. Limitations and Future Work

This study has several limitations and future investigation will aim to address the following points.

- (1) The present experiment was conducted with Japanese university students in their early 20s. Therefore, the effect of information presentation may change when targeting people of various age groups and nationalities. Future experiments will be conducted targeting a more diverse range of users.
- (2) The experimental situation was limited. We adopted a task that required 30 consecutive selections and only one product category was used (i.e., tea). Because previous studies used selection on groceries in their experiment, tea products are appropriate for evaluating the effect of information viewing on selection. Thus, we assume that similar effects can occur in similar real-life situations. However, it is necessary to examine what effects occur in different situations. For example, there are situations in which the options significantly differ in subjects' preferences, including situations where subjects are not in a neutral mental or physical state, such as feeling tired, and situations where subjects forget their previous selection.
- (3) There is a situation in which the diversity of overall users' selections needs to be improved, even if individual selection diversity decreases. This situation differs from the assumed situation in our experiments, which aimed for more diverse options to be selected within individuals. In the future, using the methodology of this study, we plan to investigate the case of promoting diversity in the overall selections made by users, rather than only focusing on individual selection diversity.

6. Conclusions

This study aimed to develop an effective method for increasing a user's selection diversity by evoking product impressions through review presentation and user's emotions through the video presentation. To verify the feasibility of this method, we investigated reviews and videos that increased or decreased the selection diversity based on the positivity or negativity of the information presented. Specifically, we used an experimental task in which subjects repeatedly selected one of five types of drinks. Experiment 1 investigated the effect of viewing reviews on selection and Experiment 2 investigated the effect of watching a video before selection. For the experiments, we implemented an online application to purchase products. Experiment 1 indicated that viewing positive reviews may promote the user's selection diversity and that both positive and negative reviews may increase brand switching (i.e., selecting different products in consecutive selections). Experiment 2 indicated that watching a negative video may decrease a user's selection diversity. The results of this study help us to consider the effects of viewing reviews and videos in designing interfaces to promote selection diversity.

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Appendix A. Entropy

This paper calculated entropy H as the following equation when k options are available.

$$H = - \sum_{i=1}^k p_i \log_k p_i \quad (\text{A1})$$

$$p_i = \frac{s_i}{\sum_{i=1}^k s_i} \quad (\text{A2})$$

The s_i represents the number of times option i was selected, and p_i represents the proportion of the option i in total. This entropy indicates that one is the most diverse selection result, and zero is the most biased selection result.

Appendix B. Dataset Used in Our Experiment

Table A1. Positive reviews used in Experiment 1. The sentiment scores were calculated with Google Natural Language API, and a higher value represents a more positive sentiment.

Flavor	Review Text	Score
milk	The tea was not too sweet, so I could enjoy the flavor of the tea.	0.900
	I find it enhances the flavor of the aromatic tea!	0.900
	It is delicious with a proper tea leaf aroma.	0.900
	It is the item I pick up when I want something sweet and rich to drink easily.	0.900
	This milk tea is not too sweet, not too tart, and has a clean, easy-to-drink taste.	0.900
lemon	I hadn't had it in a while, but it was a classic lemon tea with a good sweet and sour concoction.	0.900
	It was nice to drink it during breaks from work, as it seemed to take away some of the fatigue.	0.900
	It is always a favorite with its unchanged elegant taste.	0.900
	It is just the right amount of sweetness and tastes just as good chilled or at room temperature.	0.900
	The aftertaste is very clean and refreshing. Highly recommended.	0.900

Table A1. *Cont.*

Flavor	Review Text	Score
sugarless	It is moderately sweet and easy to drink even with a meal.	0.900
	I like it because it doesn't leave an astringent taste in my mouth after drinking.	0.900
	It has a pleasant mouthfeel and black tea aroma, and can be drunk on its own or with a meal, and goes well with any meal, whether rice or bread.	0.900
	Zero kcal per 100 mL of product	0.900
	Good for snack time!	0.900
sugared	It is easy to drink, with a refreshingly moderate sweetness.	0.900
	It was even easier to drink when warmed up.	0.900
	This one is also easy to drink and has a nice aftertaste, no complaints.	0.900
	It has a strong sweetness without astringency.	0.900
	It is a standard product.	0.900
sesame	It is a savory and delicious barley tea.	0.900
	What a nice aroma and flavor of sesame seeds!	0.900
	My blood pressure has been bothering me lately, so this could be good.	0.900
	It's a refreshing tea with a pleasant sesame aroma, and if you like sesame, you'll love it right off the bat!	0.900
	The drink has a strong aroma and taste of sesame seeds and went well with Japanese food.	0.900

Table A2. Negative reviews used in Experiment 1. The sentiment scores were calculated with Google Natural Language API, and a lower value represents a more negative sentiment.

Flavor	Review Text	Score
milk	It is not very good.	−0.900
	Too sweet.	−0.700
	This one tastes a little different from the canned version, something like watery - it is light in flavor.	−0.600
	The aftertaste is not refreshing at all, as it also leaves a sweet aftertaste.	−0.600
	Maybe the manufacturer should review the materials.	−0.500
lemon	I'm not sure if it's perfect as a lemon tea.	−0.800
	I would prefer it to be a little less sweet.	−0.800
	It still tastes a little too sweet.	−0.800
	I prefer the lemon to be darker and more acidic.	−0.700
	It kind of leaves a lingering feeling in the throat... It's not the type of drink that you can drink in gulps.	−0.500
sugarless	It was not very tasty.	−0.900
	The aftertaste also left a peculiar flavor that did not taste good.	−0.700
	This product has 55% hand-picked Darjeeling tea leaves, while the 2 L bottle had 73% Darjeeling.	−0.500
	I had it for breakfast. Too plain taste.	−0.500
	It is perfect as a tea, but something is missing just because it is unsweetened.	−0.400
sugared	Perhaps it was the thin aroma, but even the taste seemed thin.	−0.900
	I bought and drank it for the first time in a long time and found that the aroma of the tea had faded.	−0.800
	Even the taste seemed thin and a bit bland.	−0.800
	It contains a whopping 7.4 g of sugar per bottle, so it's too sweet and not refreshing...	−0.700
	Compared to the old product, I thought the aroma of the tea was very diluted.	−0.600

Table A2. Cont.

Flavor	Review Text	Score
sesame	I don't like the unique taste...	−0.800
	The sesame seeds did not work for me.	−0.700
	I wish the price was a little lower.	−0.500
	It does not suit my palate.	−0.400
	My mother says she loved it from the beginning and drinks more than I do, so her tastes may differ.	−0.100

Table A3. Video used in Experiment 2. The URLs were accessed on 5 June 2023.

Emotion	Category	Title (in English) URL	Length (min:sec)
positive	sports	PBA's Best Bowling Trick Shots https://www.youtube.com/watch?v=dLLRg0sur6g	1:55
positive	news	Baby seal in Life-threatening Situation, Watched over 24 Hours a Day for a Month https://www.youtube.com/watch?v=LhH2rfUGHh8	1:09
positive	movie	"Saving Mr. Banks" Trailer https://www.youtube.com/watch?v=iJrsmAdVFKA	2:13
negative	movie	"Betrayed" Trailer https://www.youtube.com/watch?v=xDJoodYBWNE	3:09
negative	accident	Couple who Victim of Tailgating Driver Share Their Fears https://www.youtube.com/watch?v=JFqY0r2qt7Y	3:47
negative	news	Telling the War: Juro Hattori, A-bomb Survivor and Storyteller in Hiroshima https://www.youtube.com/watch?v=5uB7wLb3Vsw	2:18
neutral	market	Rakuten Market NEWS July 7, 2012 [close] https://www.youtube.com/watch?v=6aHDnBobQHQ	4:03
neutral	weather	Clear and Calm Skies in Hokkaido, Watch Out for Sudden Weather Changes Inland. https://www.youtube.com/watch?v=UbACWzeAf0E	1:04
neutral	scenery	Japanese Alps in Rainy Season: Mt. Karasawa https://www.youtube.com/watch?v=pFWFtr6e3zk	0:50

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