実践論文

選択実験におけるチェックボックス位置効果の再検証
ユーグレナ食品に関する大学生調査データを事例として
Reexamination of the Checkbox Positioning Effect in Choice Experiments
- Evidence from a Survey of Japanese Undergraduates on Food Containing Euglena -

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環境の経済評価において選択実験が頻繁に用いられるようになった一方で，調査票設計に際して検討すべき課題のひとつであろう，選択実験のチェックボックス位置効果を検証した研究が Ohdoko and Tamamiya (2016)以外に存在しない．Ohdoko and Tamamiya (2016)は正規分布を仮定した混合ロジットを用いているが，スケールパラメータの不均一性など，混合ロジットには限界のあることが報告されつつある．分析手法のさらなる改善のために，Fiebig et al. (2010)では選好の多様性とスケールパラメータの不均一性を同時に分析できる一般化多項ロジットが開発された．そこで本研究は，Ohdoko and Tamamiya (2016)のデータを用いて，より柔軟な一般化多項ロジットで選択実験のチェックボックス位置効果を検証した．分析の結果，点推定としては位置効果のないことが示された一方で, パラメータの分布の検討からは, チェックボックスと価格属性を選択セットの上に置くことで，部分的な属性情報の非処理が生じると示唆された．

While choice experiment (CE) techniques are increasingly being used in many environmental valuation studies, there are a number of methodological issues to be resolved, such as ordering or positional effects. Although the design of CE questions includes decisions on the placing of checkboxes, with the exception of Ohdoko and Tamamiya (2016), the impact of the checkbox positioning effect on these techniques has not been examined. Ohdoko and Tamamiya (2016) employed a simple random parameter or mixed logit (MIXL) model, which specifies the normal distribution as the mixing distribution. Problematically, recent CE studies have found that it is rather restrictive to assume a normal distribution for a MIXL model without scale heterogeneity. Fiebig et al. (2010) developed a generalized multinomial logit (GMNL) model to flexibly incorporate heterogeneities in both the marginal utility and scale parameters. We employ this approach to reexamine the checkbox positioning effect result in Ohdoko and Tamamiya (2016) using a more flexible GMNL model. While the model's point estimates do not support the presence of the positioning effect as the mean point estimate, the distributions of the parameters indicate partial attribute nonattendance due to placing both the checkboxes at the top and price attributes at the bottom of the choice sets.

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1. Introduction

While choice experiment (CE) techniques have increasingly been applied in environmental valuation studies, many methodological issues remain to be resolved, one of which is ordering or positional effects. The design of CE questions requires decisions on the placing of checkboxes. However, with the exception of Ohdoko and Tamamiya [40], the effect of checkbox positioning on these techniques has not been considered. This is an important issue because eye movements and visual features can influence CE responses, which can lead to a design flaw in the survey instrument and bias the results. Indeed, it is increasingly common to combine CE with eye-tracking techniques to examine eye movements or eye fixation to better understand survey responses and behavioral features relating to CE (e.g. Meißner and Decker [36]). Because checkbox positions can become a visual feature of CE questions and can influence the eye movements of respondents, it is important to investigate whether there are positioning effects.

Ohdoko and Tamamiya [40] conducted a food CE and analyzed the checkbox positioning effect on CE questions for which the checkboxes were placed above or below the choice sets. Their results suggested that only the top-placed attribute is affected by nonattendance, and that the effect can be alleviated when the checkbox is placed below the choice set, with the price attribute also at the bottom. Ohdoko and Tamamiya's econometric analysis used a random parameter mixed logit (MIXL) model, employing the normal distribution as the mixing distribution, to ensure simplicity of the analytical procedures. However, recent studies on CE have clarified that it is rather restrictive to assume a normal distribution and to employ a MIXL model without scale heterogeneity. Fiebig et al. [16] developed a generalized multinomial logit (GMNL) model that incorporates heterogeneities in both the marginal utility parameters and a scale parameter, which is a more flexible approach than that used in the MIXL model, and one that can more precisely analyze the checkbox positioning effect. Therefore, in this paper, we employ a GMNL model to reexamine the result of Ohdoko and Tamamiya [40].

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature. The dataset and the econometric methods employed are discussed in Section 3. We present the results and discussion in Section 4. Concluding remarks, including topics for future research, are provided in Section 5.

2. Literature Review

Although CE techniques are being applied increasingly in many contexts, a number of methodological issues remain unresolved. Adamowicz et al. [1] summarized nine such issues in environmental valuation studies[1]. In

[1] The nine issues noted by Adamowicz et al. are concerned with: (1) how experimental design issues should be tackled; (2) how we should treat tastes or preference heterogeneity and heterogeneity on the scale or inverted variance of the error component; (3) the choice format effects or effects on dimensionality and complexity, which relate to the number of alternatives or attributes; (4) how we treat decision rules and the information processing strategy of respondents; (5) households and groups, which relate to whether respondents make their decisions jointly at an intrahousehold

this paper, we focus on the issues of preference and scale heterogeneity, and information processing, solely in relation to positional effects.

2.1. Preference and Scale Heterogeneity

Along with the growing use of CE techniques, increasing attention has been paid to the analysis of CE data. The traditional multinomial logit (MNL, McFadden [35]) model assumed preference homogeneity and that preferences were independent of irrelevant alternatives (IIA), which corresponds to the identically and independently distributed error component. Following this, two alternative analytical models were frequently employed to incorporate preference heterogeneity and to overcome the need to assume the IIA property: a random parameter logit model or MIXL, (Revelt and Train [46], Train [52], among others) and a latent class model (Boxall and Adamowicz [6], Shonkwiler and Shaw [51], Greene and Hensher [19], among others). The former allows for a continuous distribution of preferences, whereas the latter allows for a discrete distribution.

However, there is an underlying issue that is inherent in the use of the random utility model (RUM), namely a scaling problem. A RUM assumes that the indirect utility function associated with alternatives of CE questions is $U_{njt} = V_{njt}(X) + \varepsilon_{njt}$, where $n = 1, \cdots, N$ denotes the respondents; $j = 1, \cdots, J$ is the alternatives in the choice set; $t = 1, \cdots, T$ is the choice occasion; X is the matrix of attributes of the alternatives; and ε_{njt} is the error component. The observable component of indirect utility, $V_{njt}(X)$, has been frequently specified in an additively separate form, $\tilde{\beta}' X_{njt}$, where $\tilde{\beta}$ denotes the marginal utility vector, which we also utilized. However, it has been demonstrated that the "true" marginal utility vector, β, has been demonstrated to be confounded with the scale parameter, λ, which is inversely proportional to the variance of the error component, such that $\tilde{\beta} = \beta\lambda$ (Louviere et al. [33]). For example, Louviere and Eagle [31] demonstrated that the model should be developed to distinguish between preference heterogeneity and scale heterogeneity. A critical issue has been whether respondents' heterogeneous features are included in their preferences, or scales, or both.

Fiebig et al. [16] developed the GMNL model, after Keane [23] first presented a relevant research program. Fiebig et al. [16] incorporated two parameters in the discrete choice model so that preference heterogeneity and scale heterogeneity could be analyzed simultaneously. They demonstrated that the GMNL model was preferred in seven out of the 10 datasets that they analyzed. For the other three datasets, the preferred model was the scale heterogeneity multinomial logit (S-MNL) model, which is a subclass of the GMNL model and incorporates only scale heterogeneity with fixed preference parameters.

Currently, the GMNL model is being applied increasingly in choice modeling (CM), which includes CE, best–worst scaling (BWS) studies (Louviere et al. [32]). Czajkowski et al.

level or individually; (6) incentive compatibility and strategic behavior; (7) property choice; (8) the particular requirements of recreation demand models; and (9) spatial aspects.

[11] applied a GMNL model to a CE study on forest ecosystem management in Poland, which demonstrated that the GMNL model had an enhanced fit compared with the MIXL model. Li et al. [29] applied a GMNL model to a CE study on purchases of refrigerators by consumers, where the CE question included a voluntary climate action program by the manufacturer as an attribute. They demonstrated that the GMNL model had an enhanced fit compared with the MNL and MIXL models. Doiron et al. [13] applied a GMNL model to a BWS study on the job choices of student nurses and demonstrated that the GMNL model had an enhanced fit compared with the MNL and MIXL models. Overall, the GMNL model has gradually become the standard discrete choice model to express respondents' choices correctly and precisely.

2.2. Positional Effects

Because CE methods include social survey features, the question of ordering or positional effects, which are known to occur frequently in social survey instruments, is relevant. In CM research contexts, Chrzan [9] suggested that there are three positional effects in CM: the choice set order, the order of profiles or alternatives within choice sets, and the attribute order within profiles. Chrzan recommended that profile and attribute orders should be rotated. Scott and Vick [50] conducted a CE study in Scotland to elicit patients' preferences regarding doctor–patient relationships, and suggested that the later in the survey that the attribute is provided, the more preferred it is by respondents. Farrar and Ryan [14] elicited hospital consultant preferences for potential clinical service developments in the UK using a CE, which employed CE questions without a certain price attribute, and found that there were no attribute order effects. Kjær et al. [25] undertook a CM study on Danish patient preferences for psoriasis treatment, which suggested that respondents were more price sensitive when the price attribute was placed at the bottom of the choice set, which led to "conservative" (that is, lower) willingness-to-pay estimates. Ohdoko and Yoshida [41] found no attribute order effects on nonprice attributes for Japanese residents who were asked CE questions on the management of forest species diversity. In sum, it would seem that we do not have to be overly concerned about the attribute order effect, apart from that concerning the price attribute.

Although choice sets, profiles, and attribute order effects have attracted attention in various contexts, few studies have focused on the checkbox positioning effect in CM/CE questions. Ohdoko [39] examined the impact of the checkbox positioning effect in BWS studies in Japan, and found that it existed when estimating the coefficients of variation of item importance. The results suggested that the checkbox position should be rotated or randomly assigned laterally in BWS questions as much as possible. Ohdoko [39] indicated that the left-to-right Japanese horizontally writing system influences BWS responses, citing Dobel et al. [12], who suggested that certain writing systems influence positioning bias. As the Japanese horizontally writing system is left to right and lines are cumulated vertically in a top-

to-bottom direction, it is almost certain that Japanese readers are accustomed to moving their eyes from left to right and from top to bottom. Especially in the context of survey research in Japan, survey instruments frequently employ a lateral writing system and, therefore, the lateral writing system seems to influence CE questions. Ohdoko and Tamamiya [(40)] conducted a food CE and analyzed the checkbox positioning effect on the CE questions when they placed the checkboxes above or below the choice sets. The results suggested that there was only an effect on the top-placed attribute as the attribute experienced nonattendance due to placing the checkboxes at the top and the price attribute at the bottom of the choice sets. They suggested that there is a need for further research on the reason for the effect using eye trackers, latent class models, or stated ignorance by respondents to examine the relationship between checkbox positioning and respondents' ignoring attributes. Alternatively, the checkboxes should be set below the choice sets along with the bottom-placed price attribute.

Many studies have examined the phenomenon of attribute nonattendance, where respondents only attend to some of the attributes in the CE choice set. This is one of the heuristics of processing information (Hensher et al. [(20)]; Colombo et al. [(10)]; Hess et al. [(21)]; Hole et al. [(22)]; Kehlbacher et al. [(24)]; Lagarde [(27)]; Balcombe et al. [(2)]; Glenk et al. [(18)]; Nguyen et al. [(38)]). In addition, because it is common to place checkboxes for CM questions below the choice set (see the Appendix), eye movement or visual features can influence the CM response, which can lead to a certain design flaw in CM survey instruments. Indeed, it is increasingly common to combine CM with eye-tracking techniques to examine eye movement or eye fixation to better understand survey responses and behavioral features relating to CM (Meißner and Decker [(36)]; Orquin et al. [(42)]; Vidal et al. [(53)]; Behe et al. [(4)]; Bialkova et al. [(5)]; Balcombe et al. [(2)]; Rasch et al. [(45)]). Because checkbox position can become a visual feature of CM questions and influence the eye movement of respondents, we should investigate whether there are positioning effects and, if so, how they operate.

3. Materials and Methods

The potential for human consumption of euglena and other microalgae is receiving increasing attention. Mata et al. [(34)] reviewed the development and generation of biofuels from microalgae, and the product development of food containing euglena is increasingly being investigated in Japan (Redmond [(44)]). Euglena contains many nutritional compounds, including paramylon[2], vitamins, and calcium. As the labeling of functional food—food with special healthy qualities—has been permitted in Japan since April 2015, there is substantial potential to develop and diffuse euglena foods in the Japanese market.

Marketing research is essential in the development of brand-new food products. Krystallis et al. [(26)] suggested that a hypothetical CE would be useful in predicting the latent market structure or consumer preferences for new food products and undertook such a study

[2] See e.g. Calvayrac et al. [(8)].

in the Greek market, focusing on three children's snacks enriched with nutritional compounds: savory puffs, chips, and croissants. Larue et al. [28] also conducted a CE survey on food with functional health benefits, along with genetically modified food production, and found that organic functional food would be profitable in Canada. To assess whether Japanese food consumers would accept new euglena foods, we employ a CE technique to elicit consumer preferences. This study also enables us to test for the existence of the checkbox positioning effect in CE. As a pilot study, we designed our survey using a sample of undergraduate students studying at Dokkyo University in Japan. To enable undergraduate respondents to easily understand our CE scenario, we employed the example of a hypothetical functional chewing gum that could potentially incorporate euglena.

We administered our survey at Dokkyo University from April 4 to 28, 2015. Before implementation, we conducted preliminary discussions with six undergraduates attending a seminar course given by Dr. Ohdoko on the design of the questionnaire and the selection of the attributes of CE questions; we then conducted a pretest session to improve the quality of the questionnaire using 14 other undergraduates on the seminar course. We conducted an in-person self-administered CE survey to elicit preferences for the attributes of the chewing gum, including type of nutritional content, recommendations from certain information sources, amount of nutritional content, and the price of the gum, which were the attributes that we assumed undergraduates would care about in selecting a chewing gum.

We then selected the levels of the attributes (Table 1). For nutritional content, we selected calcium, vitamins, and euglena. The levels of the first two were assumed to be familiar to Japanese undergraduates. For recommendations on the gum from certain information sources, we selected three levels to mimic the actual situation of undergraduates, these being information on the Web, including Internet news and blogs, information from their friends, and information from the *tokuho* label (short for *tokutei hoken-you shokuhin* or foods with special healthy qualities) certified by the Japanese Ministry of Health, Labor, and Welfare.[3] For the amount of nutritional content and the price of the gum, we selected levels to mimic the actual situation in the Japanese market. Because the performance of a CE depends on respondents correctly interpreting the questionnaire, we simplified our questionnaire to make it as clear as possible.

We organized our questionnaire as follows. First, we collected demographic variables, including student sex, age, faculty, and department. Second, we provided information on euglena, including its definition, nutritional content, and health benefits. We then asked respondents whether they had heard about these before participating in our survey, and whether they understood our explanation. Third, we provided our hypothetical scenario (see the Appendix) and eight CE questions, along with a sample answer. Finally, we determined attitudes regarding whether the

3 http://www.mhlw.go.jp/topics/bukyoku/iyaku/syokuu-anzen/hokenkinou/hyouziseido-1.html (in Japanese; retrieved September 30, 2015).

respondents were partial to buying new commodities and their "food-style" scale (Satomi et al. [49]) as their lifestyle covariates with regard to food. In addition, we collected responses about whether they normally purchased at least some gum.

In creating the CE choice sets, we eliminated any possible correlation with the attributes in the experimental design methodology, primarily by using the main effects of a fractional factorial design along with the attributes and levels given in Table 1 to reduce the number of combinations below the maximum factorial $3^4 = 81$ (Lorenzen and Anderson [30]). We created 16 profiles, and randomly selected two of these to create our choice sets. For simplicity, we fixed the attribute order as nutritional content, recommendations, amount of nutritional content, and price, from top to bottom. Including an opt-out option made it possible to mimic real-world situations (Ryan and Skåtun [47]). Thus, we provided two alternatives and one opt-out option for each CE question, which represented eight choices per respondent in accordance with the incorporation of a "too close to call option", as explained in Fenichel et al. [15].[4]

We sampled as many undergraduates at Dokkyo University as possible using convenience sampling and campus street intercepts. We distributed our eight-item survey questionnaires to 200 undergraduates and obtained 168 effective responses (response rate 84%), incorporating 1,343 useful observations. To test the checkbox positioning effect, we created two split samples: those who were provided with CE questions in which the checkboxes were placed above the choice sets (sample A), and those for whom they were placed below the choice sets (sample B). Figures 1 and 2 illustrate examples of the items in samples A and B, respectively. Table 2 shows the demographics of our sample, and Tables 3 and 4 show the respondents' attitudes.[5]

Fiebig et al. [16] first assumed the following random utility model in their GMNL model:

$$U_{njt} = V_{njt}(X) + \varepsilon_{njt} = (\beta\lambda)'X_{njt} + \varepsilon_{njt} \quad \text{[Eq. 1]},$$

where ε_{njt} is the error component that depends on the Type I extreme value distribution; and $\lambda = \pi/\sqrt{6\sigma_\varepsilon{}^2}$ is the scale parameter, which is inversely proportional to the variance of the error component, $\sigma_\varepsilon{}^2$. Second, they extended the utility function to incorporate heterogeneities in both the marginal utility vector and the scale parameter, as follows:

$$U_{njt} = (\beta\lambda_n + \gamma\eta_n + (1-\gamma)\lambda_n\eta_n)'X_{njt} + \varepsilon_{njt} \quad \text{[Eq. 2]},$$

where η_n denotes the standard deviation of the marginal utility. The parameter γ is set to consider two GMNL models below. Then, the choice probability of the respondents becomes:

$$P(j|X_{njt}; B, \Lambda) = P(U_{njt} > U_{nkt}, \forall k \neq j) = \iint \prod_{t=1}^{T} \exp\left((\beta_n\lambda_n)'X_{njt}\right) / \sum_{k=1}^{J} \exp\left((\beta_n\lambda_n)'X_{nkt}\right) f(\beta|B) f(\lambda|\Lambda) d\beta d\lambda \quad \text{[Eq. 3]}.$$

[4] Because it is difficult to translate "too close to call" in Japanese, we used "I cannot choose between the two alternatives."

[5] To utilize every covariate of the respondents, we employed only fully completed responses. We could not identify which respondents were sampled using convenience sampling or campus street intercepts.

Simulated maximum likelihood estimation is employed (Train [52]).

Several logit models are nested within the GMNL model. When $\gamma = 1$, then $\beta_n = \beta\lambda_n + \eta_n$, which leads to GMNL-I, which assumes that the scale parameter affects only the mean marginal utilities. When $\gamma = 0$, then $\beta_n = (\beta + \eta_n)\lambda_n$, which is GMNL-II and assumes that the scale parameter affects both the mean and the standard deviation of the marginal utilities. When $\eta_n = 0\ (\forall n)$, then $\beta_n = \beta\lambda_n$, and the model has reduced to S-MNL, which assumes that the marginal utilities are identical between individuals, but that the scale parameter is distributed across individuals such that some preference uncertainty exists. When the variance of λ_n equals zero, and the expectation of λ_n is set to unity, then, $\beta_n = \beta + \eta_n$, and the model reduces to MIXL, which assumes that only the marginal utilities are distributed across individuals. Finally, when $\eta_n = 0$ and the variance of λ_n equals zero, then, $\beta_n = \beta$, and the model reduces to MNL.

We employed R 3.2.5 (R Core Team [43]) and the procedure "gmnl" (Sarrias and Daziano [48]) when estimating the GMNL model. We assumed that the distribution of η_n was normal, lognormal, uniform, or triangular. We decided to estimate the weighting parameter gamma directly, though Fiebig et al.[16] also proposed an indirect estimation procedure. The covariates of individuals can be incorporated into not only the scale parameter, such that $\lambda_n = \exp(\bar{\lambda} + \delta' h_n + \tau v_n)$[6], but also the observable component of the indirect utility as the cross terms with the attributes of alternatives, such that $h_n' X_{njt}$. The parameter of these cross terms can be interpreted as the mean point estimate of the individual differences of the marginal utilities.

We analyzed the checkbox positioning using two procedures. First, we employed dummy variables that take a value of one if the respondent was provided with CE questions in which the checkboxes were placed *below* the choice sets; and zero otherwise. Then, we incorporated the dummy into both the cross term of the marginal utility and the covariates of the scale parameter, h_n. Second, because the dummy variable is a *point estimate* of the checkbox effect, it cannot capture the effect adequately. Therefore, we estimated individual parameters to capture the distributions of preferences (Train [52]; Fiebig et al. [16]). As each distribution can differ, depending on each parameter, we adopted a Brunner–Munzel test (Brunner and Munzel [7]; Neubert and Brunner [37]). We adopted the procedure "lawstat" (Gastwirth et al. [17]) when conducting the Brunner–Munzel test.

We set alternative-specific constants (ASCs) for the leftmost and middle options in the choice set to test for alternative positional effects, following Chrzan [9]. As the rightmost option in the choice set denotes the opt-out option, this option is not preferred when every ASC is positively and significantly estimated. We employed effects coding for the qualitative variable in our choice sets, in accordance with Louviere et al. [33] and Bech and Gyrd-Hansen [3].[7] As the continuous assumptions of the attributes "amount of nutritional content" and

[6] We employed truncated normal as the distribution of v_n, truncated at ± 2.

[7] When the level of the qualitative variable is $l = 1, 2, \cdots, L$, and the arbitrarily omitted level is L, then the parameter of the omitted level, β_L, is estimated by the negative sum of the parameters of

"price" are linear approximations of the effects of the attributes, and our main focal point is to examine the checkbox positioning effect more precisely, we treated every level of attribute as a qualitative variable. We decided to incorporate every mean marginal utility parameters of attributes in choice sets with every ASC in the first place of our estimation procedure. Then, we employed the stepwise regression procedure with forward selection, judged by the Akaike information criterion (AIC), corrected AIC, and Bayesian information criterion.

Table 1: Attributes and levels of the CE

Attribute (unit)	Levels
Type of nutritional content	Calcium, vitamins, euglena
Recommended by	Web, friends, *tokuho* labels
Amount of nutritional content (mg)	100, 200, 300
Price (JPY/pack)	90, 110, 130

	□	□	□
	M	N	L
Type of nutritional content	Euglena	Vitamins	I cannot choose between the two alternatives
Recommended by	Web	Friends	
Amount of nutritional content (mg)	300 mg	200 mg	
Price (JPY/pack)	JPY 110	JPY 130	

Fig. 1: Example of responses for sample A with checkbox positioned at the top.

	M	N	L
Type of nutritional content	Euglena	Vitamins	I cannot choose between the two alternatives
Recommended by	Web	Friends	
Amount of nutritional content (mg)	300 mg	200 mg	
Price (JPY/pack)	JPY 110	JPY 130	
	□	□	□

Fig. 2: Example of responses for sample B with checkbox positioned at the bottom.

the remaining levels: $\beta_L = -\sum_{m \neq L} \beta_m$.

4. Results and Discussion

Before estimating the CE results and testing the checkbox positioning effect, we checked the homogeneities of the covariates between the split samples. First, we checked sample homogeneity within the demographics employing Fisher's exact test (the fifth column in Table 2). We were unable to reject the null hypothesis and, therefore, we concluded that samples A and B are identical in terms of sample demographics at least at the 10% level of significance. Second, we checked for attitudes (the fifth column in Tables 3 and 4). As with most of the items, sample homogeneity was not statistically rejected, except for the food-style scale item "I often enjoy a meal more when I am in a place with a good atmosphere." Indeed, as the empirical distribution of the items appeared to be the same qualitatively, we assumed that all of the covariates were statistically identical across the subsamples.

Both of the GMNL model results converged successfully. We provide our variable list in Table 5, and our estimated result in Table 6. First, we briefly interpret the ASC and scale parameters, τ and γ. We obtained positive and significant mean ASC. This indicates that our opt-out option is not preferable for respondents, and that we could capture the alternative position effects with ASCs. Then, we obtained significant standard deviation parameters in the choice set. We obtain significant heterogeneous scale parameters.

The standard deviation parameters for euglena are labeling, Web, and Amount 300 mg. The parameters for euglena suggest that it may reflects the attitudes in the food-style scale shown in Table 4, and/or the familiarity with euglena. The parameters for Web indicate that there are certain heterogeneities in terms of preferences regarding information sources. The parameter for Amount 300 mg indicates heterogeneous preferences in terms of the amount of nutritional content, and/or reflects the attitudes of the food-style scale in Table 4.

Most of the mean parameters were estimated as significant. For the attribute "Type of nutritional content," the estimated parameter for euglena was significantly positive, which reflects positive preferences for this brand-new nutritional content. For the vitamin level, the parameter was not significant and the parameter for the level of calcium was negative ($-(0 + 5.154) = -5.154$). The respondents did not want calcium to be included in chewing gum, whereas they were indifferent about vitamins being included. For the attribute "Recommended by," the level for Web was estimated as negative, which indicates that respondents did not prefer to obtain recommendations on food from Internet news or blogs. This suggests that food marketing should not rely on these sources to obtain undergraduate student customers. When attempting to attract students to purchase brand-new food commodities, other Web channels, such as private social networks should be utilized. As for the level for *tokuho* labeling, the estimate was not significant, suggesting that respondents are indifferent about recommendations on food content from the Japanese authorities. When

marketing brand-new food commodities to students, caution should be in diffusing *tokuho* labeling. Calculating the parameter for the level for "Friends" resulted in a positive value ($-(-5.832+0)=5.832$), which suggests that a personal recommendation from friends has a positive effect in attracting the undergraduate community to try brand-new commodities. The estimated parameters for the attribute "Amount" were significant. The parameters Amount 200 mg and Amount 300 mg were significantly positive, with the size of the coefficient increasing as the amount increased. The parameter for Amount 100 mg had a significantly negative value, which implies that a greater amount of nutrition should be contained in the brand-new food product. However, we could not compare the scientific information with the nutritional content intake in our survey instrument. Thus, as a policy implication, the relevant authorities should insist on food labeling that includes scientific information on the recommended daily values. For the parameter of the attribute "Price," the estimates for Price JPY130 were significantly negative, for Price JPY110 they were not significant, and for Price JPY90, they were calculated as positive ($-(0+(-7.055))=7.055$). The changes in the size of the coefficient corresponded with increases in the price. Overall, the results for the parameters are compatible with sound intuition.

We find that there is no significant effect of the dummy variable set to sample B in the estimated result in Table 6. However, as noted above, the dummy variable is a *point estimate* of the checkbox positioning effect. Therefore, we next estimated individual parameters to test more precisely whether the distribution of the parameters was affected by the checkbox positioning.

We show the results for the individual parameters in Table 7, and box plots of each parameter of Model 2 are shown in Figures 3–10. For all parameters, hypotheses of the identical distribution between subsamples are statistically rejected. Then, every parameter of sample A (in which the checkboxes were placed above the CE questions) tends to shrink toward zero. This suggests that when the checkboxes of CE questions are placed above the questions, respondents tend to ignore part of the information provided on the CE questions. Thus, we should place the checkboxes for CE below the questions with the bottom-placed price attribute to ensure that respondents take in all the information provided on the CE questions.

5. Conclusion

We investigated the checkbox positioning effect in CE by undertaking an undergraduate student survey on a brand-new food commodity using GMNL modeling. The results suggest that there is a certain checkbox effect that relates to a lack of attention being paid to the information provided on the CE questions. We can alleviate the attribute of nonattendance when the checkbox is placed below the choice set, with the price attribute on the bottom. However, we did not investigate whether this issue occurs when the

checkbox is placed above the choice set with the price attribute on the top. In this case, we may observe a certain distance effect between the checkbox and the price attribute.

Attribute nonattendance for CM/CE is an important issue that requires addressing. To confirm the checkbox positioning effect on CM/CE, we should use such procedures to examine the relationship between the checkbox position and information processing by respondents. In particular, because the checkbox position is a geographical feature of the questionnaire, eye movements are likely to provide a good explanation of such positioning effects.

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Table 2: Demographics

Item	Subitem	Sample A	Sample B	P-value
No. of samples		82	86	
Sex	Male	43	37	0.279
	Female	39	49	
Age (in years)	18	9	6	0.883
	19	32	36	
	20	31	30	
	21	8	10	
	22	2	3	
	23	0	1	
	Mean	19.537	19.663	
	SD	0.905	0.978	
Faculty	Foreign Languages	32	31	0.632
	International Liberal Arts	5	10	
	Economics	31	33	
	Law	14	12	
About euglena				
Had heard about it before participating	Yes	9	11	0.814
in our survey	No	73	75	
Understood our explanation	Yes	73	78	0.801
	No	9	8	
Normally purchased chewing gum	Yes	36	32	0.433
	No	46	54	

Notes: SD, standard deviation. P-values were estimated using Fisher's exact test.

Table 3: Attitudes (attracted to purchasing new products)

		Sample A	Sample B	P-value
I am attracted by commodities labeled "limited time offer"	Mean	4.000	4.070	0.704
	SD	1.042	0.905	
I am attracted by brand-new commodities	Mean	3.902	3.953	0.458
	SD	0.964	0.969	
I am attracted by commodities containing brand-new nutrients	Mean	2.768	3.023	0.326
	SD	1.158	1.095	

Table 4: Attitudes of food-style scale

		Sample A	Sample B	P-value
It is enjoyable to have a meal with my friends	Mean	4.610	4.593	0.783
	SD	0.698	0.602	
It is very important to have a meal together with other people to create relationships	Mean	4.610	4.512	0.639
	SD	0.681	0.699	
I often enjoy a meal more when I am in a place with a good atmosphere	Mean	4.524	4.419	0.035**
	SD	0.933	0.774	
I find it enjoyable to have a meal with many other people	Mean	3.866	4.105	0.415
	SD	1.141	0.946	
I frequently have conversations when eating a meal	Mean	3.732	3.895	0.760
	SD	1.031	0.983	
It is enjoyable to have a meal with my family members	Mean	4.037	4.163	0.672
	SD	0.999	0.866	
I have meals regularly	Mean	2.988	2.942	0.442
	SD	1.171	1.141	
I take nutritional balance into consideration	Mean	3.012	2.814	0.323
	SD	1.160	1.057	
It is common for me to have a meal with my family members	Mean	3.000	2.907	0.947
	SD	1.370	1.360	
I have meals to relax	Mean	3.341	3.256	0.427
	SD	1.317	1.140	
In daily life, I look forward to having a meal	Mean	3.598	3.709	0.680
	SD	1.064	0.931	
I frequently eat until I am full	Mean	3.707	3.605	0.182
	SD	1.036	0.961	
I am particular about food safety	Mean	3.378	3.581	0.761
	SD	1.118	1.046	
I care about a food’s expiration date	Mean	3.561	3.698	0.583
	SD	1.123	1.064	
I like to have food that is said to be good for health	Mean	3.171	3.291	0.440
	SD	1.142	0.981	

Note: SD, standard deviation. P-values were estimated using Fisher’s exact test. ** indicates significance at the 5% level. We coded the responses as follows: 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree.

Table 5: List of variables

Variable	Content	Description
ASC_M	Alternative-specific constant of option M	Takes a value of 1 if the chosen alternative is the leftmost option M; 0 otherwise
ASC_N	Alternative-specific constant of option N	Takes a value of 1 if the chosen alternative is the middle option N; 0 otherwise
Calcium	The type of nutritional content is calcium	Estimated value from other effect-coded variable estimates
Vitamins	The type of nutritional content is vitamins in general	Takes a value of 1 if the chosen alternative contains this level of nutritional content; –1 if it contains the level for "Calcium", which is an omitted variable; 0 otherwise
Euglena	The type of nutritional content is euglena	Takes a value of 1 if the chosen alternative contains this level of nutritional content; –1 if it contains the level for "Calcium," which is an omitted variable; 0 otherwise
Friends	The source of the recommendation is friends of the respondent	Estimated value from other effect-coded variable estimates
Web	The source of the recommendation is Internet news and/or blogs	Takes a value of 1 if the chosen alternative contains this level of information source; –1 if it contains the level for "Friends," which is an omitted variable; 0 otherwise
tokuho	The source of the recommendation is *tokuho* labeling	Takes a value of 1 if the chosen alternative contains this level of information source; –1 if it contains the level for "Friends," which is an omitted variable; 0 otherwise
Amount	The amount of nutritional content	Numerical value

Table 5 (cont'd)

Variable	Content	Description
Amount 100 mg	The amount of nutritional content is 100 mg	Estimated value from other effect-coded variable estimates
Amount 200 mg	The amount of nutritional content is 200 mg	Takes a value of 1 if the chosen alternative contains this level of information source; –1 if it contains the level for "100 mg," which is an omitted variable; 0 otherwise
Amount 300 mg	The amount of nutritional content is 300 mg	Takes a value of 1 if the chosen alternative contains this level of information source; –1 if it contains the level for "100 mg," which is an omitted variable; 0 otherwise
Price	The price of a pack of chewing gum with 14 pieces	Numerical value
Price JPY90	The price of a pack of chewing gum with 14 pieces is JPY 90	Estimated value from other effect-coded variable estimates
Price JPY110	The price of a pack of chewing gum with 14 pieces is JPY 110	Takes a value of 1 if the chosen alternative contains this level of information source; –1 if it contains the level for "JPY90," which is an omitted variable; 0 otherwise
Price JPY130	The price of a pack of chewing gum with 14 pieces is JPY 130	Takes a value of 1 if the chosen alternative contains this level of information source; –1 if it contains the level for "JPY110," which is an omitted variable; 0 otherwise

Table 6: GMNL results

Variables		Coeff.		T value	P-value
Mean					
ASC1		1.106	***	9.049	0.000
ASC2		1.334	***	11.007	0.000
Calcium		–5.306			
Vitamins		0.151		0.103	0.918
Euglena		5.154	**	2.313	0.021
Friends		4.325			
Web		–5.832	**	–2.305	0.021
tokuho		1.507		1.539	0.124
Amount 100 mg		–7.605			
Amount 200 mg		1.786	**	2.049	0.041
Amount 300 mg		5.819	**	2.142	0.032
Price JPY90		8.187			
Price JPY110		–1.132		–1.574	0.116
Price JPY130		–7.055	**	–2.305	0.021
SD	Prob. distribution				
Euglena	Triangular	8.515	**	2.132	0.033
Web	Uniform	6.202	**	2.083	0.037
Amount 300 mg	Uniform	7.027	**	2.066	0.039
τ		2.828	***	8.046	0.000
Γ		–0.119	*	–1.932	0.053
Log likelihood		–1030.200			
No. of observations		1343			
No. of samples		168			
Halton replication		100			

Notes: ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. SD, standard deviation. The mean parameter for the omitted level of effect-coded variables is calculated using the parameters of the remaining levels.

Table 7: Individual parameters and results of the Brunner–Munzel test

		Sample A	Sample B	P-value
Vitamins	Minimum	0.001	0.001	0.015**
	1st Quartile	0.003	0.006	
	Median	0.009	0.026	
	3rd Quartile	0.089	0.212	
	Maximum	1.035	2.214	
Euglena	Minimum	0.012	0.013	0.015**
	1st Quartile	0.033	0.061	
	Median	0.088	0.257	
	3rd Quartile	0.883	2.110	
	Maximum	10.297	22.039	
Web	Minimum	0.014	0.015	0.015**
	1st Quartile	0.039	0.072	
	Median	0.104	0.304	
	3rd Quartile	1.046	2.501	
	Maximum	12.201	26.115	
tokuho	Minimum	–7.733	–16.553	0.015**
	1st Quartile	–0.663	–1.585	
	Median	–0.066	–0.193	
	3rd Quartile	–0.025	–0.046	
	Maximum	–0.009	–0.010	

Table 7 (cont'd)

		Sample A	Sample B	P-value
Amount 200 mg	Minimum	–48.203	–103.173	0.015**
	1st Quartile	–4.133	–9.879	
	Median	–0.410	–1.201	
	3rd Quartile	–0.153	–0.284	
	Maximum	–0.055	–0.061	
Amount 300 mg	Minimum	–1.236	–0.877	0.033**
	1st Quartile	–0.264	0.073	
	Median	0.367	0.648	
	3rd Quartile	2.093	6.920	
	Maximum	67.544	81.394	
Price JPY110	Minimum	–44.800	–101.000	0.038**
	1st Quartile	–2.220	–9.180	
	Median	–0.414	–0.868	
	3rd Quartile	–0.190	–0.237	
	Maximum	3.260	0.194	
Price JPY130	Minimum	–0.735	–0.178	0.014**
	1st Quartile	0.152	0.319	
	Median	0.396	0.872	
	3rd Quartile	2.602	4.306	
	Maximum	55.930	114.108	

Notes: P-values were estimated using the Brunner–Munzel test. ** indicates significance at the 5% level. The null indicates that the distribution of parameters is identical between subsamples.

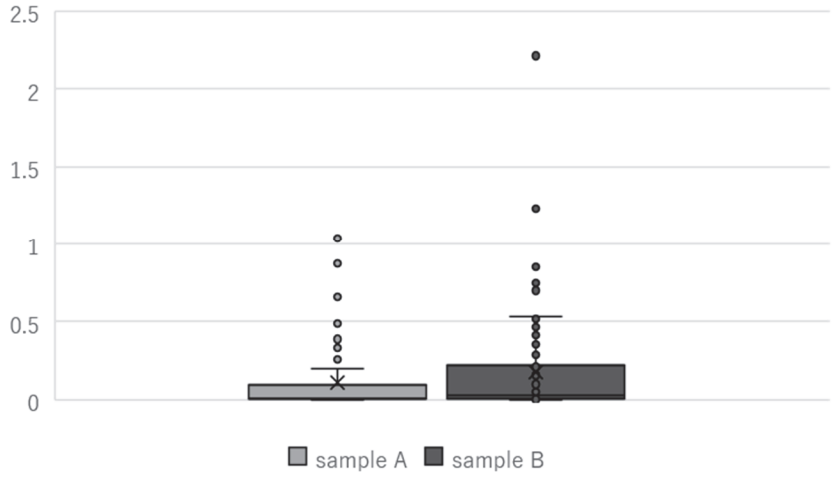

Fig. 3: Parameter distribution of Vitamins

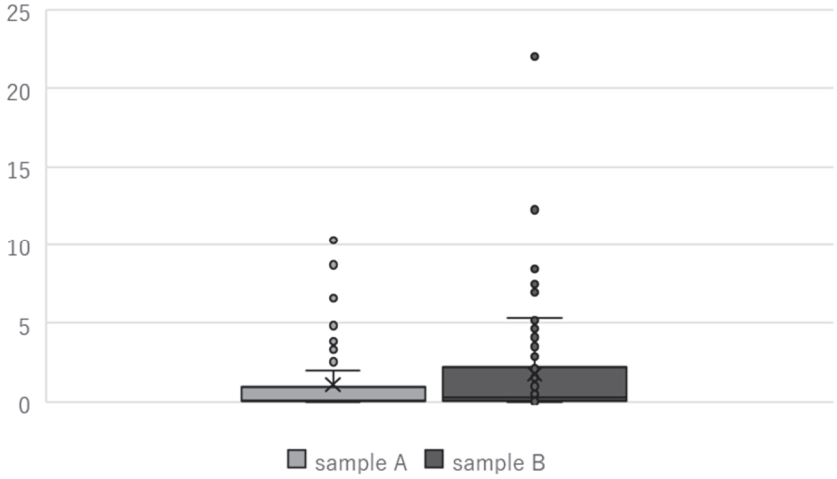

Fig. 4: Parameter distribution of Euglena

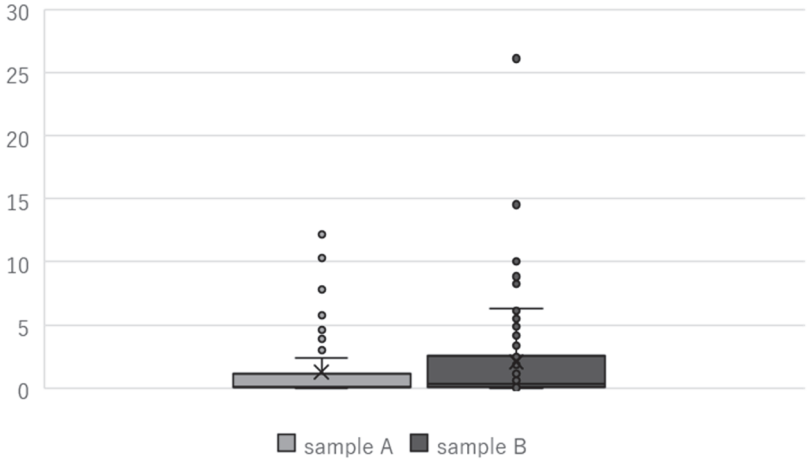

Fig. 5: Parameter distribution of Web

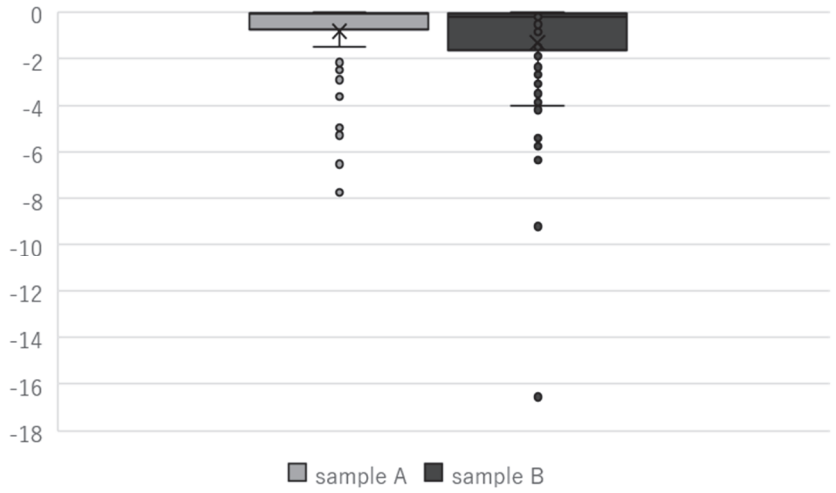

Fig. 6: Parameter distribution of Tokuho

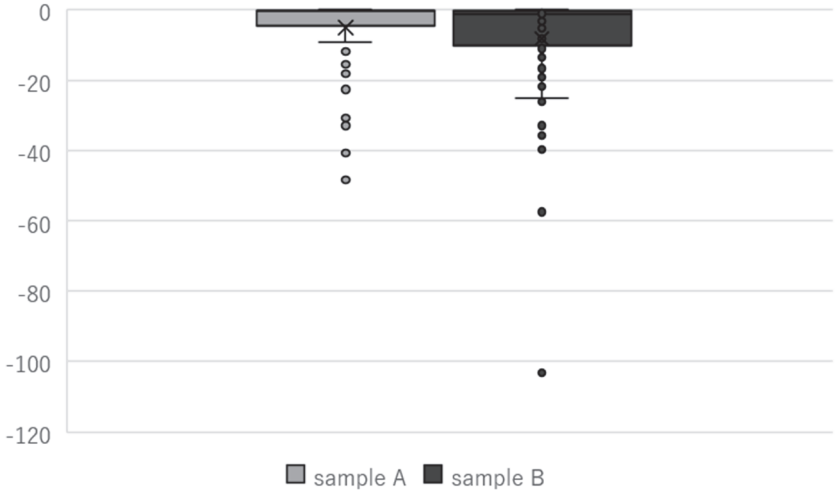

Fig. 7: Parameter distribution of Amount 200mg

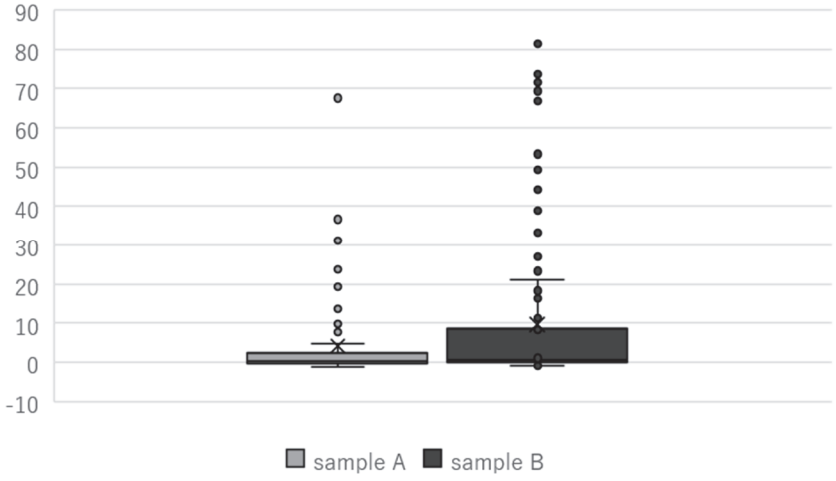

Fig. 8: Parameter distribution of Amount 300mg

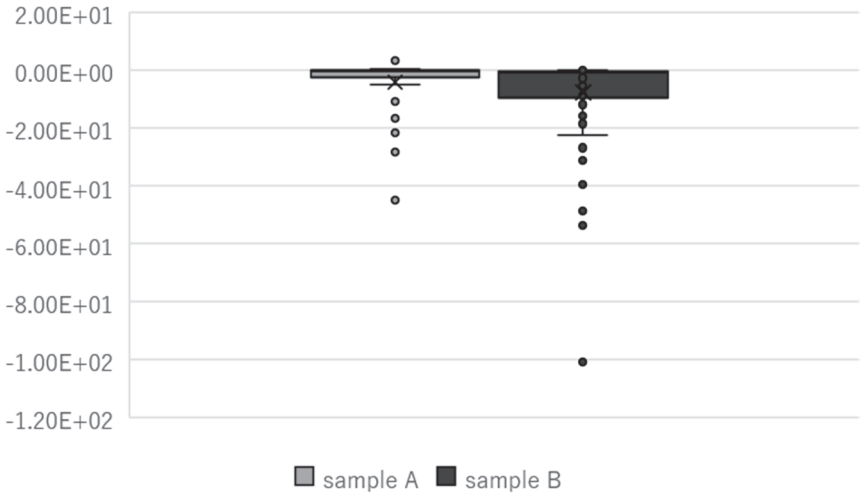

Fig. 9: Parameter distribution of Price JPY110

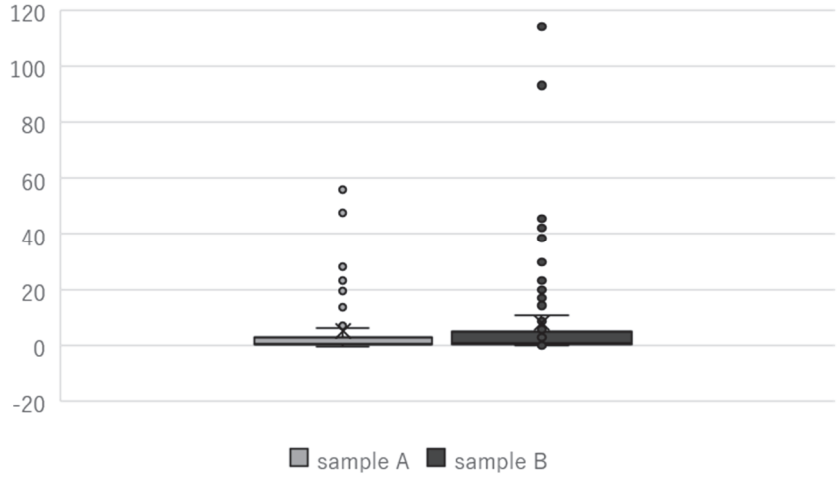

Fig. 10: Parameter distribution of Price JPY130

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Appendix: Choice experiment scenario of sample B

“Suppose you want to buy a pack of chewing gum. Please choose your most preferred option from the following eight choice sets. When choosing, please consider the cost of each option will decrease your actual disposable income. Meanwhile, assume everything else remains constant.”

Sample answer when you prefer option N.

	M	N	L
Type of nutritional content	Euglena	Vitamins	I cannot choose between the two alternatives.
Recommended by	Web	Friends	
Amount of nutritional content	300 mg	200 mg	
Price (JPY/pack)	JPY 110	JPY 130	
	□	□	□

Contents of alternatives

Type of nutritional content	The type of nutritional content of the chewing gum 1) Euglena: it contains 59 nutritional elements 2) Vitamins: it contains vitamins in general 3) Calcium: it contains only calcium
Recommended by	Those who recommended that you buy the chewing gum: 1) ‘Tokuho’: the chewing gum is proved to have particular health benefits scientifically, and is certified by certain authorities of the Japanese government 2) Web: the chewing gum was recommended by certain news or Internet blogs 3) Friends: the chewing gum was recommended by your friends
Amount of nutritional content	The amount of nutritional content of the chewing gum
Price (JPY/pack)	The price of a pack of chewing gum containing 14 pieces

Q1. How about the following combinations?

	M	N	L
Type of nutritional content	Euglena	Calcium	I cannot choose between the two alternatives.
Recommended by	Friends	Friends	
Amount of nutritional content	100 mg	200 mg	
Price (JPY/pack)	JPY 110	JPY 90	
	□	□	□

Q2. How about the following combinations?

	M	N	L
Type of nutritional content	Calcium	Euglena	I cannot choose between the two alternatives.
Recommended by	Tokuho	Tokuho	
Amount of nutritional content	300 mg	200 mg	
Price (JPY/pack)	JPY 110	JPY 130	
	□	□	□

Q3. How about the following combinations?

	M	N	L
Type of nutritional content	Calcium	Euglena	I cannot choose between the two alternatives.
Recommended by	Friends	Friends	
Amount of nutritional content	100 mg	200 mg	
Price (JPY/pack)	JPY 130	JPY 110	
	□	□	□

Q4. How about the following combinations?

	M	N	L
Type of nutritional content	Euglena	Vitamins	I cannot choose between the two alternatives.
Recommended by	Tokuho	Tokuho	
Amount of nutritional content	100 mg	200 mg	
Price (JPY/pack)	JPY 90	JPY 110	
	□	□	□

Q5. How about the following combinations?

	M	N	L
Type of nutritional content	Euglena	Vitamins	I cannot choose between the two alternatives.
Recommended by	Friends	Web	
Amount of nutritional content	200 mg	100 mg	
Price (JPY/pack)	JPY 110	JPY 110	
	□	□	□

Q6. How about the following combinations?

	M	N	L
Type of nutritional content	Vitamins	Euglena	I cannot choose between the two alternatives.
Recommended by	Friends	Web	
Amount of nutritional content	200 mg	300 mg	
Price (JPY/pack)	JPY 130	JPY 130	
	□	□	□

Q7. How about the following combinations?

	M	N	L
Type of nutritional content	Calcium	Vitamins	I cannot choose between the two alternatives.
Recommended by	Web	Friends	
Amount of nutritional content	200 mg	300 mg	
Price (JPY/pack)	JPY 110	JPY 90	
	□	□	□

Q8. How about the following combination?

	M	N	L
Type of nutritional content	Euglena	Euglena	I cannot choose between the two alternatives.
Recommended by	Web	Friends	
Amount of nutritional content	200 mg	300mg	
Price (JPY/pack)	JPY 90	JPY 110	
	□	□	□