ORIGINAL ARTICLE

CLASSIFICATION OF MENUS ON HOME DINING TABLES BASED UPON HUMAN MEAL *Kansei*

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Abstract: To evaluate human meal *kansei* methods of paired comparisons are considered to be used. This paper concerns a method to classify menus on home dining tables by using the method of paired comparisons. There are many methods of paired comparisons proposing and among those methods the method proposed by Thurstone is used for this study because the burden of the subjects in the experiment to obtain the data on human *Kansei* is comparatively light. In Case V of Thurstone's method of paired comparisons a model is assumed that human sensations are normally distributed with equal standard deviations, and the scales are obtained so that the units of them are the standard deviations of the standard normal distribution hence the scales are useful to compare *Kansei* among many stimuli. It is however necessary for the use of Case V to test goodness of fit to the model Thurstone has assumed. An experiment by paired comparisons to obtained data on human meal *Kansei* was conducted using 200 menus on home dining tables and goodness of fit to the model was tested. For the results it was concluded that meal *Kansei* for 151 menus among 200 menus does not fit the model assumed in Case V of Thurstone's method. It is therefore decided that the scales obtained for human meal *Kansei* are not effective hence a method is considered to classify menus on home dining tables into several groups according to human meal *Kansei* based upon the scales obtained by the method of paired comparisons. Here it is described how to classify menus on home dining tables according to human meal *Kansei* and some of the results of classification are shown.

Key words: *Classification of menus on home dining tables, Human meal Kansei, Thurstone's method of paired comparisons, Agreement of Kansei*

1. INTRODUCTION

We take meals every day and it is considered that human meal *Kansei* varies with every person. Our meal tendencies also differ depending on individuals or households. Here human meal tendencies are considered to be broadly divided into a convenience-oriented meal tendency, a health-oriented meal tendency and an earnest-oriented meal tendency and our convenience-oriented feelings, health-oriented feelings and earnest-oriented feelings are investigated with respect to 200 menus on home dining tables by using the method of paired comparisons.

The methods of paired comparisons have been proposed by Thurstone, Scheffe, Bradley etc. and their modified methods have been also proposed [1]. Since the method proposed by Thurstone gives the scales the units of which are the standard deviations of the standard normal distribution [2], it enable us to compare *Kansei* among many stimuli. It is however assumed in Thurstone's method that human sensations are normally distributed and the standard deviations of each distribution are equal. It is therefore necessary to find out whether obtained data by paired comparisons fit the

assumption of Thurstone's method.

In this paper it is described how to test goodness of fit to Thurstone's proposed model and the results are shown. For the results of the test it has been found that *Kansei* evaluation data obtained from the experiment conducted for this study does not fit Thurstone's model on the whole. Therefore instead of evaluation of human meal *Kansei* classification of menus on home dining tables based upon *Kansei* by paired comparisons is considered and discussed here.

2. EXPERIMENT BY PAIRED COMPARISONS

An experiment on *Kansei* evaluation by paired comparisons was conducted, the subjects of which are 135 University students and equally divided into 3 groups, that is, each group consists of 45 subjects. In the experiment the subjects were asked three different questions depending on groups with respect to 200 menus on home dining tables. Namely they were asked which they feel each menu is a convenience-oriented menu or a health-oriented menu, a health-oriented menu or an earnest-oriented menu, and an earnest-oriented

menu or a convenience-oriented menu respectively.

From the experiment on human evaluation the proportions that subjects chose a member of each pair are determined. Table 1 shows the proportions for fried fish dressed with liquid starch. In terms of Table 1 this states that 60.0 percent of subjects among 45 subjects in a group answered that fried fish dressed with liquid starch is convenience-oriented food in the comparison of convenience-oriented food and health-oriented food, 42.2 percent of subjects answered that fried fish dressed with liquid starch is health-oriented food in the comparison of health-oriented food and earnest-oriented food, and 60.0 percent of subjects answered that fried fish dressed with liquid starch is earnest-oriented food in the comparison of earnest-oriented food and convenience-oriented food respectively.

Table 1: Proportions of subjects who chose fried fish dressed with liquid starch

	Convenience	Health	Earnest
Convenience		0.400	0.600
Health	0.600		0.578
Earnest	0.400	0.422	

Table 2 shows the normal scores corresponding to the proportions shown in Table 1, the average of normal scores and the scales for convenience-oriented feelings, health-oriented feelings and earnest-oriented feelings for fried fish dressed with liquid starch. The scales are obtained by multiplying the average of normal scores by $\sqrt{2}$. We have obtained the numerical results from Table 2 that the scales of convenience-oriented feelings, health-oriented feelings and earnest-oriented feelings for fried fish dressed with liquid starch by Thurstone's method of paired comparisons are 0.000, -0.325 and 0.325 respectively.

Table 3 shows the proportions for sea food and vegetables dressed with liquid starch, and Table 4 shows the normal scores corresponding to the proportions in Table 3, the average of normal scores and scales for convenience-oriented feelings, health-oriented feelings and earnest-oriented feelings for sea food and vegetables dressed with liquid starch. We have obtained the numerical results from Table 4 that the scales of convenience-oriented feelings, health-oriented feelings

Table 2: Scales for fried fish dressed with liquid starch

	Convenience	Health	Earnest
Convenience		-0.25	0.25
Health	0.25		0.21
Earnest	-0.25	-0.21	
Average	0.000	-0.230	0.230
Scales	0.000	-0.325	0.325

and earnest-oriented feelings for sea food and vegetables dressed with liquid starch by Thurstone's method of paired comparisons are -0.163, 0.163 and 0.000 respectively.

Table 3: Proportions of subjects who chose sea food and vegetables dressed with liquid starch

	Convenience	Health	Earnest
Convenience		0.467	0.622
Health	0.533		0.378
Earnest	0.378	0.622	

Table 4: Scales for sea food and vegetables dressed with liquid starch

	Convenience	Health	Earnest
Convenience		-0.08	0.31
Health	0.08		-0.31
Earnest	-0.31	0.31	
Average	-0.115	0.115	0.000
Scales	-0.163	0.163	0.000

3. TEST OF GOODNESS OF FIT

As for the results obtained as shown in Tables 1-4, the goodness of fit to the model assumed in Case V of Thurstone's method of paired comparisons is tested. To do this we obtain the estimated proportions EP_{ch} , EP_{he} and EP_{ec} corresponding to the differences of convenience-oriented and health-oriented average values, health-oriented and earnest-oriented average values and earnest-oriented and convenience-oriented average values respectively. We also obtain true proportions TP_{ch} , TP_{he} and TP_{ec} for EP_{ch} , EP_{he} and EP_{ec} respectively.

Now for each proportions arcsine transformation is

made as follows:

$$\begin{aligned} E\theta_{ch} &= \arcsin \sqrt{EP_{ch}} \\ E\theta_{he} &= \arcsin \sqrt{EP_{he}} \\ E\theta_{ec} &= \arcsin \sqrt{EP_{ec}} \\ T\theta_{ch} &= \arcsin \sqrt{TP_{ch}} \\ T\theta_{he} &= \arcsin \sqrt{TP_{he}} \\ T\theta_{ec} &= \arcsin \sqrt{TP_{ec}} \end{aligned} \quad (1)$$

We calculate the test statistic

$$\chi_0^2 = \frac{n[(E\theta_{ch} - T\theta_{ch})^2 + (E\theta_{he} - T\theta_{he})^2 + (E\theta_{ec} - T\theta_{ec})^2]}{821} \quad (2)$$

and obtain the critical value $\chi^2(df_1, \alpha)$ at the significance level α for degrees of freedom

$$df_1 = \frac{1}{2}(n-1)(n-2) \quad (3)$$

where n is the number of stimuli.

If $\chi_0^2 < \chi^2(df_1, \alpha)$ is satisfied, it is decided that *Kansei* fits the assumption of Thurstone's method [2].

The fitness of *Kansei* to Thurstone's assumption has been tested for 200 menus on home dining tables including fried fish dressed with liquid starch and sea food and vegetables dressed with liquid starch. In this case stimuli are a convenience-oriented feeling, a health-oriented feeling and an earnest-oriented feeling to menus hence there are three stimuli, that is, $n=3$. Substituting it in (3) we obtain $df_1 = 1$. Thus the critical value at 5% percent level of significance comes out

$$\chi^2(1, 0.05) = 3.84 \quad (4)$$

The test statistic χ_0^2 was obtained from (2) to be 1.93 which is less than the critical value 3.84 for fried fish dressed with liquid starch and 4.84 which is not less than the critical value 3.84 for sea food and vegetables dressed with liquid starch respectively. It is therefore statistically decided that observed *Kansei* fits the assumption of Case V of Thurstone's method for fried fish dressed with liquid starch but observed *Kansei* does not fit the assumption for sea food and vegetables dressed with liquid starch. The results were obtained for

200 menus on home dining tables as follows: observed *Kansei* fits the assumption for 51 menus and *Kansei* does not fits the assumption for 149 menus. For the results it is considered to be impossible to use the values obtained by Case V of Thurstone's method to evaluate *Kansei*. It might be therefore necessary to consider another method [3-5] to evaluate human meal *Kansei* but here a method is considered to classify menus on home dining tables according to human *Kansei* by using the method of paired comparisons.

4. AGREEMENT OF *Kansei*

In order to classify menus on home dining tables using the data obtained from the experiment on *Kansei* evaluation, it is necessary to confirm the agreement of observed *Kansei* among many subjects. To do this coefficient of agreement is used [1].

Now let n be the number of subjects, k be the number of stimuli and x_{ij} be the number of subjects who choose stimulus i in the comparison of stimuli i and j . Then coefficient of agreement is given by

$$u = \frac{2[nC_2 \times_k C_2 - \sum_{i=1}^{k-1} \sum_{j=i+1}^k x_{ij}(n - x_{ij})]}{nC_2 \times_k C_2} - 1 \quad (5)$$

where $-1 \leq u \leq 1$. The values obtained by (5) show how observed *Kansei* agrees among subjects. To test significance of agreement on *Kansei* the chi-square test is conducted. To do this, first, we calculate the test statistic

$$\chi_0^2 = \frac{4}{n-2} [nC_2 \times_k C_2 - \sum_{i=1}^{k-1} \sum_{j=i+1}^k x_{ij}(n - x_{ij}) - \frac{nk(n-1)(n-3)(k-1)}{8(n-2)}] \quad (6)$$

and next we need to obtain degrees of freedom. The value of degrees of freedom is given by

$$df_1 = \frac{nk(n-1)(k-1)}{2(n-2)^2} \quad (7)$$

If $\chi_0^2 \geq \chi^2(df_2, \alpha)$ is satisfied, it is decided that *Kansei* agrees at the significance level α . Here $n=45$, $k=3$ hence we have $df_2 = 3.21$. The critical value $\chi^2(df_2, 0.05)$ at 5% level of significance comes out

$$\begin{aligned}
7.81 &= \chi^2(3, 0.05) < \chi^2(df_2, 0.05) \\
&< \chi^2(4, 0.05) = 9.50 \\
\therefore 7.81 &< \chi^2(df_2, 0.05) < 9.50 \quad (8)
\end{aligned}$$

The test statistic χ_0^2 is calculated by (6). It is 4.98 for fried fish dressed with liquid starch and 5.91 for sea food and vegetables dressed with liquid starch. Both values of χ_0^2 for fried fish dressed with liquid starch and sea food and vegetables dressed with liquid starch are less than 7.81 which is less than the critical value $\chi^2(df_2, 0.05)$. It is therefore decided that observed *Kansei* for fried fish dressed with liquid starch and sea food and vegetables dressed with liquid starch does not agree among subjects. The agreement of *Kansei* was tested with respect to 200 menus on home dining tables and it has been concluded that observed *Kansei* for 35 menus (17.5%) agrees and that for 165 menus (82.5%) does not agree among subjects.

Tables 5 and 6 show 15 menus in which *Kansei* agrees (Table 5) and *Kansei* does not agree (Table 6) as examples. In those Tables the menus' values of agreement of coefficient u and test statistic χ_0^2 are also shown.

5. CLASSIFICATION OF MENUS

Here it is considered that menus on home dining tables are classified into the four groups: a group of convenience-oriented menus, a group of health-oriented menus and a group of earnest-oriented menus and a group of non-oriented menus. The menus for which it is statistically decided that observed *Kansei* does not agree among subjects are put into a group of non-oriented menus. Therefore fried fish dressed with liquid starch and sea food and vegetables dressed with liquid starch taken as examples of menus on home dining tables from 200 menus belong to a group of non-oriented menus. There are 35 menus among 200 menus in which *Kansei* does not agree and those menus belong to a group of non-oriented menus. The menus listed in Table 5 therefore becomes examples of non-oriented menus. As for the menus in which *Kansei* agrees if the scale of the convenience-oriented feeling is the largest compared with two other feelings, the menu is put into the group of convenience-oriented menus, if the scale of the health-oriented feeling is the largest, the menu is put into

Table 5: The menus in which *Kansei* does not agree

Slices of sea food	
$u = -0.02$	$\chi_0^2 = 0.33$
Pasta salad · Salad noodles · Chinese noodles salad	
$u = -0.01$	$\chi_0^2 = 2.00$
Eggs fried in a pan	
$u = 0.01$	$\chi_0^2 = 4.05$
Cooked rice and red beans	
$u = 0.01$	$\chi_0^2 = 4.79$
Cheese	
$u = 0.01$	$\chi_0^2 = 4.98$
Tea	
$u = 0.01$	$\chi_0^2 = 5.17$
Broiled vegetables	
$u = 0.02$	$\chi_0^2 = 5.54$
Chinese soap	
$u = 0.02$	$\chi_0^2 = 6.10$
Bread	
$u = 0.03$	$\chi_0^2 = 6.84$
Broiled shellfish	
$u = 0.03$	$\chi_0^2 = 7.03$
Pickled ume	
$u = 0.03$	$\chi_0^2 = 7.03$
Vegetables boiled down in soy	
$u = 0.03$	$\chi_0^2 = 7.40$
Boiled fish paste	
$u = 0.03$	$\chi_0^2 = 7.40$
Minced fish	
$u = 0.03$	$\chi_0^2 = 7.77$
Kinds of boiled plain · chowder	
$u = 0.03$	$\chi_0^2 = 7.77$

the group of health-oriented menus and if the scale of the earnest-oriented feeling is the largest, the menu is put into the group of earnest-oriented menus. Table 7 shows examples of the menus in which it is statistically decided that *Kansei* agrees and their scales for the convenience-oriented feeling, the health-oriented feeling and the earnest-oriented feeling. In terms of this Table this states that corned beef turns out to be a convenience-oriented menu because the scale for the convenience-oriented feeling is the largest, yogurt turns out to be a health-oriented menu because the scale for the

Table 6: The menus in which *Kansei* agrees

Toast	
$u = 0.04$	$\chi_0^2 = 9.70$
Stick salad	
$u = 0.07$	$\chi_0^2 = 12.61$
Meuniere of fish	
$u = 0.09$	$\chi_0^2 = 15.96$
Rice ball	
$u = 0.12$	$\chi_0^2 = 19.49$
Mixed rice	
$u = 0.13$	$\chi_0^2 = 20.79$
Rice fried in a hot pan	
$u = 0.14$	$\chi_0^2 = 22.10$
Fish teriyaki	
$u = 0.18$	$\chi_0^2 = 27.49$
Kinds of bean curd	
$u = 0.20$	$\chi_0^2 = 31.03$
Mixed salad	
$u = 0.24$	$\chi_0^2 = 35.86$
Steak	
$u = 0.27$	$\chi_0^2 = 40.51$
Green fruit	
$u = 0.27$	$\chi_0^2 = 40.51$
Gratin	
$u = 0.29$	$\chi_0^2 = 43.86$
Bacon	
$u = 0.30$	$\chi_0^2 = 44.42$
Laver	
$u = 0.30$	$\chi_0^2 = 44.79$
Dried vegetables and sea food	
$u = 0.38$	$\chi_0^2 = 56.33$

health-oriented feeling is the largest and spaghetti turns out to be an earnest-oriented menu because the scale for the earnest-oriented feeling is the largest.

Table 7: Scales of menus

Menu	Convenience	Health	Earnest
Corned beef	1.499	-1.442	-0.057
Yogurt	-0.615	1.923	-1.308
Spagetti	0.304	-1.513	1.209

As examples of classification according to human meal *Kansei* Tables 8, 9 and 10 show 12 convenience-oriented menus (Table 8), health-oriented menus (Table 9) and earnest-oriented menus (Table 10) and the largest scales respectively

Table 8: Convenience-oriented menus

Corned beef	
The scale for the convenience-oriented feeling	1.499
Bacon	
The scale for the convenience-oriented feeling	1.089
Ham	
The scale for the convenience-oriented feeling	0.997
Rice ball	
The scale for the convenience-oriented feeling	0.778
Vienna sausage	
The scale for the convenience-oriented feeling	0.580
Rice fried in a hot pan	
The scale for the convenience-oriented feeling	0.552
Fried fish balls	
The scale for the convenience-oriented feeling	9.523
Potato salad	
The scale for the convenience-oriented feeling	0.474
A kind of fish paste	
The scale for the convenience-oriented feeling	0.470
Sandwich	
The scale for the convenience-oriented feeling	0.438
Stick salad	
The scale for the convenience-oriented feeling	0.297
Toast	
The scale for the convenience-oriented feeling	0.120

6. CONCLUDING REMARKS

In this paper considering that human meal tendencies are broadly divided into a convenience-oriented tendency, a health-oriented tendency and an earnest-oriented tendency a method was studied to classify menus on home dining tables into convenience-oriented menus, health-oriented menus, earnest-oriented menus and non-oriented menus using the method of paired comparisons.

Since it has been found by statistical test that *Kansei* evaluation data obtained from the experiment by paired

Table 9: Health-oriented menus

Yogurt	
The scale for the health-oriented feeling	1.923
Marine algae salad	
The scale for the health-oriented feeling	1.923
Japanese tea	
The scale for the health-oriented feeling	1.549
Laver	
The scale for the health-oriented feeling	1.423
Dried vegetables and sea food	
The scale for the health-oriented feeling	1.344
Green fruit	
The scale for the health-oriented feeling	1.336
Boiled vegetables	
The scale for the health-oriented feeling	1.273
Mixed salad	
The scale for the health-oriented feeling	1.202
Tomato・Vegetables juice drink	
The scale for the health-oriented feeling	1.195
Kinds of miso	
The scale for the health-oriented feeling	1.138
Kinds of bean curd	
The scale for the health-oriented feeling	1.089
Fish eggs products	
The scale for the health-oriented feeling	0.877

comparisons does not fit the model assumed in Case V of Thurstone's method of paired comparisons, those data were not used to evaluate meal *Kansei* and used to classify the menus on home dining tables.

By obtaining actual data on menus on home dining tables the classification described here is considered to be useful to know our meal tendencies

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Table 10: Earnest-oriented menus

Spagetti	
The scale for the earnest-oriented feeling	1.209
Steak	
The scale for the earnest-oriented feeling	1.167
Curry rice	
The scale for the earnest -oriented feeling	1.082
Stew	
The scale for the earnest -oriented feeling	1.032
Rice with hashed meat	
The scale for the earnest -oriented feeling	0.983
Teriyaki of fish	
The scale for the earnest-oriented feeling	0.976
Gratin	
The scale for the earnest-oriented feeling	0.962
Mixed rice	
The scale for the earnest-oriented feeling	0.877
Sukiyaki pan	
The scale for the earnest-oriented feeling	0.651
Sea food broiled with butter	
The scale for the earnest-oriented feeling	0.580
Fried dumpling stuffed with minced pork	
The scale for the earnest-oriented feeling	0.566
Meuniere of fish	
The scale for the earnest-oriented feeling	0.566

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