RESEARCH REPORT

TIME SERIES JUDGMENTS IN *Kansei* EVALUATION

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Abstract: The evaluation result of the commodities in daily life has an important meaning for *Kansei* engineering. However, neither the particular evaluation technique nor the analysis technique has been so researched. The "graphical modeling" is applied to analyze the time series judgments in the *Kansei* and sensory evaluation. This is a technique to which the pass analysis is done with the repeated calculation. Three kinds of same maker's chewing gums are used as stimuli. They are muscat taste, Japanese apricot taste, and bubble gum. The five items in each stimulus that are evaluated with a 5-point rating scale are used, for example, sweetness, flavor, palatability, and so on. The causal relations of all 15 kinds are analyzed with the results of ten subjects. In the time series of evaluation values, the time order always corresponds to the causal relation. Only the pass coefficient from the evaluation of the previous state to the following evaluation is calculated. A comparatively strong causal relation is admitted to the evaluation item that relates to the characteristic of each stimulus. It is suggested that the *Kansei* and sensory evaluation of an important quality of the commodities is not to become independent reciprocally in the time series. This means that the previous evaluation exerts the influence until the future.

Keywords: *Sensory evaluation, Causal analysis, Time series*

1. INTRODUCTION

In *Kansei* engineering, it is important to know how the customer is using the commodities. It is also important to know how he is evaluating those. And, it is necessary to develop the commodities from the evaluation result. The commodities are continuously used in daily life. The evaluations are obtained in the time series. However, neither the particular evaluation technique nor the analysis technique has been so researched.

The perception that changes in a time series has been represented by one evaluation value in the experiment of *Kansei* and sensory evaluation. For instance, one evaluation of a lifted weight is requested for one trial. However, the perception of weight changes with the passage of lifting time. It is a problem what evaluation value of such perception that changes in a time series can be obtained [1].

Various methods have been contrived. In the method of successive magnitude estimation, the criterion is set beforehand, and an evaluation value is obtained for the perception every fixed time. This method has been used in the experiment of sound's adaptation [2]. In this method, the sound to evaluate and that of the criterion are presented at the same time. The subject binaurally listens to these two sounds. Moreover, the entire stimulus situation changes through the presentation of a criterion. The method of successive magnitude estimation cannot be applied in all situations.

Moreover, the perception that changes in a time series is usually evaluated by the cross-modality matching. This method is one kind of magnitude estimation method. For instance, the vibration feeling in driving a car is evaluated with the volume of a sound. An one-to-one correspondence between two different modalities is necessary for this method. The matching is requested at a certain regular interval in a time series or after any perceptual change.

In the method of category judgment, for instance, there is a study of chest pain [3]. The prescription of rehabilitation for the patient with an angina pectoris is arranged by the evaluation of pain. In this category judgment, the pain is evaluated under two standards. One standard, which is the maximum category level, is a pain when becoming an angina pectoris. The other one, which is the moderate level, is a pain when becoming painful and stopping to walk in daily life. This is called the RPE scale (scale for rating of perceived exertion). However, there are many problems also in this scale. The most important point is not to obtain the guarantee of stability about these two criteria set beforehand.

There are many cases where the previous result influences the present judgment. And, it is a problem whether the previous result is one or two trials ahead. Moreover, it is not clear whether the previous result only influences the present judgment or many previous results. In addition, it is also not clear whether the result is the

evaluation value or the memory.

The time series judgments in *Kansei* and sensory evaluation have not been so researched. The interrelation between the judgments is modeled, and the model can be evaluated with the method of pass analysis or the two stage least square method. However, it is difficult to evaluate if this model is appropriate. Then, the technique, by which this interrelation can be evaluated from the result of a numerical operation without doing a prior modeling, is necessary. This technique is "graphical modeling" [4]. In this technique, the pass analysis is done with the repeated calculation. The cutting point of the pass coefficient is set beforehand.

The pass, which has a lower coefficient than this point, is excluded from the calculation beforehand. Only the remainder's passes are analyzed. In this research, "graphical modeling" is applied to analyze the time series judgments in the *Kansei* and sensory evaluation of chewing gum.

2. EXPERIMENT

The subjects composed three groups (A,B,C) of every ten assessors. They were 30 university students. Three kinds of same maker's chewing gums were used as stimuli. They were muscat taste (A), Japanese apricot taste (B), and bubble gum (C). The subject bit a piece of a chewing gum. The task was a swallowing of saliva biting five times. After saliva was swallowed, the evaluations of 5-point rating scales for the following five items were demanded. This trial repeated 20 times.

These scales were unipolar ones from "It is not at all" to "It is very". They were scored from 1 to 5. The evaluation items of stimulus A were sweetness, taste, flavor, elasticity, and palatability. Those of B were sweetness, sourness, saltiness, flavor, and softness. Those of C were sweetness, elasticity, mouthfeel, adhesiveness, and palatability.

3. RESULTS AND DISCUSSION

In this experiment, the evaluation will not begin to increase suddenly after keeping biting the chewing gum. The evaluation in the time series will keep decreasing. That will not show neither a periodic change nor a random change.

The 20 averages of ten subjects in each evaluation item were calculated (Table 1,2,3). Figure 1 is a typical passage of these evaluations in the time series. The averages of 4th, 8th, 12th, 16th, and 20th times were used from the tendency of time series in the following analyses. The causal relations of all 15 kinds were analyzed with the results of ten subjects.

In the time series of evaluation values, the time order always corresponds to the causal relation. It is not logically contradicted that the evaluation of the previous state influences the present evaluation. It is not able to assume that the present evaluation exerts the influence on the evaluation of the previous state. Therefore, only the pass coefficient from the evaluation of the previous state to the following evaluation was calculated. The cutting point of the pass coefficient was assumed to be 0.2. The pass coefficient smaller than 0.66 is equal to 0.0 ($df=7, p<.05$).

The pass chart of A is Figure 2, that of B is Figure 3, and that of C is Figure 4. In A and B, the pass coefficient between the present evaluation value and that of the previous state indicated a comparatively large value. In A, they were obtained for the evaluation items of sweetness, flavor, and elasticity. In B, they were obtained for the evaluation items of sweetness, saltiness, and softness. On the other hand, most of the pass coefficients in C were very low. The comparatively high pass coefficients were obtained for the evaluation items of elasticity and adhesiveness.

Average of judgments

Figure 1: Typical passage of evaluations.

Table 1 : Results of A

Time	Sweetness	Taste	Flavor	Elasticity	Palatability
	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD
1	3.30 0.82	3.20 1.03	3.60 0.97	2.90 1.60	3.30 0.95
2	4.40 0.70	4.60 0.52	3.90 0.74	3.70 1.06	4.00 0.82
3	4.40 0.70	4.50 0.53	4.00 0.82	3.80 0.79	4.40 0.52
4	4.60 0.52	4.60 0.52	4.10 0.88	3.90 0.88	4.60 0.52
5	4.80 0.42	4.70 0.48	4.00 0.82	4.00 0.94	4.40 0.52
6	4.50 0.71	4.50 0.53	3.90 0.88	3.60 1.17	4.40 0.52
7	4.30 0.67	4.40 0.52	3.50 0.97	3.70 1.42	4.40 0.52
8	4.20 0.63	4.10 0.57	3.20 0.79	3.40 1.58	4.20 0.63
9	3.80 0.79	4.00 0.67	3.00 0.82	3.20 1.48	4.10 0.57
10	3.90 0.74	3.70 0.82	3.00 0.82	3.60 1.17	4.00 0.67
11	3.60 0.97	3.80 0.79	2.70 1.06	3.50 1.27	3.70 0.95
12	3.40 1.07	3.20 1.03	2.50 0.85	3.30 1.34	3.70 0.95
13	3.00 1.05	2.70 0.82	2.50 0.85	3.50 1.43	3.70 1.06
14	3.00 1.05	2.50 0.97	2.30 0.82	2.90 1.45	3.40 0.97
15	2.80 1.23	2.30 0.82	2.00 0.94	3.10 1.52	3.20 0.92
16	2.60 0.97	2.20 0.63	1.80 0.79	2.90 1.60	3.10 0.99
17	2.20 0.42	2.00 0.67	1.50 0.85	2.60 1.43	3.00 0.82
18	2.20 0.79	2.00 0.67	1.60 0.84	2.90 1.52	2.70 1.06
19	2.00 0.94	1.60 0.84	1.50 0.85	2.90 1.37	2.40 0.97
20	1.90 0.99	1.50 0.85	1.40 0.84	2.90 1.29	2.30 1.06

Table 2 : Results of B

Time	Sweetness	Sourness	Saltiness	Flavor	Softness
	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD
1	2.80 1.14	3.00 1.15	2.10 0.88	3.00 1.05	4.30 0.95
2	4.10 0.57	3.60 0.97	2.50 1.08	3.30 1.16	3.80 1.03
3	4.60 0.52	3.80 0.92	2.50 1.27	3.60 1.17	2.90 0.74
4	4.30 0.82	3.90 0.99	2.40 1.17	3.70 1.16	2.50 0.85
5	4.30 1.25	3.90 1.20	2.30 1.16	3.70 1.06	1.90 0.74
6	4.30 0.95	3.90 1.10	2.40 1.17	3.70 0.95	1.70 0.48
7	4.30 1.06	3.70 1.25	2.30 1.16	3.60 1.07	1.70 0.48
8	4.20 0.92	3.50 1.27	2.20 1.23	3.40 1.17	1.70 0.67
9	3.60 1.17	3.60 1.07	2.10 1.10	3.20 1.23	1.60 0.70
10	3.50 1.18	3.30 1.34	2.00 1.15	3.00 1.25	1.60 0.70
11	3.30 1.25	3.30 1.34	1.90 1.10	2.80 1.40	1.80 0.79
12	2.80 1.14	2.80 1.23	1.80 0.92	2.60 0.84	1.90 0.88
13	2.80 1.23	2.40 1.26	1.60 0.97	2.30 0.95	2.00 1.05
14	2.50 1.18	2.40 0.97	1.60 0.84	2.50 1.08	2.10 1.20
15	2.30 1.34	2.20 1.03	1.50 0.85	2.30 0.82	2.10 1.20
16	2.20 1.14	2.10 1.10	1.50 0.85	2.00 0.82	2.10 1.37
17	1.60 0.70	1.80 0.63	1.50 0.85	1.70 0.48	2.30 1.49
18	1.50 0.53	1.60 0.52	1.50 0.85	1.60 0.52	2.20 1.40
19	1.50 0.53	1.30 0.48	1.40 0.84	1.70 0.67	2.20 1.40
20	1.30 0.48	1.40 0.52	1.40 0.84	1.70 0.67	2.20 1.40

Table 3 : Results of C

Time	Sweetness	Elasticity	Mouthfeel	Adhesiveness	Palatability
	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD
1	3.30 1.25	3.30 1.49	3.30 1.25	2.90 1.37	3.60 1.07
2	4.00 0.82	3.30 1.06	3.10 0.99	2.80 1.14	3.90 0.99
3	4.30 0.82	3.50 0.85	2.80 0.79	3.20 0.92	4.20 1.03
4	4.50 0.53	3.70 1.06	2.90 0.74	3.50 1.08	4.50 0.71
5	4.60 0.52	3.40 1.07	3.20 0.63	3.30 0.95	4.60 0.70
6	4.70 0.48	3.30 1.42	2.70 0.82	3.20 1.03	4.50 0.85
7	4.50 0.71	2.90 1.45	2.60 0.84	3.10 0.88	4.40 0.84
8	4.20 0.79	3.00 1.33	2.40 0.52	3.40 0.84	3.90 0.74
9	3.70 0.48	2.90 1.10	2.10 0.57	3.20 0.92	3.80 0.63
10	3.40 0.70	3.10 1.10	2.00 0.47	3.20 0.63	3.50 0.85
11	3.10 0.74	2.80 1.32	1.80 0.79	3.00 1.05	3.10 0.57
12	2.90 0.57	2.80 1.32	1.70 0.67	3.00 1.25	2.90 0.57
13	2.60 0.52	2.80 1.32	1.60 0.70	2.90 1.20	2.60 0.52
14	2.30 0.48	2.90 1.29	1.60 0.84	3.00 1.25	2.40 0.52
15	2.30 0.48	2.50 1.18	1.40 0.70	3.10 1.29	2.20 0.63
16	2.00 0.47	2.70 1.34	1.40 0.70	3.00 1.41	2.10 0.57
17	2.00 0.00	2.50 1.18	1.30 0.67	3.00 1.41	2.00 0.47
18	1.60 0.52	2.80 1.48	1.30 0.67	3.10 1.52	1.80 0.63
19	1.40 0.52	2.90 1.52	1.30 0.67	3.20 1.62	1.40 0.52
20	1.40 0.52	2.60 1.26	1.30 0.67	3.30 1.77	1.30 0.48

Figure 3 : Pass chart of B (a: sweetness, b: sourness, c: saltiness, d: flavor, e: softness).

Thus, a comparatively strong causal relation was admitted to the evaluation item that related to the characteristic of each stimulus. It is suggested that the *Kansei* and sensory evaluation of the physical attribute, which is the important quality of the commodities, is not to become independent reciprocally in the time series. This means that the previous evaluation exerts the influence until the future. And, the evaluations of the qualities that do not relate directly to the characteristics of the commodities are reciprocally independent.

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Figure 4 : Pass chart of C (a: sweetness, b: elasticity, c: mouthfeel, d: adhesiveness, e: palatability).

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