Comparison of The Method of Temporal Dominance of Sensations and After-tasting Sensory Evaluation

Yuki Ehara, Shogo Okamoto, Takumu Okada and Yoji Yamada
Department of Mechanical Systems Engineering, Nagoya University, Japan

Abstract—**The temporal dominance of sensations (TDS) method can record changes in multiple time-variant sensations while eating food products. Since this is a relatively new method, its characteristics remain unclear. This study aims to reveal the characteristics of the data obtained by the TDS method compared to conventional sensory evaluation methods. For this purpose, in the experiment, participants evaluated ten types of pickled plums using both methods. We analyzed the data using principal component analysis methods and multivariate ANOVA and found that both methods could equally discriminate brands of pickled plums. Nonetheless, the brands discriminated by the two methods did not largely overlap, suggesting that the two methods are qualitatively distinct.**

I. INTRODUCTION

Thus far, many sensory evaluation methods for food products have been developed. Most of these methods require assessors to rate food products after eating them in a non-timely manner. In contrast, some methods were developed to record the time-series of subjective data while eating food products. The time-intensity [1] and temporal dominance of sensations (TDS) methods [2] are representative ways to capture the time evolution of human sensory experiences. Especially the TDS method has drawn attention as an effective method for recording multiple subjective sensory attributes simultaneously. In this method, the changes in dominantly experienced sensations when eating foods are recorded in real time. However, since the TDS method is a comparatively new method proposed in 2009, the characteristics of the recorded data remain unclear, and common analysis methods have yet to be established whereas qualitative discussion and canonical variate analysis are frequently used [3]. This paper aims to reveal the characteristics of the data obtained from TDS methods by comparing with those obtained from a conventional sensory evaluation method. Assessors rated 10 types of Umeboshi, which are pickled salty plums, using both types of sensory evaluation methods. We then analyzed the obtained data using principal component analysis (PCA) and multivariate analysis of variance (MANOVA) and investigated the differences between two methods from the viewpoint of product classification.

II. TWO TYPES OF SENSORY EVALUATION METHODS

A. TDS Method

In the TDS method, the timings for pressing buttons with adjective labels displayed on a computer screen are recorded. These adjectives describe tastes of food and eating experiences. An assessor pushes the start button when putting samples into his/her mouth and continues to select a button with the adjective that fairly represents his/her dominant feeling at the moment. Dominant sensation is defined as the sensation catching the attention at a given time [2]. The assessor then pushes the "stop" button when he/she finishes eating and perceptions in the mouth vanish. The assessor is allowed to push the same adjective button as many times as desired, and is not required to select all adjective buttons at least once.

B. Conventional sensory evaluation after tasting

As a typical example of conventional sensory evaluation methods, we employed an adjective rating task in which an assessor scores products based on the adjectives as criteria using a seven -point Likert scale. Each adjective is rated from 1 (extremely disagree) to 7 (extremely agree) after eating food samples.

III. EXPERIMENT: SENSORY EVALUATION OF FOODS

A. Participants and Products

The participants were 20 university students ranging in age from 21 to 26 years old. They voluntarily participated in the experiment with written agreement. Ten types of Umeboshi brands labeled P1 to P10 were used. In the experiment, each bite-sized Umeboshi sample on a spoon was presented in front of the participants.

B. Selection of Attribute Words

We selected 16 words as criteria of foods, suitably representing the taste, flavor, texture, and affective characteristics of Umeboshi, out of 163 words expressing tastes or affections. Eight were related to tastes, flavor, and texture-i.e., sour (salty), smooth (melty), sweet, refreshing, juicy, fruity, watery, and umami- and the other eight were were affective words-i.e., like, delicious, classy (elegant), dislike, flavorful, rich (deep), sharp, and arousing. These words were used in both sensory evaluation methods.

C. Task

The aforementioned two types of sensory appraisal tasks were conducted for each participant. In the TDS method, he/she closed his/her eyes and pinched his/her nose before putting samples into his/her mouth. He/she then carried out the task of pushing buttons. In the task of after-tasting sensory appraisal, each participant ate a piece of pickle and then rated
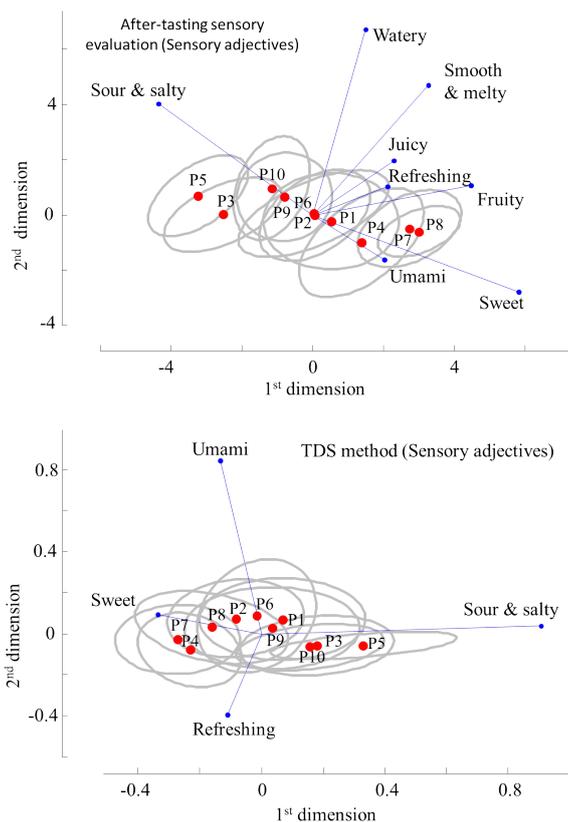
Fig. 1. PCA scores obtained by the conventional sensory evaluation after tasting (top) and the TDS method (bottom). P1–P10 are the centroids of 10 types of food products. Blue lines are the vectors of major attributes on the 1st-2nd plane

all 16 words. He/she rinsed his/her mouth before each trial. Experiments were conducted over two days for each participant. On the first day, the TDS and after-tasting sensory appraisal methods were tested. On the other day, they repeated the TDS task. The order to present food samples was randomized.

D. Analysis and Results

For the normalization of the TDS data, the period during which each adjective button was selected was divided by the time from the start to the end of the tasting. For each participant, these periods were averaged among two trials for the same product. We then applied PCA on these periods. For the after-tasting sensory evaluation, each adjective score was converted so that the average value for each participant became zero, and then, PCA was applied. For both types of sensory appraisal methods, perceptual attributes including tastes, flavors, and textures and affective ones were separately analyzed.

Fig. 1 shows the two-dimensional principal component scores of each food product for the TDS method and after-tasting sensory evaluation as a result of PCA for tasting adjectives. The red points are the centroids of individual

Umeboshi brands among the participants. The ellipses represent their standard deviations. The contribution ratios of two principal components were 0.40 and 0.17 for after-tasting sensory evaluation and 0.39 and 0.15 for the TDS method. The two types of sensory evaluation methods showed differences in their dimensional structures of the first and second principal components. "Sweet," "umami," "sour and salty," and "refreshing" were remarkable for the TDS method whereas "sweet," "sour and salty," "watery," and "smooth" were remarkable for the after-tasting sensory evaluation method.

We compared the two-dimensional coordinates of 2 out of 10 arbitrary types of Umeboshi brands by MANOVA. The number of brand pairs that could be statistically distinguished (p ¡ 0.05) by the after-tasting sensory evaluation was 30 out of 45. In contrast, 28 pairs could be distinguished by the TDS method. Nine pairs could be distinguished by either of the two methods.

Similarly, the results of affective attributes were analyzed by PCA and MANOVA. The contribution ratios of PCA's first and second principal components for the after-tasting method were 0.48 and 0.30, respectively. Those for the TDS method were 0.27 and 0.16, respectively. The number of distinguishable brand pairs were 24 and 22, respectively, for the after-tasting and TDS methods. Twenty pairs were discriminated by either method, and the two methods did not largely agree with each other.

IV. CONCLUSION

The characteristics of the data obtained by the TDS method were investigated through the classification of 10 types of Umeboshi brands. The perceptual and affective attributes were evaluated using the TDS method and conventional after-tasting sensory evaluation method. The data obtained by each method were analyzed by PCA, which indicated that the dimensional structures obtained by the two methods were disti

nct. Furthermore, the numbers of distinguishable pairs of Umeboshi products were investigated by MANOVA for each method. More than half of the product pairs could be distinguished in both types of sensory evaluation methods. However, distinguished pairs did not completely match in both methods. These results suggest that the TDS method is substantially different from conventional after-tasting sensory appraisals. In terms of product discrimination, we cannot conclude that one of them is superior to the other.

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