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Concept of Food Sensory Engineering and Its Application

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Abstract

A concept of food sensory evaluation on the basis of multi-layer consciousness theory of Vasubandhu with three-way branching perception logic was developed. To understand the relationship between sensory reaction and consciousness, a model of consciousness structure and flow chart of mental process was constructed with incorporation of different time units and transformation processes. Based on the analogies among five sensory system of human and computer logic, time and attention weight were included in the new sensory evaluation concept. The concept was applied to develop a new sensory evaluation method using bar code and frequency concept. The sensory questionnaire consisted of objective and subjective consciousness parameters. Using the responses of the subjects, bar codes with different intervals and thickness were generated after the calibration of the bar width by multiplying attention weight factors to the relevant consciousness layer, and it was transformed into relevant sensory curves to produce an individual sensory curve. The method was tested 12 subjects for cooked rice. Sensory barcode and curve patterns of cooked rice showed remarkable differences in their patterns among the individuals.

Keywords: Vasubandhu, consciousness, sensory evaluation, bar code, curve pattern

INTRODUCTION

Sensory science plays a key role in the food industry because consumers acceptance is judged through sensory evaluation of food product. The sensory evaluation has been conducted by food panelists with respect to sensing the taste, order, and kinesthesis of fresh and processed foods. Because the sensory judgement is a subjective, the variability of the sensory data among panelists is an inherent problem. Many methodologies and models have been developed to minimize the individual variance with little progress (Ennis 1998). Two different approaches have been employed to minimize the variance, one in psychological way and the other in statistical treatment (Amerine *et al* 1965; Lawless and Heymann 1998).

Since Fechner (1866) pointed out the importance of mind in sensory science, several researchers including Anderson (1974) have studied the relationship between external stimuli and human perception. Thurstone (1927) proposed a psychometric function involving psychological magnitude or perception, known as psychological noise. His proposal has played a major role in the theoretical development of sensory science (Ennis 1998).

Although studies have performed on the scaling perceptional intensity to establish the relationship between sensory response and external stimuli, the perception mechanism is not yet fully understood (Altmann 1999; Wells 1998; Fernandez-Duque and Johmson 1999; Eliasmith and Thargard 2001; Engel and Singer 2001; Harth 1997; Hoffmann 1999; Duerlinger 1997).

Considering the sensory evaluation of food is an instant decision-making process, where various environmental conditions coexist, it is closely related to individual experiences on food. Schutz (1998), in his review of sensory discipline, described that the sensory evaluation is based on the physiological underpinning. Outstanding researches on neurobiology and information technology

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in computer sciences provide for us to understand the cognition process through sensory receptors. Particularly, perception processes in auditory and visual systems have been studied through experimental evidences of transmission of external stimuli related to brain activity (Glassman 2000; Karakas 1997).

The sensory evaluation has been conducted on the basis of subjective judgement, and expressed through materialized objective data such as linguistic description, score, and spider web methods, in which involved no dynamic nature. Considering sensory test is an on-line process based on the information acquired from neural receptors associated with eating behavior of human, sensory data must include time factor in its expression as the cases of audio and visual are. For a single chemical component, sensory intensity has been expressed as a function of time (Garrido *et al.*, 2001). However, sensory evaluation of food, has not yet been presented as a function of time (Holway and Hurvich 1957; Lawless *et al.*, 1992).

The objective of this paper is thus to develop a new concept of food sensory evaluation on the basis of multilayered consciousness theory and to construct new type of sensory bar code and curve of food.

THEORY

Analogy of sensory signal pattern to a bar code

Human behavior is always accompanied by the five-sensory receptors; taste-, odorant-, photo-, touch-, and stretch-receptors. The five-sensory neurons acquire stimuli from the external world and convert them into electrical signals with amplitudes of 110mV in neuron cells, and transmit them to the brain at a velocity of 100 m/ms (Lodish *et al.*, 2000).

A mental cognitive activity against the stimuli involves more than a simple information transfer processing, but rather is based on the event counting system as reported in the visual sensory system (Naatanen *et al.*, 1982). A pattern of similarities exists between the neural signal and the commercially used bar codes (Fig. 1). First is the shape similarity between the impulse and the bar code characterized by high/low binary logic with

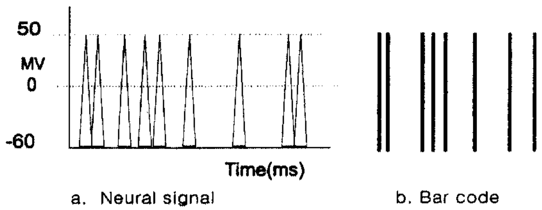


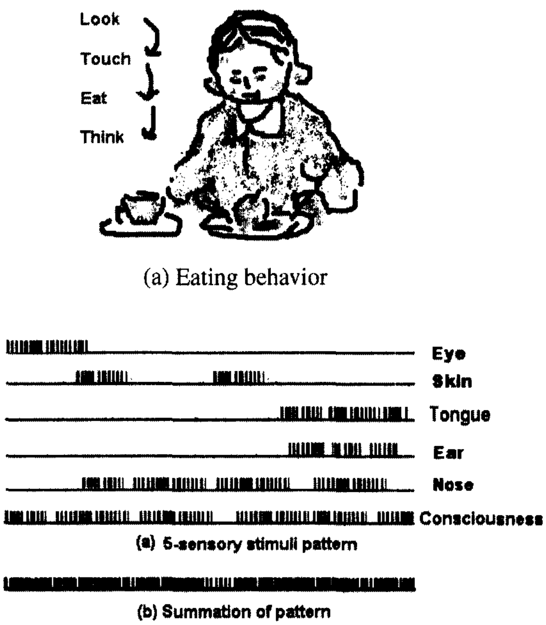
Fig. 1. Similarity between human neural signal pattern and barcode.

identical magnitude. Another is the sequential array of signals (events) with intervals of time or space (Harth 1997). In the visual perception, the alternating activities in dorsal flexion neuron (DFN) and ventral flexion neuron (VFN) reported by Willows (1967) are similar to the bar code pattern of Fig. 1(a) (Harth 1997) or pulse train (Barlow 1972; Freeman 1997). Supposing that the five sensory bases work under the same controller, signals acquired through a taste-receptor must be identical to those of other receptors such as sound- and image-receptors, which can be expressed both in terms of intensity and time.

Food is cooked with ingredients (intensity or chemical concentration) together with preparation time, for instance, mixing A and B ingredients for 2 minutes, heating for 5 minutes at 80°C, cooling for 10 minutes and so on. Therefore, the intake of food is similar to a featuring the cooked work in a concert hall (mouth). Likewise an expert musician can regenerate songs using a score (sound intensity) and bit or time, a cooker can reproduce the cooked food by eating, along with recalling the ingredients and sequence of operation (time). Consequently, food product can be considered as an information (memory) package with various memories composed of intensity and time parameters.

Sensory responses on eating behavior

Suppose cooked rice is being served on the table. The white colored image of rice will stimulate the visual receptor. Several signals from other receptors will be produced together with their characteristic patterns of stimuli as illustrated in Fig. 2. Considering increasing evidences of the pattern cognition (Naatanen *et al.*, 1982; Nelson and Illingworth 1991, Harth 1997), food sensory bears a strong possibility to work in a similar



(a) Eating behavior

(b) Schematic sensory signal pattern

Fig. 2. Sensory stimuli with bar code patterns during food consumption.

way. Sensory evaluation of food may be the summation of the bar codes and overlapped by other code-patterns previously registered in consciousness [Fig. 2(b)].

Human neural network and its control logic

During the consumption of food, electrical signals are continuously generated and transmitted from neuron to neuron by sequential and parallel ways of complexity, ultimately reaching the controller, myself, for further action (Harth 1997). The controller then produces appropriate responsive signals to activate the motor neurons (Freeman 1997). The artificial network, as a simulated human neural network, consists of artificial neural layers [marked ● in Fig. (3)] and interconnection. The output of the neural network is determined by the input based on the weight value, w_i, which is the synaptic strength of the input, i. The activation function, f(•), in the network determines the threshold value for input data to generate output with high/low binary logic (Mittal 1997).

In spite of the effective role of hidden layers in the artificial neural network (Nelson and Illingworth 1991; Zurada 1992), the role of human consciousness layers, however, has not yet been reported in food sensory work.

Vasubandhus's theory and sensory perception

In AD 400, Vasubandhu described that the structure of human consciousness consisted of eight layers (Anacker 1984, Duerlinger 1997) with three consciousness layers existing aside from the five known sensual bases (Fig. 4).

Vasubandhu's theory is also a model comparable to that of hidden layer in neural network [Fig. 3(b)], and can be an important approach toward disclosing the role and function of the hidden layer, and probably can be related to the latent drivers of hedonic behavior, the hunger for food. The possibility of the existence of multi-consciousness layers was suggested through several models with neural information flow steps and memory

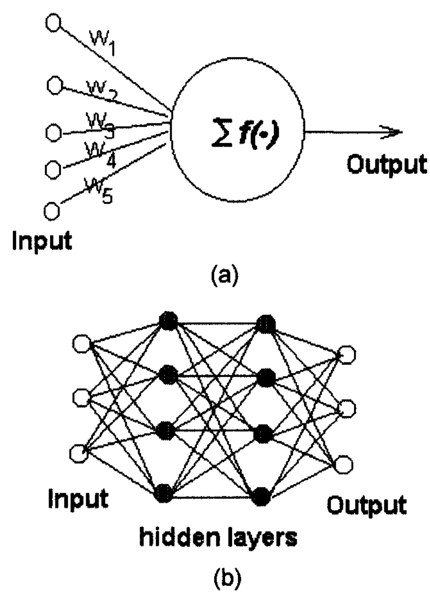


Fig. 3. Artificial neuron and hidden layer of neural network system.

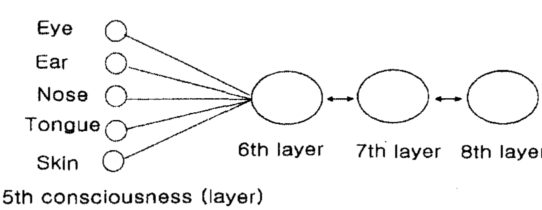


Fig. 4. Vasubandhus multi-layer consciousness structure.

layers in where a reflective and concomitant neural activity in cyclic self-referent were found (Harth 1997; Eliasmith and Thargard. 2001). The human brain functions with two memory structures composing short-term and long-term memories. Furthermore, several models indicate that cognition system involve multiple steps or structures, particularly in both audio and visual systems (Pribram and Meade 1999; Harth 1997)

Human consciousness model

From the sensory modeling point of view, therefore, multi-dimensional studies on the sensory data require a new model consisting of multi-layered decision structure. Construction of a universal computing machine theory by Turing (1936; Wells 1998), has allowed the way for understanding human mental behavior in terms of Information-Processing Device metaphor. Various attempts have been made to construct human consciousness model with sensory modalities and memory layers (Broadbent 1958; Fernandez-Duque and Johmson. 1999) with the experimental evidences and psychophysiological metaphors (Fernandez-Duque and Johmson, 1999)

A multi-layer consciousness model is therefore postulated on the basis of Vasubandhu's theory (Anacker 1984, Duerlinger 1997) combining with information processing metaphor (Fig. 5) (Chun and Jun 2000, 2001; Karakas 1997).

Schematic structure of the model illustrates how the consciousness layers are interconnected with five-sensory receptors, through which the external world is sensed and communicated among the consciousness layers (Fig. 5). Five-sensory receptors are connected to the sixth consciousness, and each receptor has a respective gate that operates using attention power. The sixth layer produces the 2nd attention power when the receptors are interfaced to external objects. The sixth consciousness, therefore, acts as the gateway or attention rate controller, and as a data logger of incoming signals.

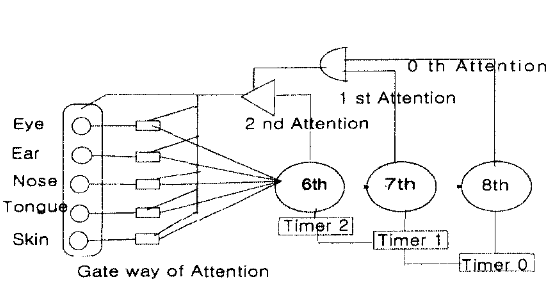


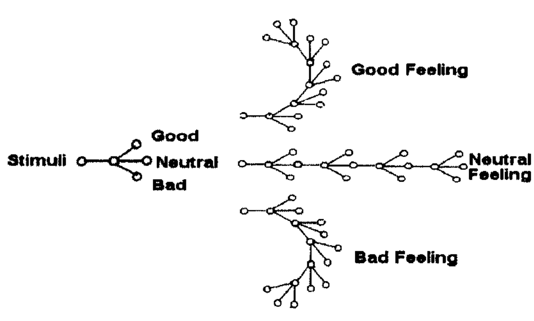
Fig. 5. Human consciousness model with multi-layer structure.

The role of attention involves task-oriented activity of the consciousness to search objects using the five sensory systems as described by Karakas (1997) and Altmann (1999). Author assumed multi-attention-drivers being functioning under the control of the most deepest consciousness layer, the eighth consciousness. The 0th and 1st attentions were assumed to make access to the internal memories or internal environmental stimuli with corresponding time units. Without the internal attention systems, dream, mind food, and recall of old memory have no ground. In analogues description, mental has an ability to sustain activity in the absence of external input (Harth, 1997) suggesting the presence of an inter-layer data communication.

Three-way branching perception logic and the consciousness flowchart

Persons with different past experience on food show different feelings on the intake of the food. This suggests that mind food in their memories influences individual sensory response of the real food. Three-way branching perception (3-WBP) during the human cognition process, as described by Vasubandhu, is illustrated in Fig. 6 which shows how the information on a food is branched and biased as the transformation steps proceeds to generate sensual feeling [Fig. 6(a) and (b)].

The 3-WBP is similar to Alternative Forced Choice



(a) Three-way branching perception
(b) Multi steps of perception branching

Fig. 6. Schematic illustration of 3-way branching perception law.

(Thurstone 1927; Ennis 1998), but different in its consecutive process of branching. As a consequence the sensation on food is biased toward where the dominant memories on food are present.

Operation mechanism of human consciousness and mind food

Thus, incorporating 3-WBP law into the Vasubandhus multi-layer consciousness model with neural information processing theory (Fig. 4 and 5), a flow chart of the model is constructed as shown in Fig. 7 (Karakas 1997; Harth 1997). The first mental activity is initiated by eighth consciousness, and then flows through consecutive stages, which have 3-way branching mechanism, in a manner similar to the water flow branching out to rejoining as one stream. The relationship between a thinking and the next one is comparable to that of "the grasper and the grasped" or "subjectivity-objectivity" (Anacker 1984). The consciousness stream forms an endless cycle with two countercurrent information flows as do the blood streams in human body. About the mental flowchart reported by Merleau-Pontry (1942) described that mind is the structure of behavior action-perception cycle (Freemann 1995).

Several supporting and generalized reasoning were found in visual sensory system showing the top-down information flow loop (Harth 1997).

In outward stream of the proposed flowchart for the multi-consciouness system, three active transformations occur together with three passive transformations for perception and cognition process as shown in Fig. 5. The first appearance of subjectivity-objectivity duality, the bud of the selfness occurs from the eighth consciousness layer and become acting representative of oneself in the 7^{th} layer. Control signal (word) from seventh layer is transmitted to the sixth consciousness for the activation of the five-sensory receptors in a similar manner to the top-down control process. Upon the receptors contacting with the external phenomena, attention weights for each receptor are determined by the 6^{th} consciousness layer under the influences of 7^{th} and 8^{th} consciousness to control the input gate for external information. Through the first passive transformation process in the sixth layer, the acquired data are classified into several groups depending on their properties, such as color, chemical ingredient, and shape of the object sensed.

The classified data are then coded with relevant tags and registered with names or codes in the seventh layer. As the information accumulated, membership and category concepts are developed. The classified informational identities expand to a wide network, through which various new identities are created to build an internal world in ones consciousness (Fig. 7).

At this stage, information on food existing in the internal world can be called as "mind or virtual food". The mind food, therefore, can not be sensed or touched physically, but is preserved as a memory in the consciousness, and retrieved upon facing real food. It acts as a latent driver of liking and preference of food. And it is a sensible objectivity of the deeper layer of consciousness. Accordingly, food feeling is closely associated with both the mind food of the internal world and the real one in external world. For an efficient management of memory, old memories must be replaced by new incoming data. This indicates that mind food is not fixed but is time-dependent with spatio-temperal image pattern.

Mathematical description of sensory process

Sensory evaluation (SE) must be defined with state variables of the two above mentioned worlds and time terms as described in Equation 1.

$$SE = f(x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, t_1, t_2) \qquad (1)$$

where x_1, x_2, x_3, x_4 and x_5 denote data acquired from five-sensory receptors, x_6, x_7 and x_8 are data existing in 6^{th}-, 7^{th}- and 8^{th}-consciousness, and t_1 and t_2 denote the time units in external and internal worlds, respectively.

The solution of Equation (1) is hardly obtainable due to the number of variables, and unknown nature of the consciousness variables; x_6, x_7, and x_8, which are dependent on the subjectivity-objectivity duality. Studies on the multi-dimensional analysis of sensory evaluation are indicative that multi-variable property of the sensory evaluation may be associated (Sherpad 1962a, 1962b). Neural scientists offer observation of the space-time patterns from brain imaging of human during intentional behavior. And physicists also offer the dynamical system theory with space-time patterns of neural activity (Karakas 1997).

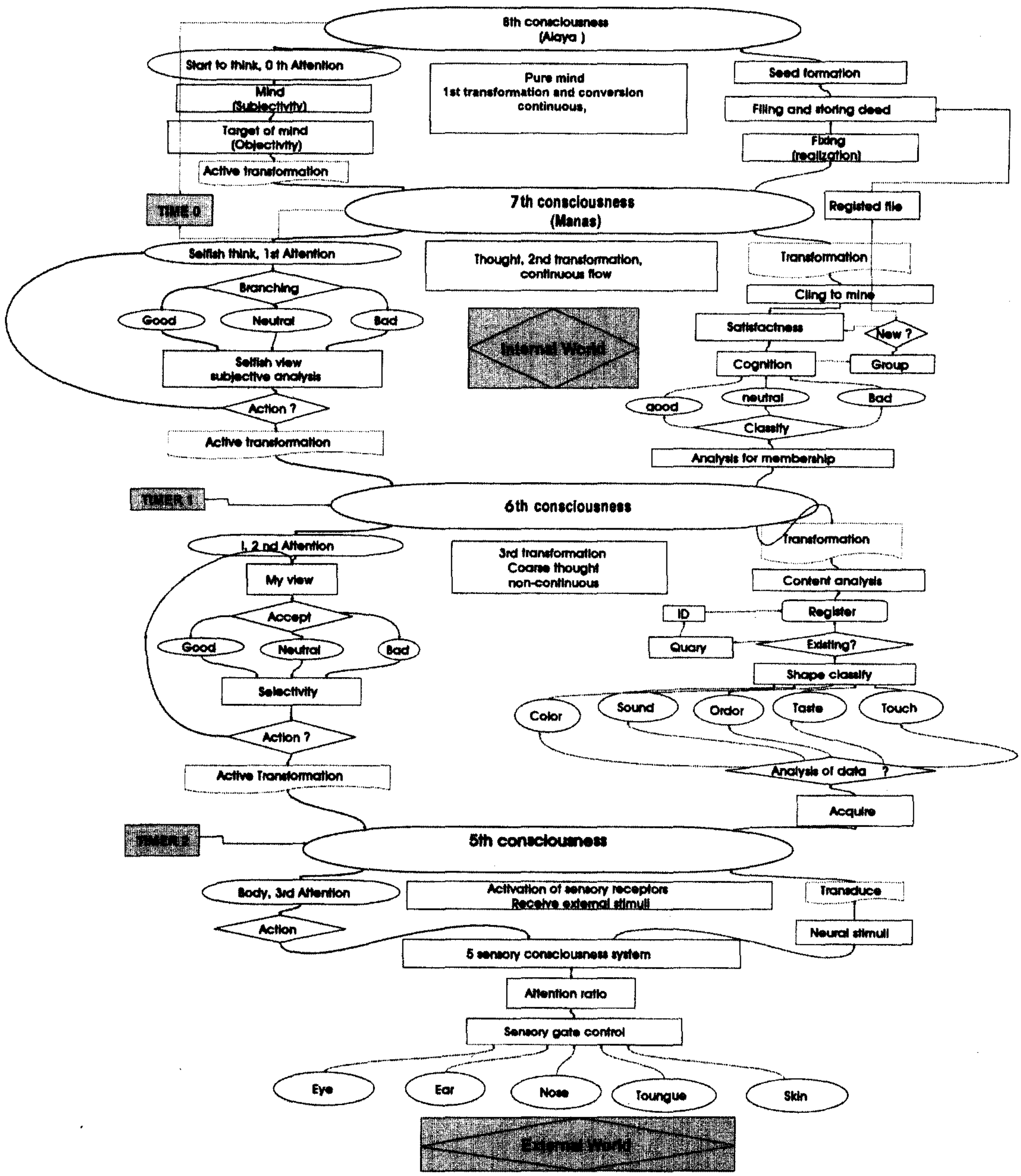


Fig. 7. The flow chart of human consciousness system.

Assuming the pulse of the stimuli as a square bar, it can be converted into a sinusoidal curve by applying Fourier transformation (Kreyszic, 1998) or computer graphical method. A function f(x) is said to be periodic if it is defined for all real x, and if there is some positive number T, time term, such that

$$f(x + T) = f(x) \quad (2)$$

The graph of Equation (2) is a periodic repetition at any interval length, T. For any integer n, the equation is:

$$f(x + nT) = f(x) \quad (3)$$

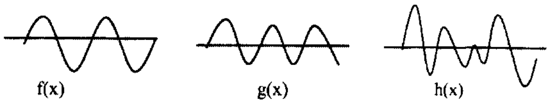


Fig. 8. Frequency curve converted from bar code data.

Furthermore, if f(x) and g(x) have period T, then the function h(x) is said to be meaningful.

$$h(x) = af(x) + bg(x) \quad (4)$$

where a and b are constants.

Equation (4) represent frequency curve composed of time and intensity at x-axis and y-axis, respectively (Fig. 8). This indicates that a sensory bar code of food, can be expressed as a form of frequency curve, which in turn can be used as a new method for the sensory evaluation of food. An analogue of the summation of periodic signal has been found in audio or music system (Glassman, 2000). From the analogues between neural signal pattern and information processing of computer system, a new concept of sensory evaluation for food is proposed with a case study with cooked rice.

MATERIALS AND METHODS

Rice cooking

Rice (Japonica) was cooked with an electrical rice cooker (SJ-A3000, Samsung, Korea) at water addition ratios 1.5. After cooking, the cooked rice was cured for 10 min prior to the sensory evaluation.

Panel test

Panelists were selected based on interest, time available from the graduate student majoring food science, and 8 of them were male and 4 were male (n =12). They were explained about terminology of the new sensory evaluation questionnaire (Table 1). Panelist evaluated sample in an uncontrolled laboratory room.

Preparation of sensory bar code and sensory curve

Based on the responses of the panelists, a rule of stimuli-arrangement for the inquiry groups and the sensory attribution weights were assumed as shown in Table 2.

Table 1. Attribution weight of the inquiry groups

Inquiry group	Number of response (stimuli)	Sensory attribution weight
1. Material	5	1
2. Processing	10	1
3. Product	6	8
4. Eating environment	8	4
5. 5th consciousness	8	8
6. 6th consciousness	4	2
7. 7th consciousness	13	4
8. 8th consciousness	5	2

For the construction of bar code pattern, six of eight inquiry groups (3~8 groups in Table 1) with their registers having different register block of 5 bits. One register for Group-5 and 16 registers for the remaining groups were allocated, respectively.

The registers is loaded with a high logic 1 for the corresponding response. The loaded registers were converted into rectangular bars with unit thickness. The thickness of bars in the group were determined by multiplying the relevant default attribution weights (see Table 1) to obtain sensory bar code pattern for individuals of a particular group. The sensory bar codes were converted into the relevant curves using a computer software developed during the course of this study. Finally, the overall sensory curves were obtained by averaging the sensory curves of the six groups.

RESULTS

Bar code generation table

For the construction of food sensory curve, a bar code-generating table, which includes all external and internal parameters of human sensory activities associated with food consumption, must be prepared. Qualitative descriptions of the parameters of food products are as follows:

a. Objective parameters

Food material: cultivars / cultivation / harvest / post harvest treatment / physico-chemical properties

Table 2. The sensory evaluation questionnaire for cooked rice

Cooked rice	Description
Material	
rice cultivar	short grain (0), long grain (1)
age after harvest (yr)	0, 1, 2
milling grade	0.6, 0.7, 0.8, 0.9
crack	non (0), <1% (1), yes (2)
storage temp. of rice (°C)	below 0 (0), room temp (1), high temp (2)
Processing	
soaking time (hr)	<1 hr (0), several hr (1), overnight (2)
soaking temp.	cold water (0), room temp (1), warm water (2)
water ratio	wet (0), moderate (1), dryness (2)
heating profile	batch (0), continuous (1), intermittent (2)
heating method	electricity (0), gas (1), coal or wood (2), steam (3)
steaming pressure	< 0.5 (0), 0.5-0.7 (1), 0.7-1.0 (2), 1.0< (3)
finishing tempering	no (0), short (1), long (2)
degree of cooking	rare (0), medium (1), well done (2),
storage time (hr)	0 (0), <3 (1), 4 - 8 (2), > 9 (3)
storage temp.	cold (0), room temp. (1), high temp. (2)
Product	
texture	hard (0), sticky (1), juicy (2)
sweetness	low (0), moderate (1), high (2)
color	low (0), moderate (1), high (2)
flavor	low (0), moderate (1), high (2)
overall appearance	bad (0), moderate (1), good (2)
moisture	low (0), moderate (1), high (2)
Eating Environment	
chewing speed	low (0), moderate (1), high (2)
lightness	daylight (0), illumination (1), dark (2)
place	home (0), restaurant (1), other (2)
season	spring (0), summer (1), fall (2), winter (3)
audio-factor	quite (0), music(1), natural sound (2), noise (3)
visual-factors	none (0), TV or Video (1), landscape (2)
companionship	alone (0), company (1), group (2)
attention	none (0), moderate (1), high (2)
5th consciousness	
sex	male (0), female (1)
age	infant (0), childhood (1), adult (2), old (3)
health :	bad (0), fair (1), good (2)
eye	bad (0), fair (1), good (2)
ear	bad (0), fair (1), good (2)
nose	bad (0), fair (1), good (2)
tongue	bad (0), fair (1), good (2)
stomach	hungry (0), no hungry (1), full (2)
6th Consciousness	
schema	low (0), middle (1), high (2)
law or regulation	against (0), neutral (1), favor (2)
family education	low (0), middle(1), high (2)
education	none (0), element. (1), middle-high (2), college (3)
7th consciousness	
first eating age	infant (0), young (1), adult (2)
long term frequency	seldom (0), daily (1), weekly (2)
daily frequency	one (0), twice (1), 3 times (2)
preference	rare (0), medium (1), well done (2)
related rice product	soup (0), tea (1), cake (2), nuroongzee (3)
cooking experience	no (0), a few (1), yes (2)
family history of rice consumption	no (0), a few (1), yes (2)
hobby	painting (0), music (1), sport (2), reading (3)
past impression	bad (0), fair (1), good (2)
past feeling	bad (0), fair (1), good (2)
faith	against (0), neutral (1), favor (2)
ideology	against (0), neutral (1), favor (2)

Table 2. Continued

Cooked rice	Description
religious teaching	against (0), neutral (1), favor (2)
8th consciousness	
parental preference	bad (0), fair (1), good (2)
food eaten while pregnant	no (0), little (1), yes (2)
given digestibility	bad (0), fair (1), good (2)
willingness	low (0), moderate (1), high (2)
awareness of mind	no (0), little (1), yes (2)

Processing technology: processing operation /ingredient composition

b. Subjective Parameters

Sex, age, health, nationality

5-sensory state (eye, ear, nose, tongue, skin)

6th consciousness: education / knowledge / experience

7th consciousness: eating history / frequency of eating / duration / family food history / faith / religion / culture / personality

8th consciousness: parental food life / eating while pregnant / talent

On the basis of 3-way branching perception logic (Fig. 6) under the multi-layer consciousness pathway, sensory evaluation questionnaire was designed for cooked rice (Table 2). Some items in the table branched into more or less than three ways, which could be explained by the number transformation step.

Sensory bar code of cooked rice

Based on the responses of the five inquiries groups, sensory bar code of cooked rice for an individual was produced as shown in Fig. 9.

The bar code pattern shows sensual reaction for intake of cooked rice of an individual. Even tough, the number of inquiry items in the questionnaire and the value the attribution weight of each group have been predetermined on the basis of the knowledge retained by the author, differences were found among twelve subjects. Although the summed bard code represents the overall stimuli pattern of an individual, overlapping of bars occurred, which led the masking off some information.

Sensory curve of cooked rice

In order to reflect all sensory response, each bar code pattern was converted to a sinusoidal sensory curve as shown in Fig. 10(Equ. 4). Considering EEG of human brain as the representative signal of mental activity, information of food sensory must be included in somewhere in EEG (Sagara, 2000). As EEG and ERP are important mental image patterns for the diagnosis of mental activity (Hoffman *et al.*, 1999; Martin 1998; Glassman 2000), sensory curve may be a good tool to understand mental reaction on the food consumption.

Classification of sensory curves patterns

Based on the pattern analysis of the sensory curves, twelve subjects were classified into four different groups; A, B, C and D as shown in Fig. 11. The individual differences in the sensual curve pattern say that indi-

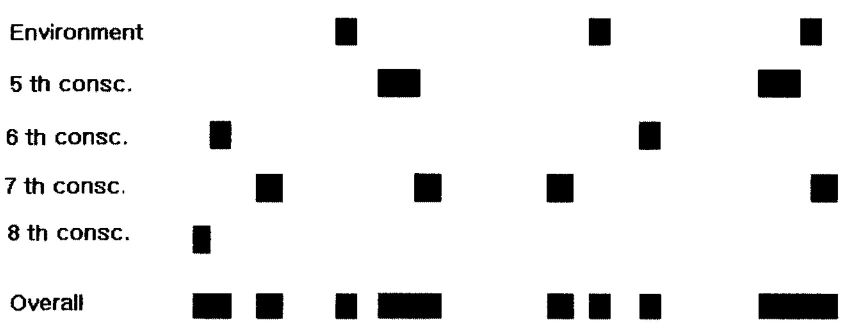


Fig. 9. Bar code of conscious background of panelist.

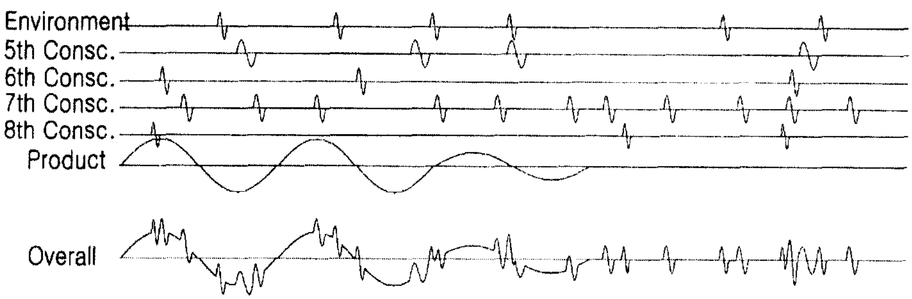


Fig. 10. Sensory curve components of an individual for cooked-rice.

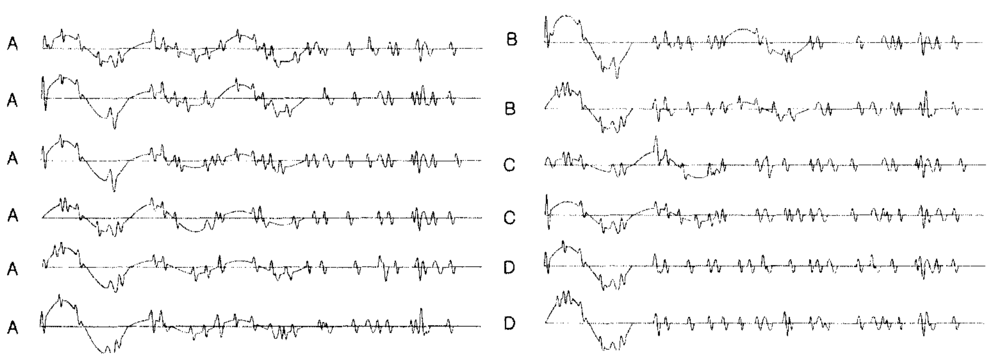


Fig. 11. Sensory curve patterns of twelve individuals and its classification to 4 groups.

vidual consciousness background plays important role in the perception process. The differentiation is the real nature of individuals feeling on food, and it is no longer the methodological error of sensory evaluation.

This indicates that food sensory of individuals can not be same due to the difference of consciousness parameters of individuals.

Role of 7th consciousness layer as the stock of past experience in ones food life

For any evaluation, the evaluator needs references to be compared with his or her choice in the 3-WBP. (see Fig. 4). The reference must be a past experience of individuals, stored in a memory layer, 7th consciousness. Based on Vasubandhus theory, the initiation of the selfness buds at 8th consciousness, with forming the subjectivity and objectivity relationship. The most of subjectivity-objectivity duality take place at any stage in the 7th and 8th layers. If the current stage of subjectivity shifted to another stage, the observing point will accordingly be changed. From this dynamic nature of the mental process, the subject percepts an object in the current subjective point of view by conducting differentiating and discrimination functions leading three categories of feeling; pleasant, neutral and unpleasant as noticed in Fig. 5. Therefore, sensory analysis is strongly associated with the consciousness layer where individual experiences have been stored. Considering the seventh consciousness as a particular memory layer, where classified information is registered and stored, it plays as the set point of a feedback control of sensory evaluation process. The dynamic nature of the set point make difficult keeping the output, sensory value, at constant value for not only an individual but also for a group of individuals.

This explains that individuals evaluate sensory value with their own inches of measurement in different directions, resulting in good, neutral or bad feelings toward the same food item. The cause of perception bias could be explained via the biased flow of consciousness stream with a predisposed information of on individual.

DISCUSSION

The new concept on the sensory evaluation of food was constructed on the basis of consciousness theory of Vasubandhu. For the development of the concept, two approaches were taken: One approach was to build a hardware model of mental process combining computer architecture with multi-layered consciousness that was comparable to the hidden layer of modern artificial neural network. Another was to develop a flow chart of the consciousness process and to identify how and where the sensation and feeling arises and associates with other consciousness layers.

Once food is consumed, the physical food is replaced by the data in memory or information, whereby, only consciousness flow exists as a virtual or cyber food in the internal world. Author describes the flow as two-directional streams, one inward stream and the other an outward stream forming a global loop in a pattern similar to human blood stream. During several transformation processes, the information on food is biased in the favor of subjectivity with judging food based on his / her own inches. The consciousness pathway can be applicable to explain the perception and cognition variances, and for the elucidation of dynamic nature of sensory evaluation.

Author made attempts to understand the analogues between the man-made machine, computer, and the consciousness structure of human. From the behavioral analysis of eating, the stimuli patterns are considered as bar codes, which are composed of sequential events and spaces as interval times. Thus, a bar code method of sensory evaluation was proposed to include as many consciousness parameters in the sensory evaluation process as possible. Using the bar code method, a sensory frequency curve of food could be produced for individual customers. The frequency curve of food indicates that the intensity is displayed against time axis even though it is not a real time.

CONCLUSION

A concept of food sensory evaluation was developed on the basis of multi-layer consciousness theory of Vasubandhu with three-way branching perception logic. To understand the relationship between sensory reaction and consciousness, a model of consciousness structure and flow chart of mental process was constructed with incorporation of different time units and transformation processes. From the dynamic mental process, subject percept objects in the current subjective point of view. The variance of sensory evaluation was explained by the perception mechanism of the multi-cosciousness layer system. Sensory evaluation of food is closely associated with 7th consciousness layer where individual experiences have been stored and conditioned. Based on the analogies among five sensory system of human and computer logic, time and attention weight were included in the new sensory evaluation methods.

The new method was tested with sensory evaluation of cooked rice. Sensory patterns of barcode and curve of 12 subjects showed meaningful results showing remarkable differences in their patterns.

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