Toward Temporal Taste Sensing: Contrasting Human Experience with Machine Perception in Food Appreciation

Hiroki Fxyma
Kobe University, 1-2 Tsurukabuto, Nada-ku, Kobe, Japan

Abstract

This paper explores the temporal aspects of food and beverage appreciation, particularly focusing on the interplay between taste sensors and human sensory experiences. It begins by discussing the fundamental principle of taste sensors, which analyze chemical substances but often fail to capture the complexities of human taste perception. To address this limitation, the concept of "artificial tongues" is introduced, aiming to replicate human taste perception more accurately. The paper then delves into the temporalities inherent in our eating experiences, categorized into three dimensions: the time of the object, the time of embodied cognition, and the time of the phenomenon. Four temporal aspects of the phenomenon are proposed: non-temporal, linear temporality, circular temporality, and point temporality, which are shaped by the eater's attention. The discussion further examines the motivations behind the temporality of food, highlighting cognitive and physical constraints such as memory and oral capacity. Additionally, the paper investigates temporalities in dessert appreciation, using the example of a strawberry mille-feuille to illustrate how the arrangement of ingredients and the sequence of consumption create unique temporal experiences. Finally, it concludes by emphasizing the need for philosophical and theoretical advancements to bridge the gap between human sensory experiences and machine sensing, thereby enhancing our understanding of taste perception in both realms.

Keywords: Temporality, Artificial tongues, Taste sensors, Aesthetics

1. Introduction

1.1. *Taste sensor and the temporality*

The basic principle of taste sensors is to analyze chemical substances that are taste components. Sugar meters and salt meters are the most basic of such sensors. However, a precise analysis of the chemical composition of food does not represent the taste that humans perceive. The characteristics of human taste perception include, for example, the fact that humans perceive different chemical substances (sucrose and aspartame) as the same taste stimulus (“sweetness”) as well as the inhibitory/synergistic effect of one taste on the perceived intensity of another taste. To reflect such cognitive characteristics of human perception and output "the taste perceived by humans" instead of simply detecting taste substances, sensors are referred to as artificial tongues. As Toko [1] reviews, there are two types of commercialized electronic tongues in the world. One is the taste sensing systems SA402B and TS-5000Z, commonly known as the taste sensor, and the other is the Astree II e-tongue.

These electronic tongues are intelligent sensors that reflect the human taste perception system in their component analysis as information processing, but their detection of temporality is limited to a small portion. The SA402B and TS-5000Z developed by Toko et al. can analyze taste as it is perceived on the tongue (initial taste) and the taste that remains after swallowing (aftertaste). These are computed based on the ease with which taste components detach from the lipid membrane, which is a taste sensor, thereby detecting, for example, a rich aftertaste. However, none of the current taste sensors measure changes in perception over time, such as fatigue with the same taste. Also, effects such as contrast between ingredients (e.g., strawberry after cream) must be measured separately and evaluated by humans.

1.2. *Temporalities in our eating experience*

Taste and smell are gaining status in aesthetics, but theories concerning their basic appreciation are insufficient. Fxyma [2] proposed the basic theory for temporality of food and beverage appreciation. According to the study, the temporality underlying food appreciation is classified into three categories: the time of the object, the time of the embodied cognition, and the time of the phenomenon. Next, Fxyma proposed four aspects of the time of the phenomenon: non-temporal, linear temporality, circular temporality, and point temporality. These four temporalities are not determined a priori but generated by the eater’s attention.

2. Motivations of the Temporality of food

Temporality as a phenomenon in the human eating experience arises from cognitive and physical constraints. In this section, I outline the primary constraints: memory

(cognitive constraints) and oral capacity (physical constraints).

The first constraint is memory. Memory is generally divided into sensory memory, short-term memory, and long-term memory. The retention period of sensory memory varies by sensory modality, but is short, ranging from less than one second to several seconds. In contrast, its retention capacity is larger than that of short-term memory. Sensory information is then stored as short-term memory, medium-term memory, and then long-term memory. Human senses cannot reproduce stimuli. We can recall pain and taste, but this is not a reproduction of the pain or taste "itself. If it were possible to reproduce the pain itself, we would experience intense pain again every time we explain the situation of a serious injury.

On the other hand, a machine's sensors can reproduce the stimuli as numerical values; the values measured 10 years ago can once again be input into the sensors; the wine opened 10 years ago and the wine opened now can be tasted "at the same time". The human being seems to be comparing the two, but one is the sensor data of the actual wine in front of us, while the other is the edited and partly erased/enhanced long-term memory of the wine of 10 years ago.

This means that the time possessed by the machine is basically point temporality in Fxyma's temporality classification. The present and the past appear simultaneously in the here and now. It is not Linear temporality because there is no passage of time or order. It is also different from Circular temporality because it recreates the same stimulus in the past. Circular temporality is about finding repetition in different experiences. For example, spring is repetitive, but the content of the spring experience is not identical every year. The reproduction of exactly the same stimuli is different from the concept of Circular temporality. Thus, the simultaneous appearance of the here and now as a condensed time of the present and the past is Point Temporality.

This constraining characteristic of human memory to be edited, forgotten, and reinforced over time gives rise to Linear Temporality or Circular temporality. When eating a parfait, the first strawberry, the next taste of cream, and the subsequent strawberries are not experienced separately, but have a linear continuity or a circular temporality structure as repetitions of strawberries. When a person eats a parfait, temporal memory is passed on from one bite to the next; if the same taste continues in the mouth, the person becomes bored, and if the sweet flavor of the cream is followed by the sour jam, there is a contrast. In the repetition of strawberries and cream, the strawberry is presented with a different role each time it appears. Here, more than the summation of the elements, an aesthetic experience emerges.

The second constraint is the physical structure of the nasal and oral cavities. Generally, the volume of the oral cavity is smaller than that of the stomach, and humans divide food during meals, sending the entire amount of one meal to the stomach in several to several tens of times. In the case of eating the entire amount of food at once, there is no temporality. The division of food itself becomes the basic unit of temporality, such as order and repetition. For example, beef steak is divided into several pieces with a knife, finely crushed with several times the number of chewing, and sent to the stomach.

Human meals are embedded in multiple cyclical temporalities. The time span ranges from seconds, such as repeated chewing and swallowing, to levels such as three meals a day (rise and fall of blood sugar in some hours), and complex cyclical cycles such as food aversion/preference learning (in some hours to days), or seasonal foods (in a year). When analyzing food with taste sensors, it is liquefied with a mixer and the composition of flavor components is analyzed. Here, temporalities such as division with a knife or repetitive chewing are disregarded, and analysis is conducted as timeless, ignoring point time or time passage.

The analysis times increase significantly when the number of steps in the implicit integral is expanded. In the implicit method, the solutions of simultaneous equations are obtained by inserted Newton-Raphson method, and numerical substitutions into symbolic matrix within this process require the computation processing time. The symbolic matrix is enlarged by increasing the number of implicit stages, which takes more computation time. Therefore, it is important to implement an efficient substitution process into a symbolic matrix for the implementation of higher order implicit methods in MBD analysis.

3. Temporalities in Dessert Appreciation

In this section, I will examine the process by which humans experience food, using one dish of dessert as an example. This dessert shown in Fig. 1 is provided at the pastry shop *Assiette Dessert Maruyama*, located in Nishinomiya City, Japan.

Fig.1 The Strawberry Millefeuille of *Assiette Dessert Maruyama*.

The strawberries scattered on the plate play different roles in the beginning and the end of the dish. Of course, they also play a role in giving an impact at the moment

they are presented. However, this function is a visual one. The strawberries eaten at the beginning of the meal function to tell the taste of the strawberries or to introduce the flavor of the strawberries used as an ingredient. In order to understand the function of the strawberries in the latter stages, it is necessary to interpret the flavor of the millefeuille in the main body of the dish. The millefeuille is characterized by the horizontal structure of the cut layers, rather than the more common style in which layers of pie and cream are piled up vertically.

In a typical layered millefeuille, one must cut the pastry with a fork to achieve the intended size, which is not only cumbersome but also risks disrupting the balance between the pie pastry and the strawberries by causing cream to spill out. However, in *Maruyama*'s millefeuille, a bite-sized portion is pre-cut, allowing one to enjoy the pie pastry, cream, and strawberries atop without compromising their balance.

In *Maruyama*'s mille-feuille, the meticulous calculation behind this bite-sized composition becomes fully evident as one progresses through consuming it. As the layers of cream and pastry are meticulously arranged side by side, defying the conventional definition of a mille-feuille, scooping up a set with a fork automatically results in an accompanying strawberry, completing a mouthful. The pastry is not of the rigid variety but rather consists of delicate, thin layers stacked upon one another. When pressed against the custard cream with the tongue and teeth, the pastry dissolves effortlessly without requiring a bite, instantly enveloping the tongue in the smoothness of the cream. There is no sensation of strawberry juice separating from the custard cream and flowing out. While the strawberries provide a fibrous texture and a refreshing acidity to the tip of the tongue, the carefully controlled juice harmoniously melds with the pastry and cream, creating an impression of "strawberry custard cream" rather than separating out.

The perfect harmony of pastry, cream, and strawberries creates an impression of "strawberry custard cream" where everything melts together in the mouth, to the extent that one might almost forget the awareness of "eating strawberries" as they progress through the middle and later stages. To prevent this forgetting, the role of the strawberries scattered on the plate from the middle to the end comes into play. The strawberries scattered on the plate ensure a return to the main theme that might otherwise be lost due to the remarkable harmony.

This mille-feuille is likely intended to be consumed from left to right. Evidence of this can be found in the absence of cream at the right end, indicating a progression. In the overall linear progression of time, each bite-sized millefeuille forms a condensed, Point Temporality through the perfect harmony of its ingredients. While the repetition of millefeuille layers from left to right introduces a recursive Cyclical Temporality, there comes a moment when continuity threatens to turn into monotony and a sense of timeless monotony (i.e., Atemporality). At this juncture, the strawberries scattered on the plate serve as "privileged moments [3], bringing the consciousness of the eater back to the cyclical time.

4. Conclusion

This paper examines the differences between human sensory experiences and machine sensing through the description of the experience of eating a dessert on a plate. I argue that the human experience of eating is temporal in nature, primarily motivated by two constraints: the limitations of memory and oral capacity. In contrast, machine taste sensing, without these constraints, is an experience characterized by "point time" or "timelessness," where past, present, and future information are analyzed homogeneously.

The current limitations of sensing in reflecting the temporal aspects of the human eating experience, especially linear or cyclical time, do not stem from inadequacies in sensor capabilities or the scientific knowledge supporting them.

Rather, the deficiency lies in the philosophical and theoretical understanding of what should be sensed. We lack theories to explain the experience and phenomena of consuming a dessert or savoring a glass of wine, which limits taste sensing to mere component analysis. Taste sensors themselves are capable of detecting taste components more "accurately" than humans, "objectively" across various conditions, and with an unparalleled sensitivity to subtle taste components. If taste sensors are to transcend mere component analysis and aim to reproduce "eating" as an intellectual behavior of machines, what is required is philosophical and theoretical leadership in science.

References

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Authors Introduction

Dr. Hiroki Fxyma

He is currently an Assistant Professor at Kobe University. He completed his doctoral and master's degrees at Keio University. His current research topic is the aesthetic appreciation of taste and its cognitive process.