Chapter 1

Elements of Food Acceptability

As shown in Fig. 1, there are a number of elements of food acceptability, i.e., the aspects of foods that determine whether humans will accept and consume the foods or not.

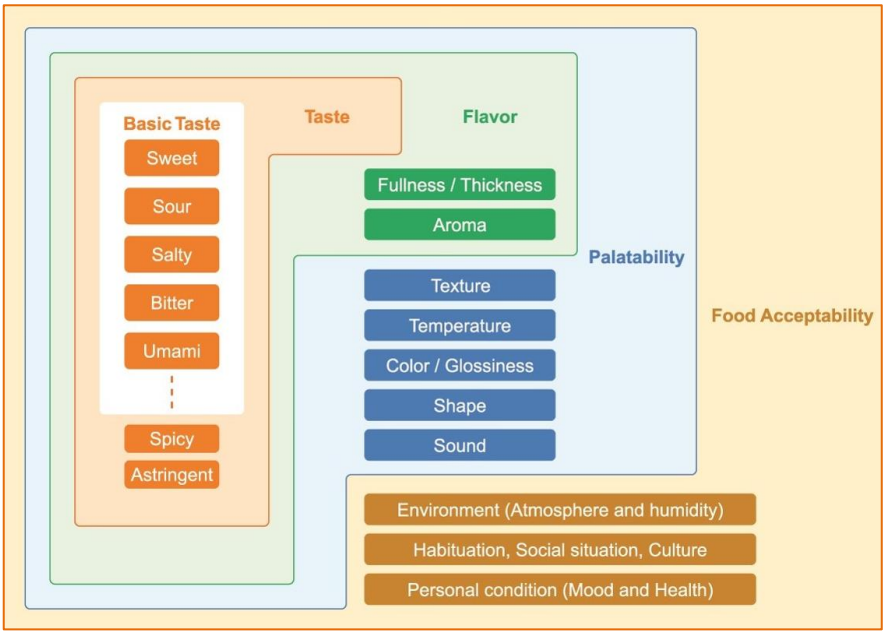

Fig. 1. *Elements of food acceptability (Umami Information Center).*

1.1 Taste

The most important element of food acceptability is taste. As shown in the figure, there are five basic tastes: sweet, salty, umami, bitter, and sour tastes. Each basic taste has its own physiological role. Typical sweet substances are sugars, which supply energy; thus, a sweet taste is a signal of energy to humans. Salts are essential elements for health, and a salty taste is a signal of minerals. Glutamate, a main umami substance, is most abundantly present in proteins. Glutamate is a precursor of a protein and a component of protein hydrolysate. An umami taste is a signal of protein. Sugars, salts and proteins are important nutrients, and thus

humans recognize the signals that foods with these tastes provide.

As will be discussed later, the essential components of crab-meat taste are amino acids, umami and NaCl. The amino acids contribute to the characteristic taste of crab meat. The omission of umami substances decreases the deliciousness of crab meat, but the omission of NaCl greatly attenuates the crab-meat taste.

Fig. 2. *Expression of baby in response to sweet, sour, bitter and umami stimuli (Umami Information center).*

Poisonous substances often have a bitter taste, and thus a bitter taste is a signal of poison. Putrid matter has a sour taste, and unripe fruits also often have a sour taste. The seeds of mature fruits can be spread through the droppings of animals. Seeds of unripe fruits cannot be germinated. The sour taste of unripe fruits may help keep them from being eaten by animals. For animals, a sour taste is a signal that protects the animals from eating putrid foods and unripe fruits. Since bitter and sour substances can be bad for the health of animals (including humans), animals and human infants do not eat foods with these tastes. Fig. 2 shows a baby's expression in response to various tastes. The baby shows a satisfied expression in response to sweet and umami tastes and a threatened expression in response to sour and bitter tastes.

Adult humans have learned that bitter and sour substances are not always harmful. For example, coffee and green tea have bitter tastes, but adults like these drinks. Adults also enjoy eating some sour foods such as lemons and sour cream. That babies and animals do not like bitter and sour tastes is instinctive, and the enjoyment of some bitter and sour foods is learned behavior.

Hot pepper has a hot taste. The active component of hot pepper is capsaicin, which stimulates a sense of pain but does not stimulate taste cells. Immature persimmon has an astringent taste; the active component of immature persimmon is the plant polyphenolic compound tannin. Tannin has an ability to denature protein and it has thus been used for tanning leather. Although it does not stimulate taste cells, tannin stimulates a pain sensation by denaturing some proteins on the tongue. Thus hot and astringent tastes are not tastes in the strict sense, but the sensations induced by these stimuli are transmitted to the brain and conjugated with signals induced by taste stimuli. We can consider hot and astringent tastes as types of taste in a broad sense. They definitely contribute to the tastes of cuisines.

1.2 Odor

The odors of foods greatly contribute to “the foods taste”. When people are tasked with the identification of the tastes of apple juice and grapefruit juice while holding their noses shut, many cannot differentiate the two juices because the difference in these juices is due mainly to the difference in their odors. When one catches a cold which occludes one’s sense of smell, food is often less appealing. This is not due to a loss of the tongue’s functions, but rather to a loss of olfactory function.

Taste likes and dislikes are intrinsic. Most animals like sugars, for example. In

contrast, the likes and dislikes of most odors are learned behavior. There is little overlap between humans' likes and dislikes of odors and those of animals, because the likes and dislikes of odors are learned behavior. There are individuals who like cuisine that has strong odors such as those of garlic, coriander and fresh cheese, and other individuals who do not enjoy these cuisines because of their odors.

1.3 Texture

Texture is a very important factor of food acceptability. For example, many types of noodles are made and consumed in Japan, including *inaniwa udon* in Akita, *kishimen* in Nagoya and *sanuki udon* in Kagawa. Although all of these noodles are made from essentially the same ingredients (mainly wheat flour), each type of noodle has a very characteristic texture that is sought out by many individuals.

1.4 Visual Stimuli

When we see foods, a visual image is often evoked. For example, squid and octopus have been called "devil fish" in the U.S. and U.K., as the features of these fish evoke a sinister image. Cows are sacred animals in some parts of India, and Islam prohibits the eating of pork; these cultural traits may have a visual component.

Many Japanese do not have a good image of locusts and bee larva, but some people eat them for pleasure. Sea cucumbers, which are somewhat grotesque-looking echinoderms, are generally not eaten in the U.S. or Europe, but they are popular foodstuffs in Japan and China. The salted and fermented internal organs of sea cucumbers are very delicious (although expensive) in Japan.

Humans usually eat a food after they have identified it visually. With one's eyes closed, it is more difficult to identify the food, resulting in an uneasy feeling.

Even when a person cannot identify the food, he or she will likely judge the category of the food such as fish, meat or vegetable. In addition, when people see a food, they often recall a memory of the food eaten in the past.

Animals are cautious about eating a food that they have seen for the first time. This is called neophobia. When a rat is presented with apple juice for the first time, it will drink only about 2 ml of the juice. The second presentation of the juice leads to the rat's consumption of about 5 ml of the juice. After repeated presentations of the juice, the rat willingly drinks high amounts of the juice, because the rat has learned that the juice is both safe to drink and delicious.

1.5 Brain Pathways of Information About Foods

As shown in Fig. 3 and 4, taste information that is received at a taste organ is transmitted to the medulla via taste nerves (the chorda tympani nerve and glossopharyngeal nerves). This information is then transmitted to primary and secondary taste cortices via the thalamus.

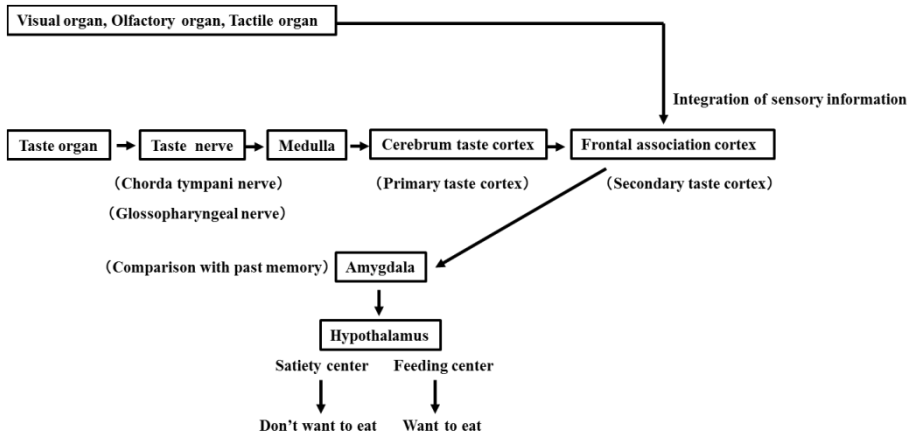

Fig. 3. *Pathways of food information from sensory organs to brain.*

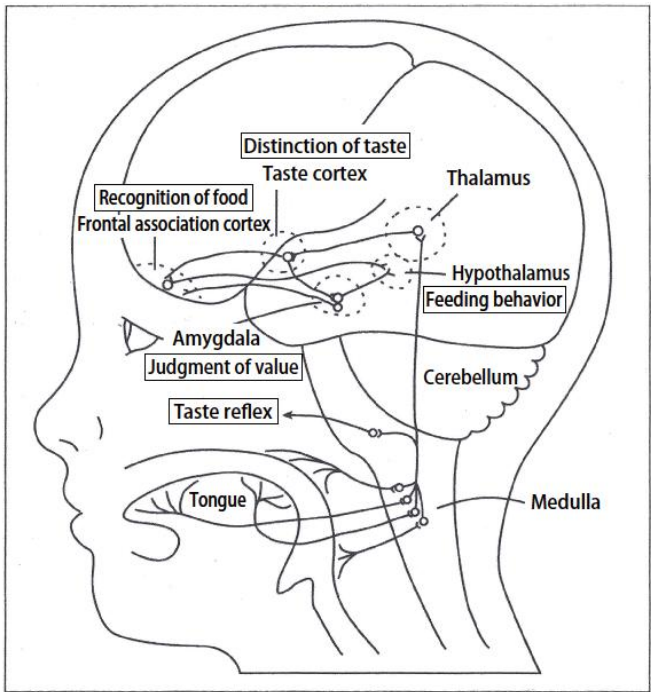

Fig. 4. *Schematic area for pathways of sensory information in brain.*

Of course, foods provide information not only about taste but also odor, shape, color, temperature and texture. Such information is taken up at the various sense organs and transmitted to the respective cortices in the cerebrum. The information is eventually integrated at the frontal association cortex. Here, when one eats strawberry, for example, the total information on the strawberry (sweet taste, red color, and good smell) is obtained.

Information at the frontal association cortex is further transmitted to the amygdala. As stated above, animals show neophobia, but they do not show neophobia when the amygdala is not functioning correctly. Animals with a dysfunctional amygdala cannot differentiate between eatable and uneatable substances, and they eat any substances. Thus, foods that are eaten are compared in the amygdala with the memories of foods eaten previously, and the decision

regarding whether the food should be eaten or not is made in the amygdala.

Another example: monkeys do not willingly eat watermelon when presented with it for the first time. After several presentations, a monkey will eat watermelon willingly, and the mere sight of watermelon makes the monkey's mouth water. At this time, the neurons that respond only to watermelon appear in the monkey's amygdala. In another experiment, a watermelon coated with a high concentration of sodium chloride was given to a monkey that had developed a liking for watermelon. The monkey did not eat the coated watermelon because it is very salty. At that time point, the neurons that respond to watermelon disappeared. This implies that the information used by neurons that respond to watermelon includes not only sight information but also information that a watermelon is sweet and delicious.

Information at the amygdala is transmitted to the hypothalamus, which has both feeding and satiety centers. Stimulation of the feeding center causes motivation to eat, and stimulation of the satiety center causes a feeling of fullness. When the feeding center in a cat is electronically stimulated, the cat continues to eat; when the satiety center is similarly stimulated, the cat does not eat anything. An information of the food which is decided to be eaten by the amygdala stimulates the feeding center. The food information that results is a decision to not eat the food stimulates the satiety center.

1.6 Memory of Foods

Many of our memories of foods are based on childhood experiences. The tastes of "good old home cooking" (usually, "mom's cooking") are remembered as good tastes even into adulthood. The circumstances surrounding our acts of eating may also be memorized in tandem with the tastes of the food. Food eaten

in comfortable circumstances is often remembered as good food, whereas food eaten in a bad environment such as with an unhappy family is often not remembered as good food. Another type of memory is when a person who experiences symptoms of food poisoning after eating a particular type of food (e.g., oysters) develops a strong dislike of the food that lasts a long time or even indefinitely. In a rat model of this phenomenon, a food product is fed to the rat and then an immediate injection of lithium chloride (which induces symptoms of poisoning) is administered. The rat memorizes that the food 'caused' poisoning symptoms, and then never eats the food again.

A gourmet eats many types of foods and can well appreciate their deliciousness. This is not because the gourmet's tongue is unusually sensitive to the tastes of food, but rather because the gourmet has accumulated abundant memories of good food. A gourmet can differentiate a delicate difference in food tastes in part by using his or her memory.

Likes and dislikes of foods vary greatly from country to country, which is not unexpected in light of the major differences in eating habits formed in childhood. We often attribute deliciousness to foods that we have eaten for many years, since our childhoods. In addition, our metabolic systems adapt to the foods that we grow up consuming.

1.7 Foods That Are Popular Among Everyone

Food likes and dislikes vary from person to person, but foods that are popular to the majority of humans do exist. For example, at a scientific conference that I attended in western Canada, two big lobsters for each person were served in the luncheon buffet. The conference attendees were from many different countries with widely varying cuisines, but everyone happily ate the lobsters.

I organized an international scientific symposium in Sapporo, Japan. For the welcoming party, many foods were served. “Salmon eggs” marinated with soy sauce were the most popular; in fact, someone exclaimed how delicious the eggs were, and then all the eggs were quickly consumed by all of the attendees. It’s likely that for the U.S. and European attendees, this occasion was the first time they had ever eaten “salmon eggs”.

1.8 The Presentation of Food, e.g., in Restaurants

Humans are also affected by the presentation of food; that is, how the food is provided, and the environment or ambiance. A restaurant’s facility, its plates and cutlery, the decorations, the arrangement of the foods on a plate, etc. all have an effect on the clientele’s enthusiasm for the food being served. Having the food and food choices explained by a waiter is often expected and can be quite helpful. Many large restaurant chains spend millions of dollars on research that identifies the best décor, serving style, and food products that will entice visitors to spend their money. In Japan, tuna obtained from the town of Ōma in Aomori prefecture is considered to be the best. When Ōma tuna is served, the waiter will inform the clientele of the food’s respected source. The restaurant-goers then know that excellent tuna is about to be served, and their brains secrete dopamine (which induces pleasant feelings) as a result. To evoke an expectation is important in restaurant service.