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Influence of Sweet Suppressing Agent on Gustatory Brain Evoked Potentials Generated by Taste Stimuli

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Abstract. A measurement system was employed to detect gustatory evoked potentials from human scalp by stimulus of a taste solution with the use of a laser beam device. The evoked potentials for four taste qualities (i.e., sweet-sucrose, salty-sodium chloride, sour-tartaric acid, and bitter-quinine-HCl) were measured before and after treatment with a sweet suppressing agent (i.e., *gymnema sylvestre* extract) to the tongue of a human. The solution was given to the chorda tympani nerve located 20 mm from the apex of the tongue and 15 mm from the left side of the center line. The maximum potential level and its latency were evaluated. Artificial saliva was used as a control solution. The evoked potentials obtained were averaged by eight evoked potentials to detect the peak of the evoked potential more clearly. The latencies for taste stimuli were found on two kinds of peaks at approximately 50 ms and 180 ms. These peaks are P1 and P2. The purpose of this study is to investigate the influence of sweet suppressing agent on P1 and P2. The influence of the sweet suppressing agent to evoked potential by salty, sour, and bitter taste stimuli was not recognized, but the responses to sweet (sucrose) were abolished after treatment with a sweet suppressing agent. It was recognized that the peak P2 originated from the taste stimulus. The peak P1 did not suffer the influence of the sweet suppression, so it was considered that the response to P1 was due to sensations other than the gustatory response, such as somatosense.

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Keywords: gustatory evoked potentials, four taste qualities, chorda tympani nerve, artificial saliva, *gymnema sylvestre* extract

Introduction

Funakoshi and Kawamura (1968 and 1971) first reported on gustatory evoked potentials. The evoked potentials were obtained by using an averaging technique. Since then, there have been other reports related to this (Kobal, 1985; Ikui, 1988; Maetani et al., 1989; Platting, 1991; Min and Sakamoto, 1997). There have been only a few such studies compared with the voluminous studies of evoked potentials referring to visual (e.g., Cobb and Dawson, 1960; Vaughan et al., 1963; Shawkat and Kriss, 1997), auditory (e.g., Celesia et al., 1968; Ninomiya et al., 1997), and somatic (e.g., Allison, 1962; Araki et al., 1997) sensations until quite recently. One reason for this is the confusion surrounding gustatory evoked potential including the many sensations of not only taste but also touch, pressure, and warm senses that have been mentioned. Recently, Murayama et al. (1996) and Kobayakawa et al. (1996) measured the cerebral magnetic fields caused by taste solution stimulus, and they attempted to estimate the site of taste response. Although stimuli such as light and sound can be defined in physical quantity, it is difficult for the stimulus of taste solution to be quantified due to chemical substances. Moreover, the following basic problems should be considered when giving taste solutions to a subject's tongue. Firstly, the timing of triggering for the sake of averaging of evoked potentials, the duration of stimulation, and the area of stimulation should be investigated. Secondly, in addition to successive taste solution stimuli, the fatigue or the adaptation of the tongue, by which the sensation for the taste solution decreases or completely disappears, occurs and a definite time is required for the recovery from these phenomena. Thirdly, the synchronization of excitation of the individual nerve fiber is difficult, so that the problem of the stimulation method should be considered (Ikui, 1988). Examining the above problems, a new apparatus for stimulating taste solution to the tongue was devised by Min and Sakamoto (1997). The evoked potentials for four tastes qualities—sweet, salty, sour, and bitter—were measured sequentially for a constant interval of taste stimulus in the study. The evoked potentials were evaluated by an averaging method. The largest positive potential generated at approximately 180 ms from the moment when the taste solution to the tongue was given. The potential was called P2. At the moment, a small positive peak at approximately 50 ms was also measured

and this peak was called P1. The origin of the two peaks has not been elucidated clearly.

Recently, the substances which suppress the selectively of the sweet sensation among the four taste qualities have been prepared by Kurihara (1969 and 1992) and Maeda et al. (1989). One of the substances was known to be gymnemic acid, which was prepared from *gymnema sylvestre* (GS), a plant name. A chewing gum containing a 1% GS extract (Meiji Seito Co., Japan) was applied as a sweet suppressing agent. The purpose of the paper is to investigate the influence of this sweet suppressing agent to P1 and P2 by the use of four taste quality stimuli. In other words, the kinds of sensations which affect the peaks could be determined. The application of a sweet suppressing agent was expected to make clear the origin of P2 for the sweet solution stimulus. The influence of a sweet suppressing agent on P2 was also investigated for taste solutions except for the sweet solution.

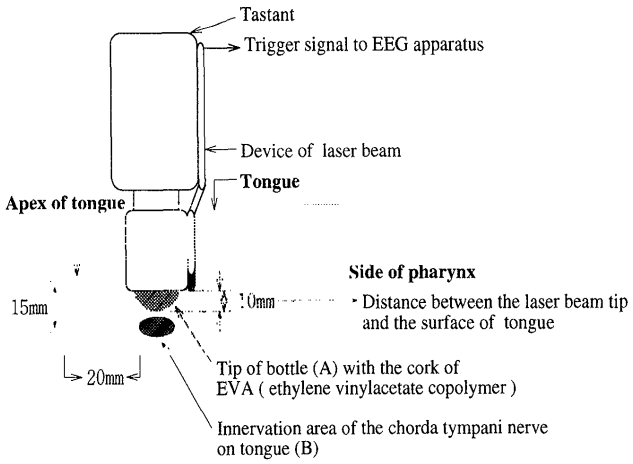

Fig. 1 The schematic drawing of apparatus for taste stimulation. The taste solution in the bottle touched the surface of the tongue of humans and when it touched the innervation area of chorda tympani nerve this moment was accurately detected by the device which used a laser beam. The signal was evaluated as a trigger. The shape of the bottle (tastant) of a taste quality solution has a diameter of 18 mm and a height of 50 mm.

Materials and Methods

Subjects

The subjects were 10 healthy men aged 22 to 27 years with normal gustatory senses. All subjects were non-smokers and were instructed to restrain from drinking or eating for at least one hour prior to the measurement.

Experimental apparatus

The apparatus for the taste stimulation is shown in Fig. 1. When the tip of the bottle A of the taste solution comes into contact with the area innervated by the chorda tympani nerve of the tongue B, the taste solution is given to the tongue B, and at the same time the laser beam device (Pacific Supply, E980-60) detects the touching moment of the tip of A without the device making contact with the area B. It is the mechanism of the detection that the device irradiates perpendicularly on the surface of the tongue, and the reflected beam from the surface of the tongue is detected by a photosensor in the device. The exact moment of the touching of A to B was set by adjusting the distance between the tip of the device and the surface of the tongue as shown in Fig. 1. The moment was used as trigger time in the procedure for averaging the evoked potentials obtained. The conventional technique to find the response by stimulus of the taste solution was controlled with the use of a magnetic valve (Lester and Halpern, 1979; Kelling and Halpern, 1986; Prescott, 1994). The procedure had a defect in detection of the latency, since the position giving the solution was set far away from the tongue where the solution was given, so that the latency obtained included a long lag time, and the value of the latency obtained was not correct.

The trigger signal detected was sent from the laser beam device to an electroencephalograph (Neuro-Pack Eight, Nihon-Kohden Co., Japan). An amount of taste solution (0.5 cc) is placed on the surface of the tongue just after the tip (8 mm in diameter) of the plastic bottle comes into contact with the surface of the tongue. The process in which the taste solution is placed on the surface of the tongue is as follows. The first step is when the tip A of the bottle of the taste solution comes into contact with the tongue. The second step is at the time the subject feels the sensation of contact as well as the sensation of taste. The latency of gustatory response differs from the latency of the sensation of contact, and they are discriminable by the difference of their latencies (stated later in the Results section).

The taste solution given was kept at 35°C and the bottle A was soaked in distilled water of 35°C. The material of the tip of A was also softened by the distilled water, so that the influence of the sensation of touch on the tongue was reduced by the treatment.

Recording of evoked potentials and statistical analysis of latencies at the peak evoked potentials

EEG was measured in a quiet room with an area of 12 m^2. The subject was instructed to sit on a chair in a relaxed state. The subject closed his eyes just before the moment the taste solution was given. The subject was requested to sleep well the night prior to the test. A one minute rest time between the tests was taken, so that the results were not affected by fatigue of gustatory sense or adaptation. The temperature of the measurement room was kept at 20–23°C and the time for the measurement was from 2:00 to 5:00 in the afternoon. The condition of the measurement was the same as used by Henkin and Christiansen (1967). Following the study of Henkin and

Table 1 Contents of artificial saliva*

Substance		Contains (mg/50 g)	Concentration (M/l)
Sodium chloride	(NaCl)	42.2	1.4×10^{-2}
Potassium chloride	(KCl)	60.0	1.6×10^{-2}
Calcium chloride	($CaCl_2$)	7.3	1.3×10^{-3}
Magnesium chloride	($MgCl_2$)	2.6	5.5×10^{-4}
Monobasic potassium phosphate	(K_2HPO_4)	17.1	2.0×10^{-3}

*Commerical name: Saliveht® (Teijin Co., Ltd., Japan).

Christiansen, similar room temperature and experiment time were employed. For example, Yoshii et al. (1981) experimented at the room temperature of 21 ± 1 degree C. As for the experiment time, Yamamoto et al. (1985) experimented from 2:00 to 4:30 in the afternoon.

The time constant of the amplifier was taken to be 0.3 s and the frequency of the high-cut filter was 30 Hz. Although the cortical site where the gustatory area exists was the temporal region, the vertex (Cz; 10/20 international system) was used in the study because it is a good site for recording gustatory evoked potential according to Kobal (1985). In the measurement of evoked potential, the monopolar leading between Cz and A1 (the left lobe) was taken, and the ground was set on F_{PZ}. The silver-silver chloride electrodes of 7 mm in diameter (Nihon Kohden, NE-121B) were used. Electrode impedances were adjusted to be less than 5kΩ. The period for analysis of evoked potential was measured to be 1000 ms. The number of taste stimuli was eight and each day evoked potential was recorded and the procedure for average of the evoked potentials was performed after the measurement.

The statistical difference between the values of the latencies before and after treatment with a sweet suppressing agent was evaluated by means of a t-test for the paired data.

Evoked potentials for four taste qualities and artificial saliva

The contents of the artificial saliva used are shown in Table 1. The concentrations of taste solutions indicating the maximum evoked potential obtained by Min and Sakamoto (1997) were used in the study (Table 2). The evoked potentials of the artificial saliva were compared with those for each taste solution. In the measurement of evoked potentials, only one kind of taste quality was given every day to remove the adaptation or fatigue of the tongue.

Stimulus parameters for evoked potentials

According to Tomita et al. (1986), the chorda tympani nerve on the tongue exists at the apex of the tongue, and the left and the right sides of the chorda tympani nerves make a fan shaped crossing. Hence, the site of stimulation in our experiment was 20 mm from the apex of the tongue and 15 mm from the left side of the center line as shown in Fig. 1. Sato et al. (1975) employed the chorda tympani nerves as the best response site for the four taste qualities. The taste solution with four taste qualities was used and the evoked potentials were measured, and then the subject chewed gymnemate gum containing a 1% GS extract for 10 minutes. After chewing the gum, evoked potential was measured by giving the subject the same taste solution again. The detailed procedures for the taste solution are as follows:

Table 2 Taste solutions

Taste solution	(taste quality)	Concentration* (M/l)
Sodium Chloride	(Salty)	1
Sucrose	(Sweet)	0.1
Tartaric acid	(Sour)	0.12
Quinine-HCl	(Bitter)	0.03

*The concentrations which solutions of four taste qualities indicate the maximum value of evoked potential are chosen in the study.

(1) The oral cavity was rinsed with distilled water to remove any influence of saliva on the tongue. The tongue was protruded forward slightly, and the experimenter held the apex of the tongue using a piece of gauze. After the experimenter ascertained that the evoked potential was stable, he placed the artificial saliva on the tongue as a control solution in order to compare the response of the artificial saliva with the gustatory evoked response regarding the taste solution. The evoked potentials for the control solution were measured.

(2) After the taste solutions were given to the tongue and the evoked potentials were measured, the subject was asked about the presence or the absence of the perception of the taste given after each measurement, and the data of evoked potentials without perception of taste were removed. That is, only the perceived evoked potentials were used for the average. The averages of the evoked potentials were thus obtained. In the preliminary experiment, the average of eight evoked potentials and the average of thirty evoked potentials were both examined, and the results revealed similar evoked potentials, so in the study the averaging number used was eight. The duration

time of the stimulation with one taste solution was two seconds. Kobal (1985) fixed 50–60 s for the time intervals of stimulations with a taste solution. In our study the time interval between stimuli with taste solutions was 60 s.

According to Sato (1963) the solutions of four taste qualities show the maximum sensitivity near body temperature in the measurement of evoked potentials. Hence, the temperature of all the taste solutions and control solutions was maintained at 35°C to remove the effect of a warm sensation.

Evaluation of evoked potentials

The evoked potentials resulting from the solutions of the four taste qualities and from the control solutions were compared. The evoked potentials for the four taste qualities before and after the treatment with gymnemate chewing gum for 10 minutes were examined.

The evoked potentials for the taste solutions had two positive maximum peaks with the latencies at approximately 50 ms and 180 ms. In the study, the latency was defined as the period between the moment when the stimulation of solution was given to the tongue and the time when the evoked potential had a peak with plus or minus amplitude. The peak of the evoked potential was evaluated as follows. The maximum value of the level of the evoked potential (P wave) or the minimum one (N wave) was determined with the precision of 0.2 μV by the operation of the cursor line used in the visual display set in the apparatus of electroencephalograph (Neuro-Pack Eight).

Evoked potentials influenced by a sweet suppressing agent

It is considered that there exists the possibility that the evoked potentials induced by taste solution stimulation include not only gustatory evoked potentials but also somatosensory evoked potentials by stimulation of the trigeminal nerves caused by touch and pressure senses. Hence, the evoked potentials for four taste qualities before and after chewing the gum containing the 1% GS extract were examined. Moreover, the somatosensory evoked potentials stimulated by the trigeminal nerve in which touch and pressure senses which seem to be involved were studied from the viewpoint of evoked potentials for the solutions of four taste qualities and the artificial saliva.

Results

Evoked potentials induced by stimulation of a taste solution

The evoked potentials by stimuli of a solution of four taste qualities in chorda tympani were measured. The optimal number of the average of the evoked potentials was investigated. Firstly, the examples of evoked potentials of sour stimulus for one subject are shown in Fig. 2. The lower parts of Fig. 2 are the evoked potentials for the sour stimulus, while the upper parts show the evoked potentials for the artificial saliva. The number in ordinate denotes the number of the average of the evoked potentials. The sharpness of the peak P2 at approximately 180 ms grows dim because of the increase of the amount of superimposure of evoked potentials. The numbers 5 to 8 denote clear sharpness of the positive peak of the evoked potentials at approximately 180 ms for all the subjects. The other positive peak P1 at approximately 50 ms was determined for all the subjects. The sharpest peak of P1 was obtained by the average of eight evoked potentials of the artificial saliva.

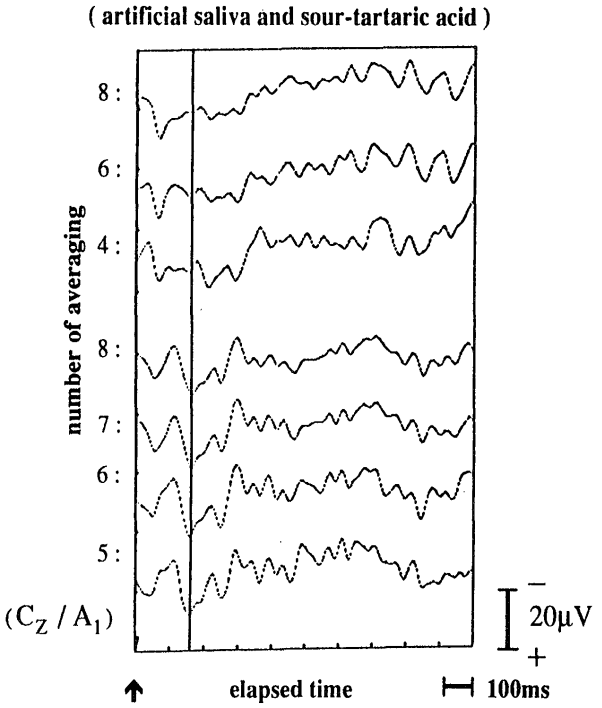

Fig. 2 Averaged evoked potentials. The number in ordinate means the number of evoked potentials added in average. The upper parts of the three evoked potentials denote the averaged evoked potentials of artificial saliva, and the lower parts show the evoked average of 0.12 M of tartaric acid. The arrow indicates the onset of stimulation.

Secondly, the typical patterns of the evoked response to a salty taste before averaging are shown in the upper part of Fig. 3, and the lower parts are the average of the evoked potentials. The upper figures give the two main positive peaks at approximately both 50 ms and 180 ms. The averaged evoked potentials indicate also two clear reproducible positive peaks at approximately 50 ms and 180 ms. The optimal number of evoked potentials in the average denotes 5 to 8 for all the subjects. The comparison of the evoked potentials from the salty stimulus in Fig.3 with those of the artificial saliva and the sour stimulus shown in the upper figures (8, 6, 4) in Fig. 2 denotes that the peak P1 commonly generates both the

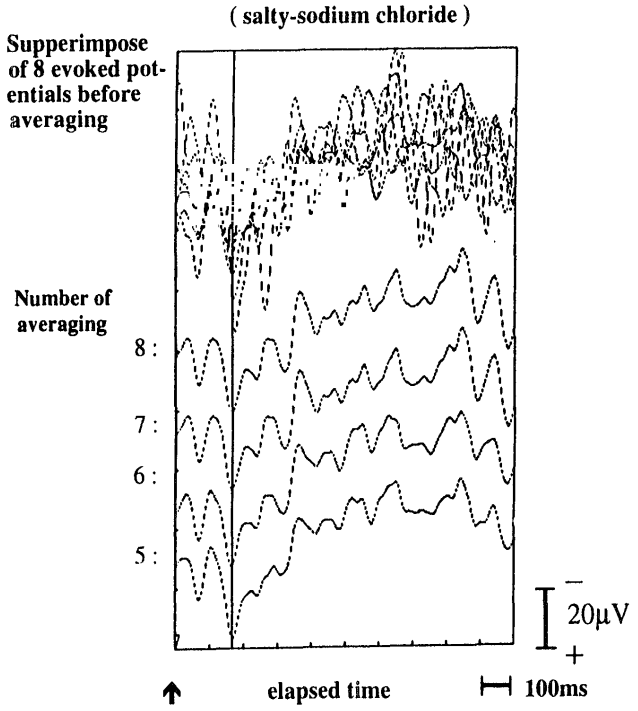

Fig. 3 Evoked responses of 1M of sodium chloride before averaging. As for the number in ordinate of the lower parts, see the footnote in Fig. 2. The arrow indicates the onset of stimulation.

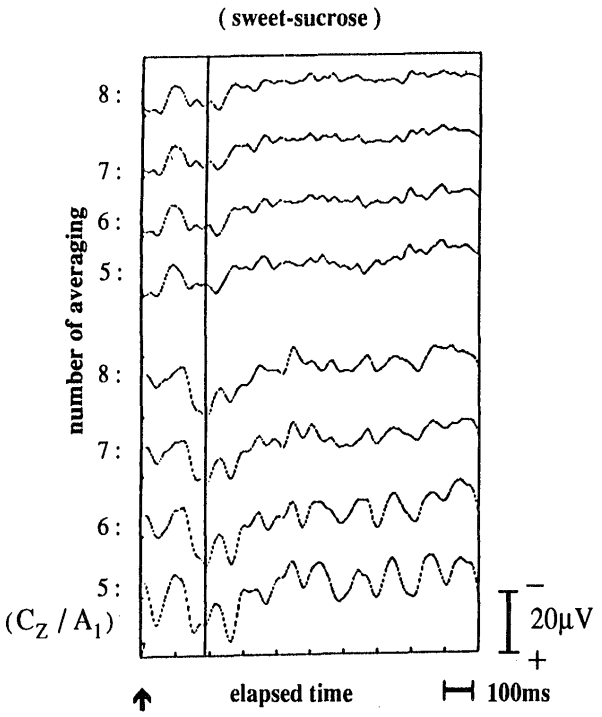

Fig. 4 The comparison between evoked potentials of 0.1 M of sucrose before and after chewing the gymnemate gum (sweet suppressing agent) for 10 minutes. The lower parts of four curves indicate the evoked potentials before the chewing gymnemate gum, while the upper parts denotes those after the chewing gymnemate gum. The recordings show that the evoked potentials by stimulation of 0.1 M of sucrose shown in the upper parts was abolished at approximately 180 ms. The arrow indicates the onset of stimulation.

taste solutions and the artificial saliva. The results mean that the origin of the peak P1 is estimated to be the touch sense of the solution stimulus. The observation of stable positive response waveforms as shown in the upper figures of Fig. 3 proves that this method is a stable technique. Positive response waveforms similar to those in Fig. 3 were also observed in other subjects, though differences in the latencies were seen. Thirdly, the taste stimulus of sweet and bitter also gave two positive peaks which were the same as that of the sour and salty tastes denoted. The examples for the solutions of the sweet and bitter taste are shown in the lower parts in Fig. 4 and the left side figures in Fig. 5, respectively.

Evoked potentials influenced by the treatment of a sweet suppressing agent

In order to determine the origin of the two positive peaks P1 and P2 for the sweet stimulus, a gum containing the GS extract which caused a sweet sense paralysis was used. The evoked potentials for the sweet stimulus were measured before and after treatment with the gymnemate gum. The examples are shown in Fig. 4. The lower parts of the figures are the evoked potentials before chewing the gymnemate gum, while the upper parts are the evoked potentials after chewing the gymnemate gum for 10 minutes. The peak P2 is shown at the positive peak at approximately 180 ms before chewing the gymnemate gum, but the positive peak is not detected after the treatment of the sweet suppressing agent. Therefore, the positive peak P2 is considered to be the response of the sweet stimulus. The optimal number of evoked potentials for average is eight for all the subjects as shown in the example in Fig. 4. The positive peak P1 existed at approximately 50 ms and it is irrespective of the treatment of the sweet suppressing agent. The peak P1 is considered in the study to be the response of the touch sense of the solution. The elucidation of the origin for the peaks P1 and P2 means that response of the touch sense is faster than the response of the taste sense when the taste solution is given on the innervation area of the chorda tympani nerve of tongue. The peak P2 for the taste stimuli, except for the sweet stimuli, was not affected by the extract of GS. The results are shown in Fig. 5, and the mean latencies of P2 for all the subjects are given in Fig. 6. The resultant values of the mean and the standard deviation for the peak P2 before the treatment of the gymnemate gum containing the extract of GS are as follows: 182 ± 47 ms for bitter, 158 ± 26 ms for sour, 167 ± 34 ms for salty, and 177 ± 42 ms for sweet. The significant differences between the latencies before and after the treatment of the gymnemate gum

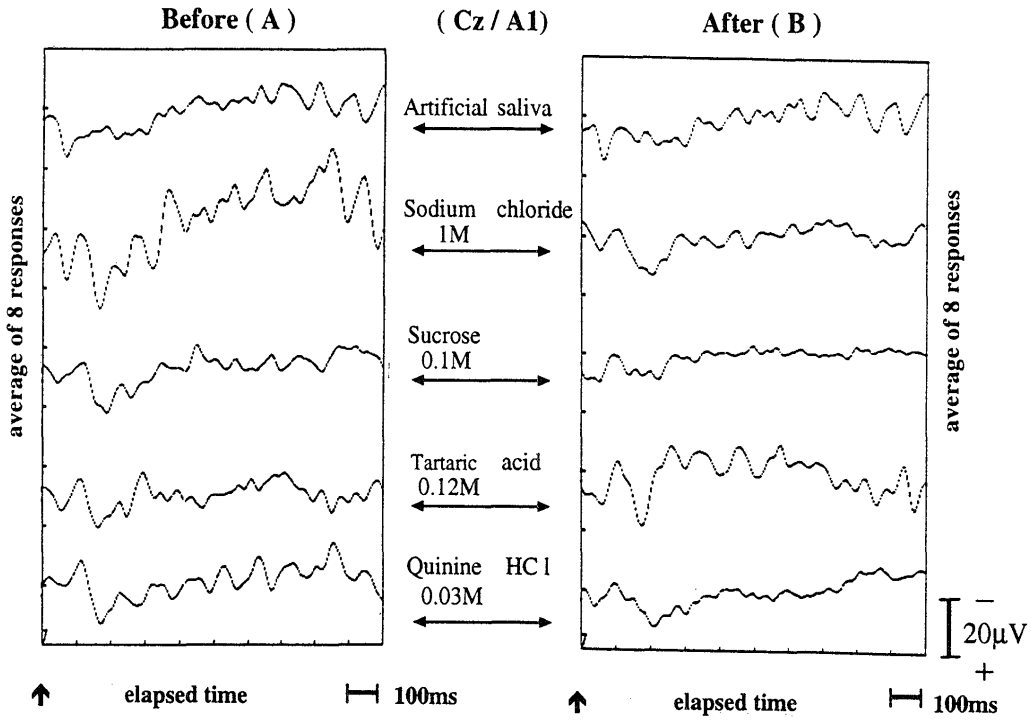

Fig. 5 Examples of typical evoked potentials to the different taste solutions according to the four taste qualities. The evoked potentials are averaged on eight responses for the four taste qualities and control solution. The evoked potentials, before and after treatment with gum chewing for 10 minutes, are shown. The arrow indicates the onset of stimulation.

were not recognized by the significant level of 5% for taste stimuli except for the sweet stimulus, while the peak P2 for the sweet stimulus vanished after the treatment with the gymnemate gum.

In the next place, the amplitude of a peak (P_A) of the evoked potential should be described. The amplitude was defined as the evoked potential difference between the peak concerned (P_A) and the neighbouring peak (P_B) prior to the peak (P_A). Namely, the amplitude of a peak was obtained as the evoked potential difference for the neighbouring peaks (i.e., P_A and P_B). As for the amplitudes of the evoked potentials P2 before and after the treatment of gymnemate gum, the results were shown in Fig. 6. The significant difference was recognized only for the sweet substance. The effect of gymnemate gum to the evoked potential is found in the first place in this study. As for the amplitude of P1, which was obtained to be the potential difference between N0 (i.e., small peak prior to P1) and P1, the amplitude showed the value larger than 1 μV. The noise level at approximately 50 ms denoted the value less than 0.5 μV, so that P1 could be distinguished from the potentials originated by noise.

Discussion

On the latencies of gustatory evoked potentials

Funakoshi and Kawamura (1968 and 1971) measured the evoked potentials induced by salty and sour tastes, but not by sweet and bitter tastes. Namely, the evoked potentials for four taste qualities were not obtained in their studies. They reported that the latencies of evoked potentials obtained were spread more over a wider range of 500–1500 ms. Kobal (1985) developed the apparatus for gaseous taste stimulus to remove touch stimuli, and he obtained pure taste stimulus. He measured the evoked potentials using a stimulus with a rising time below 20 ms and a duration of 200 ms. The obtained latencies were composed of four major components, that is, the positive peak at 300 ms, the negative peak at 410 ms, the next positive peak at 660ms, and the next negative peak at 860 ms. Although definite evoked potentials were obtained by gaseous taste stimulus, the stimulus did not make clear the definite number of taste organs stimulated or the definite innervation area of taste organ activated by the gaseous stimulus. Ikui (1988), using sophisticated taste stimulation that delivered a taste solution to a small area of the tongue surface innervated by the chorda tympani nerve, described a negative evoked potential (200~600 ms) produced by solutions of 1 M NaCl. Maetani et al. (1989) reported a triphasic wave with a positive peak at 350 ms and two negative peaks at 200 ms and 1000 ms for a salty stimulus of 10% NaCl. They determined that the second negative peak was the response correlated to a salty stimulus.

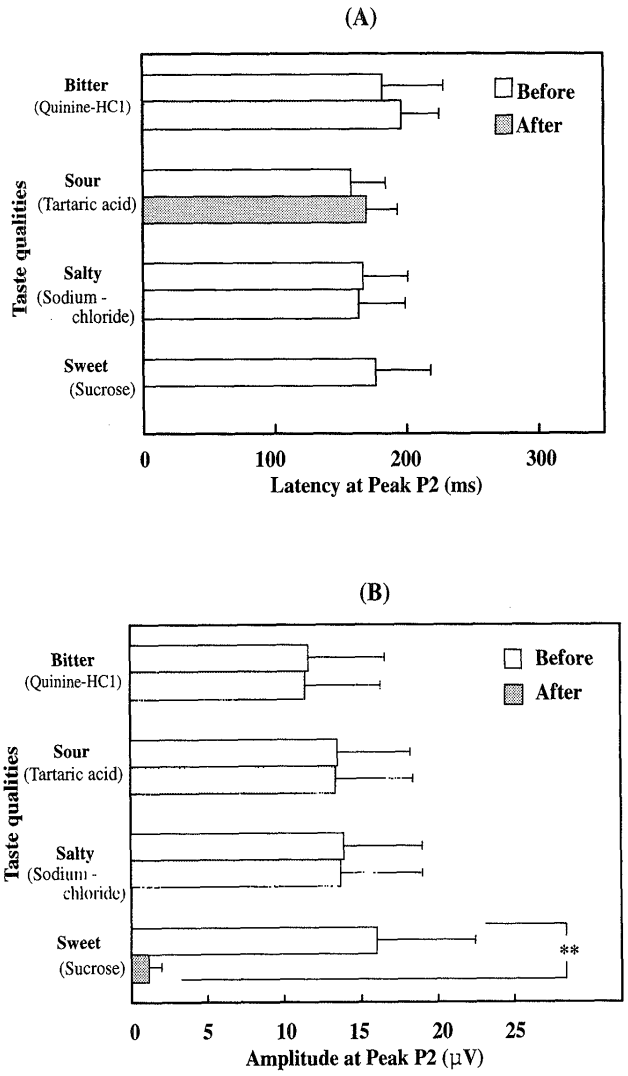

Fig. 6 Mean values and the standard deviation (S.D.) of (A) latencies at P2 for the four taste qualities before and after treatment with a sweet suppressing agent and of (B) the amplitudes. Before and after denote the latencies at P2 before and after treatment with a sweet suppressing agent. No significant differences between the *latencies* at P2 for the taste solutions of bitter, sour, and salty substances before and after treatment with a sweet suppressing agent are indicated. As for the sweet stimulation, the latency after treatment with a sweet suppressing agent was not obtained. As for the *amplitudes*, the significant differences for only sweet substance was recognized by 1% significant level.

Platting (1991) denoted that the influence of a tactile sense to the tongue could be removed with the use of a jet of distilled water by the application of the principle of olfactometer. He obtained a latency of 410 ms for a negative peak and 1200 ms for a positive peak for a salty stimulus of 1.2 M NaCl.

These authors stated above reported a long latency of more than 200 ms. The reason why conventional studies have obtained a longer latency compared with the latency of around 180 ms obtained in our study is explained as follows: The taste solution was controlled by means of an electromagnetic valve in the apparatus for the presentation of the taste solution. The solution passed through a long tube, and it arrived to the surface of tongue. Though the time that taste solution was given was considered to be the time of the opening the electromagnetic valve, the correct stimulus time given should have been the moment that the taste solution touched the surface of the tongue. There existed a time difference between the opening time of the electromagnetic valve and the touching time of the taste solutions on the tongue. Therefore, the conventional studies usually included the time lag for the dose of the taste solution, and they did not give the correct latency in the response for the taste solution stimulus. Recently, a new technique was applied using a magnetic field to study the gustatory evoked potentials, and the results showed a latency of less than 200 ms. Murayama et al. (1996) applied this technique to a taste solution of 10% glucose and 0.3 M NaCl, and they obtained the latency of 150 ms to 210 ms as the response of the taste solutions.

Kobayakawa et al. (1996) also reported a latency of 172 ms for saccharin by magnetoencephalography. In our study, the amplitude and the latency of peak P2 depended on the kind of taste qualities and on the concentration of the taste solution (Min and Sakamoto, 1997). The amplitude did not increase when the concentrations exceeded certain value when the evoked potential gives the maximum amplitude, (e.g., 0.5 M for sodium-chloride). Namely, the amplitude showed the tendency for the saturation in the concentration to exceed a certain value. A similar result was reported for the visual evoked potentials of P100 (Kurita et al., 1992). The resultant latency for P2 with the maximum amplitude in our study existed in the range 150 ms to 200 ms as shown in Fig. 6. Our results show the close values obtained by the new technique.

Evoked potentials influenced by the treatment with a sweet suppressing agent

An electrophysiological study on the sweet suppressing agent was first applied to a dog by Anderson et al. (1950). They gave the GS extract to the dog and then they investigated the response of the chorda tympani nerve after dropping saccharin and sucrose solutions. It was reported that the responses were abolished completely. The study in humans was started by Diamant et al. in 1965. The complete eliminations of the neural response to 0.5 M of sucrose after using the 1% GS extract was recognized by Diamant et al. (1965), Borg et al. (1967), and Zotterman (1971). The NaCl solution, citric acid, and quinine-HCl, that is basic taste qualities solutions except for sweet stimulus, did not change neural response after using the GS extract. They studied the change of neural response but did not measure

the evoked potentials, so that both the latency and the position on the sensory area of cortex were not studied. Kurihara (1969) studied psychologically the effect of a sweet suppressing agent with the use of a pure substance of gymnema (GAA_1) by a sensory test. The solution with the amount of 1×10^{-4} M GAA_1 suppressed completely the sweet taste of 0.3 M of sucrose solution. The effect continued for 15 minutes just after taking the solution of GAA_1 solution. Bartoshuk et al. (1969) also reported that 0.5 mg/ml gymnemic acid completely depressed the psychological response to 0.3 M sucrose in humans.

Kobayakawa et al. (1996) measured a cerebral magnetic field using an apparatus with taste stimulation. In the experiment, the subjects chewed gymnemate gum containing an extract of GS for 15 minutes, and then they took the taste substance containing 3 mM of saccharin. It was recognized that the magnetic response for the saccharin were abolished after chewing the gum for 15 minutes. These studies stated above by Diamant et al. (1965), Borg et al. (1967), Zotterman (1971), and Kobayakawa et al. (1996) did not investigate the peak of the evoked potentials. In our study, the evoked potentials before and after the treatment of gymnemate gum are obtained in Fig. 5. It was found that evoked potential of P2 at approximately 180 ms was completely abolished. The origin of the evoked potential at approximately 180 ms was recognized as the peak for the sweet solution. The effect of the extract of GS to other taste qualities except for sweet (i.e., salty, sour, and bitter tastes) was not recognized in the peak potential at approximately 150–200 ms. The determination of the origin of P2 is found in the first place by this study with the use of the evoked potential. As for P1 at approximately 50 ms, the peak was commonly measured for both four taste qualities and artificial saliva. Ishiko et al. (1980) reported a latency of somatosensory response stimulated by tapping the tongue in a human using surface electrodes. Their results showed the latencies in the range of 12.9 ms to 47.8 ms, so that the peak P1 obtained in this study is considered to be the peak produced as a somatosensory response.

Conclusions

The evoked potentials detected by the laser beam device were measured for the solution of the four taste qualities. The concentrations of solutions which gave the maximum positive evoked potentials at approximately 180 ms were selected. Artificial saliva was used as a control solution. In order to discriminate the positive peak in the range of less than 200 ms, the sweet suppressing agent, which is the gymnemate gum containing 1% GS extract, was applied. The influence of the sweet suppressing agent to the evoked potential was checked by measuring the evoked potential before and after treatment with the gymnemate gum.

1. The evoked potentials for the solutions of the four taste qualities have two positive peaks at approximately 50 ms and 180 ms in the latency range of less than 200 ms. These peaks are called P1 and P2. The evoked potential for the artificial saliva is recognized at only one positive peak at approximately 50 ms.
2. The positive peak at approximately 50 ms, P1, happened commonly for the solutions of the four taste qualities and the artificial saliva, so this peak is considered to be a response originated by the senses except for the taste sense. The main factor is estimated to be the touch sense of a solution given.
3. The positive peak P2 at approximately 180 ms for sweet stimulation (sucrose 0.1 M) was investigated by applying the sweet suppressing agent. After chewing the gymnemate gum containing the 1% GS extract for 10 minutes, it was found that the peak P2 was abolished, so the peak with the latency at approximately 150 to 200 ms can be attributed to the response to taste stimulation. The effect of the gymnemate gum containing the extract of GS was recognized for the peak P2 until 30 minutes after the 10 minutes of gum chewing stopped.
4. The positive peak P2 for the solution of taste qualities except for the sweet solution was not affected by the sweet suppressing agent.

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