

# Evoked Response to Taste Stimulations

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**Abstract:** For the recording of gustatory evoked responses, the tip of a stimulator is pressed vertically on one side of the tongue until the trigger pulses are generated by a switch attached to the bottom of the stimulator. According to our results, no detectable response was observed in the absence of taste. The positive waves were distinguishable by using the technique of superimposition before averaging, and the positive wave was made clearer by averaging.

**Key Words:** evoked response; facial nerve function; taste examination

Whereas the other sense organs function with only one nerve, the transmission of the sensation of taste to the brain is achieved by a number of nerves, including the glossopharyngeal and intermediate nerves and a small section of the vagal nerve [1]. In addition, the gustatory nerve fibers of the intermediate nerve pass through a nerve bundle consisting of the lingual, the greater petrosal, and the facial nerves. The taste of food is sent to the brain as gustatory information passing through a total of four nerves on each side: glossopharyngeal, facial, vagal, and greater petrosal nerves [1,2]. Thus, the separate taste examination of each area of gustatory innervation is necessary in clinical practice in treating patients with taste disorders. For example, in the taste examination of patients with peripheral facial nerve palsy, such as Bell's palsy, the use of filter paper discs or an electrogustometer renders possible the detection of unknown taste disorders in more than 30% of affected cases [1].

However, these techniques have the disadvantage of being subjective. Therefore, the separate taste examination of each area of gustatory innervation by an objective measurement of gustatory function, such as evoked response technique, is expected to become the standard measuring technique, to assure comparability and reproducibility. Many different approaches for the recording of gustatory evoked potentials have been employed [3–6]. However, none of them has been standardized for use in the clinical testing of taste. We now introduce

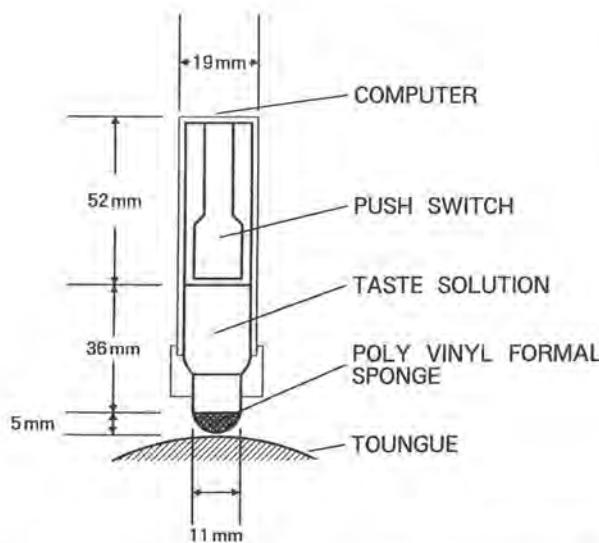
our technique of gustatory stimulations in the region of the tongue innervated by the chorda tympani nerve to establish an objective measurement of gustatory function and to localize the facial nerve lesion by an evoked response technique.

## SUBJECTS AND METHODS

The study population consisted of 11 apparently healthy male Japanese nonsmokers aged 28–34 years. Our device for the recording of evoked response to taste stimulations is shown in Figure 1. The tip of a stimulator is pressed onto the tongue so that the bottle containing the taste solution pushes a switch attached to the bottom of the stimulator until the trigger pulses are generated by a switch. An amount of taste solution (approximately 0.1 ml) is given in each presentation on the tongue through the polyvinyl formal sponge attached to the tip of the stimulator. The polyvinyl formal sponge is originally hard but soon becomes soft and elastic when wet. It will quickly expand again after administering a taste solution. The tracing starts 300 msec prior to a trigger signal, so the switch is pressed just after the start of administering the taste solution on the tongue surface. The most effective pressure to generate a trigger pulse in a certain period just after the start of administration was 170 g, according to our previous study.

An electroencephalogram was recorded by the same method with olfactory evoked responses. The practical technique of our examination is as follows: A patient was instructed to lie supine on a bed. The patient's tongue was protruded forward slightly, and an experimenter held the apex of the tongue with a piece of gauze. The tip of the stimulator was pressed vertically onto one side of the tongue until the trigger pulses were

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**Figure 1.** Our device for recording evoked responses to taste stimulations. The tip of the stimulator is pressed on the tongue until a switch at the bottom of the stimulator is pushed by the bottle containing a taste solution to generate a trigger pulse. An amount of taste solution (approximately 0.1 ml) is given in each presentation on the tongue through the polyvinyl formal sponge attached to the tip of the stimulator.

generated by a switch attached to the bottom of the stimulator. After administration of the taste solution, the patient's tongue surface was cleaned by using a filter paper gently and quickly. After eight responses had been recorded, the results were averaged by a Neuropack 4 computer (NIHON KOHDORU Co., Japan).

Artificial saliva having no taste was applied as a control solution (Table 1). Each individual was tested mainly by using two taste qualities: 20% glucose and 10% sodium chloride. Gustatory stimulation was presented once in 30 seconds so that the results were not affected by the fatigue of gustatory sense or adaptation. Each new and higher solution concentration was presented after an interval of 15 minutes. The taste solutions and control solution given were maintained at between 30° and 34°C to remove the effect of warm

sensation, which will vary depending on the quality of taste.

The site of stimulation was the region of tongue innervated by the chorda tympani nerve. According to Tomita et al. [1], the chorda tympani of the tongue exists at the apex of the tongue, and the left and right sides of 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 center line.

## RESULTS

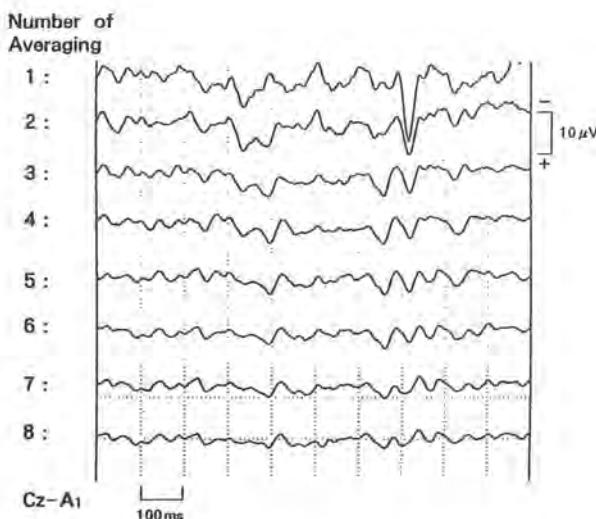
We detected no response in the absence of taste in normal young male patients (Fig. 2). A typical pattern of an evoked response to 20% glucose before averaging in a normal young patient is shown in Figure 3. Positive responses were detectable at a certain peak latency by using a superimposition technique. After averaging, a positive response became obvious (Fig. 4). In this graph, wave 8 represents eight times the total. As seen in the figure, the following data were obtained: Wave 4 or 5 shows the largest amplitude, and wave 7 or 8 represents the clearest wave. Administration of 20% glucose evoked a positive response with a peak latency at 72–197 msec in these 11 normal young patients.

A typical pattern of an evoked response to 3% sodium chloride in a normal young patient before averaging is shown in Figure 5. Positive responses were detectable at a certain peak latency by using a superimposition technique. After averaging, a positive response became obvious (Fig. 6). Also, each new and higher concentration of taste solution was presented after an interval of

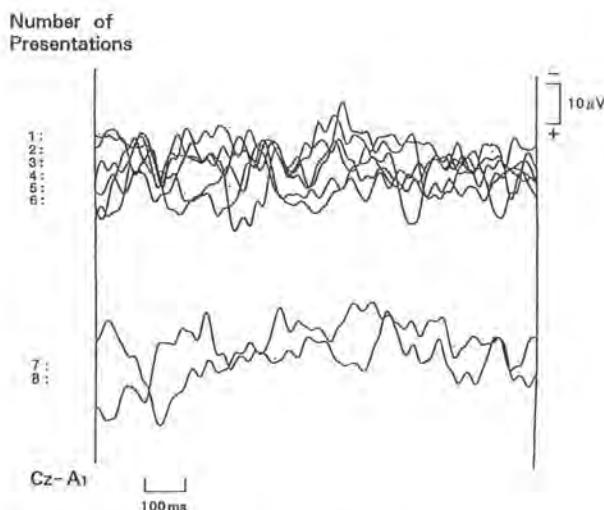
**Table 1.** Contents of Artificial Saliva\*

Substance	Milligrams per 50 Grams	Concentration (M/liter)
Sodium chloride (NaCl)	42.2	$1.4 \times 10^{-2}$
Potassium chloride (KCl)	60.0	$1.6 \times 10^{-2}$
Calcium chloride (CaCl <sub>2</sub> )	7.3	$1.3 \times 10^{-3}$
Magnesium chloride (MgCl <sub>2</sub> )	2.6	$5.5 \times 10^{-4}$
Monobasic potassium phosphate (K <sub>2</sub> HPO <sub>4</sub> )	17.1	$2.0 \times 10^{-3}$

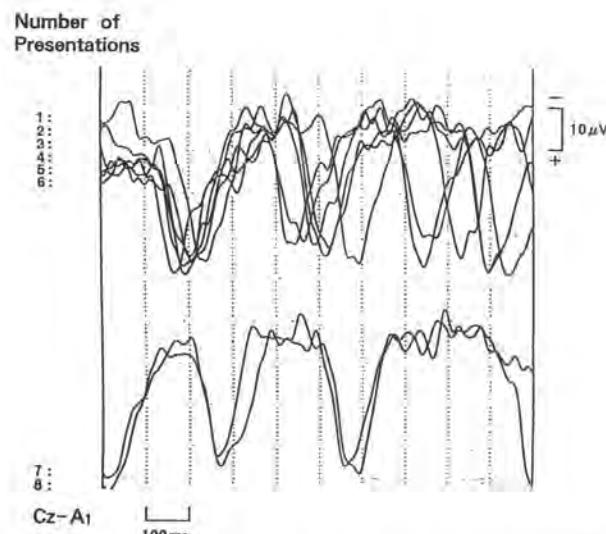
\*Commercial name: Saliveht (Teijin Co., Ltd., Japan).



**Figure 2.** Response in the absence of taste. No detectable response was seen as a result of the application of artificial saliva.



**Figure 3.** A typical pattern of an evoked response to 20% glucose before averaging. Positive responses were detectable at a certain peak latency by using a superimposition technique.



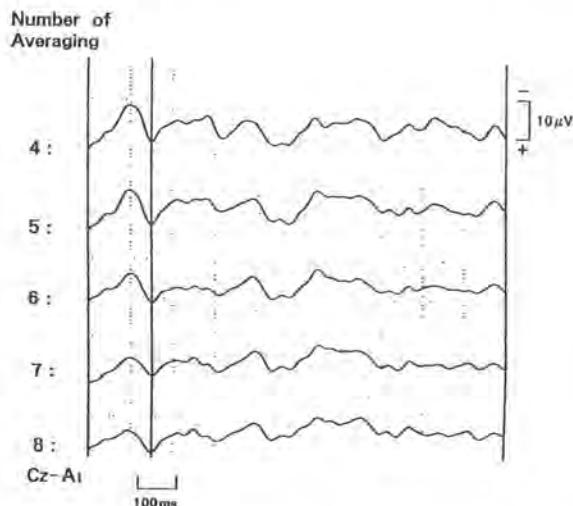
**Figure 5.** Response to 3% sodium chloride before averaging. Positive responses were detectable at a certain peak latency by using a superimposition technique.

15 minutes. Administration of 10% sodium chloride revealed a positive response with a shorter peak latency, as is shown in Figure 7. The shortening of peak latency was recorded for the more concentrated taste solution. Administration of 10% sodium chloride evoked a positive response with a peak latency at 84–188 msec in these 11 healthy young male patients.

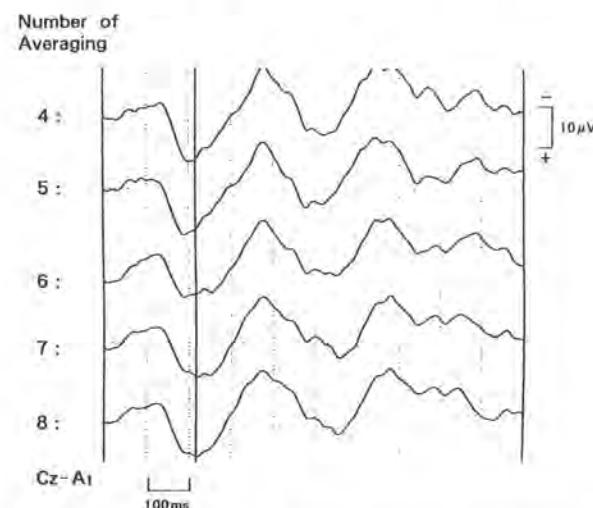
In our study, the positive waves were distinguishable by using the technique of superimposition before averaging, and the positive wave was rendered clearer

by averaging. Also, no detectable response was seen in the absence of taste in normal subjects. Accordingly, the positive response to the taste solution with a peak latency at around 70–200 msec in our study can be considered a specific result of gustatory stimulation. However, the latencies of positive response to the taste solution presented here has spread over a wide range from 70 to 200 msec. This was mainly due to the difference in elasticity or softness of the tongue.

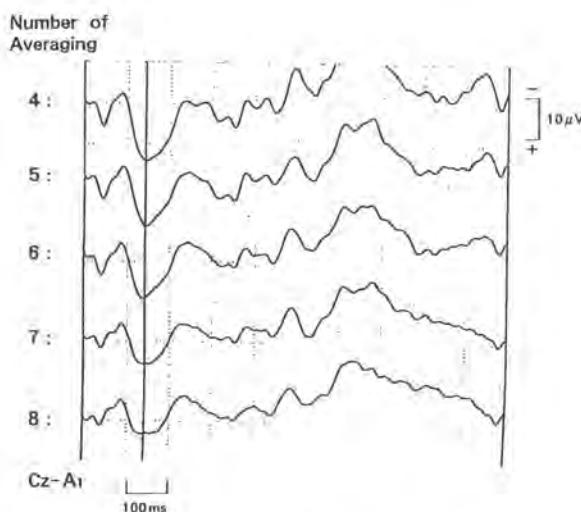
This peak latency of positive response obtained by our method may be not a true latency associated with



**Figure 4.** Response to 20% glucose after averaging, when a positive response became obvious. In this graph, wave 8 represents eight times the total. Note that wave 4 or 5 shows the largest amplitude, and wave 7 or 8 is clearest.



**Figure 6.** Response to 3% sodium chloride after averaging, when a positive response became obvious.



**Figure 7.** Response to 10% sodium chloride. Presentation of this solution revealed a positive response with a shorter peak latency. The shortening of the peak latency was recorded for the more concentrated taste solution.

taste stimulation, because a time lag exists for the dose of taste solution: That is, a time difference existed between the touching time of the taste solutions on the tongue and the generating time of the trigger signal. In our method, the tracing starts 300 msec prior to a trigger signal, so the switch for the trigger signal should be pressed just after the start of administering a taste solution on the tongue.

## DISCUSSION

Recording of gustatory evoked potentials for the objective evaluation of gustatory function has been attempted by many investigators [3–6], but a method of clinical practice in testing patients with taste disorders has not yet been standardized. Gustatory evoked potentials were not easily elicited, owing to problems associated with control of the stimulus. One reason mentioned for this is the confusion of gustatory evoked potentials, which include many sensations—not only taste but touch, pressure, and warmth [4]. Also, owing to chemical substances, quantifying the stimulus of a taste solution is difficult.

Moreover, the following basic problems should be considered when administering a taste solution to a patient's tongue. First, the timing of triggering (for the sake of averaging evoked potentials), the duration of stimulation, and the area of stimulation should be investigated. Second, in the addition of successive taste solution stimuli, fatigue or adaptation of the tongue occurs, by which the sensation for the taste solution decreases or completely disappears, and a definite time lag is

required for recovery from these phenomena. After examining the foregoing problems, we formed our new apparatus for stimulating the tongue with a taste solution.

The literature contains discussion of the evoked response to gustatory stimulation. Funakoshi and Kawamura [3] first reported gustatory evoked potentials. After that time, reports have been made by Kobal [4], Maetani et al. [5], and Min and Sakamoto [7,8]. Kobal [4] developed the apparatus for gaseous taste stimulus to remove touch stimuli. However, the stimulus did not make clear the definite innervation area of the taste organ achieved by the gaseous stimulus.

Min and Sakamoto [7,8] devised a new method: When the tip of the bottle of taste solution comes into contact with the area innervated by the chorda tympani nerve of the tongue, the taste solution is placed on the tongue and, at the same time, a laser beam detects the touching moment of the tip of the stimulator without contact between the device and the tongue. However, this technique is not available for use in the clinical testing of taste.

According to our technique for recording gustatory evoked response, the tip of a stimulator is pressed vertically onto one side of the tongue until the trigger pulses are generated by a switch attached to the bottom of the stimulator. The site of stimulation was the region of tongue innervated by the chorda tympani nerve. According to our results, the positive waves were distinguishable by using the technique of superimposition before averaging, and the positive wave was made clearer by averaging. Also, no detectable response was obtained in the absence of taste in normal young patients. Thus, the positive responses with a peak latency of 70–200 msec are evoked by the taste solutions (as described in our technique) and not by some extraneous stimuli associated with taste presentation (e.g., reaction to the tactile sense of the solution, a press of stimulator on the tongue surface, or holding of the tongue's apex). This evoked response technique will be useful for the objective evaluation of gustatory function of facial nerves, for detecting the presence of taste disorders, and for making an early diagnosis of facial nerve disorders.

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