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The Effects of Gum Chewing on the Body Reaction Time

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Key words: gum chewing, body response time, the long fibular muscle

Abstract:

In this study, we examined how gum chewing, which comprises masticatory movement obtained as an acquired function, affects sports performance by comparing physical movement response times between subjects playing sports with gum chewing and those not engaged in gum chewing. The subjects comprised 5 male adults with healthy teeth and jaws who were right handed (average age: 27.2 years old) and had no subjective or objective abnormalities in the mandibular joints or masticatory muscles, etc., and had received sufficient explanations regarding the purpose of this experiment and had agreed to participate therein. As for test muscles, we selected the right and left masseter muscles, the medial great muscle of the quadriceps femoris muscle, the gastrocnemius muscle, and the long fibular muscle, for a total of five muscles. Moreover, all of the muscles other than the left masseteric muscle were the muscles of the right leg. We measured the reaction time of the long fibular muscle and the physical movement response time. These items were compared with two variables: non-gum chewing and gum chewing. The result that there were no significant differences in either set of means, but the time tended to be shorter with gum chewing. The results of this experiment indicate that gum chewing shortens the body response time, provides the same mental effects as those previously reported, and may also provide a significantly positive effect on performance in sports.

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Introduction

In recent years, in professional sports such as baseball, it appears as though more players are chewing gum as they play. Particularly until recently, gum chewing during sports has been largely believed to have mental utility, but when a skill is required, it is believed that experience in sports performance is also necessary in addition to mental utility. Therefore, it is believed that elucidating the effects of gum chewing during sports from a perspective other the mental aspect would enable us to discover the efficacy of gum chewing, which is believed to enhance sports performance.

The masticatory system provides one of the most important oral functions in the growth and life maintenance of a human being. Moreover, it is said that in humans, chewing has the effect of improving various bodily functions. It is believed that these effects occur because information from sensory organs, such as the baroceptors in the alveolar periosteum and the muscle sensory receptors of the masticatory muscles, generated by the peripheral movement of chewing is transmitted to the nerves, resulting in enhanced activity in the brain cortex, etc.

Other reported effects of gum chewing include increases in blood flow to the brain and increases in blood pressure and heart rate,[1,2] as well as a calming effect and a stress-reducing effect,[3] etc., in terms of the psychological aspects, but there are only a few reports regarding the effects on the functions of physical movement.

Therefore, in this study, we examined how gum chewing, which comprises masticatory movement obtained as an acquired function, affects sports performance by comparing physical movement response times between subjects playing sports with gum chewing and those not engaged in gum chewing.

Method

1. Subjects

The subjects comprised 5 male adults with healthy teeth and jaws who were right handed (average age: 27.2 years old) and had no subjective or objective abnormalities in the mandibular joints or masticatory muscles, etc., and had received sufficient explanations regarding the purpose of this experiment and had agreed to participate therein.

2. Test muscles

As for test muscles, we selected the right and left masseter muscles, the medial great muscle of the quadriceps femoris muscle, the gastrocnemius muscle, and the long fibular muscle, for a total of five muscles. Moreover, all of the muscles other than the left masseteric muscle were the muscles of the right leg.

3. Gum used

As for the gum used in this experiment, we used gum that had been jointly developed by our laboratory and the Lotte Research Laboratory. This gum has no flavor and shows no significant change in viscosity after chewing for over 30 minutes. The gum was formed in 3-g plates (approx. 75 mm × 15 mm × 1.8 mm) containing maltitol as a carbohydrate, and it is a high-volume chewing gum that includes a large amount of gum base among the blended ingredients and has a typical peppermint flavor as the characteristic flavor.

4. Experimental method

The subjects stood on a plate for measuring floor reaction force with their knees bent so that they could react instantly, and they were instructed to jump quickly in response to a light stimulant from a light stimulation device comprising a 5-cm red light-emitting diode that had been placed at the height of their viewing level at a distance of 1 m. As for jumping, they were instructed to make maximum efforts toward speed and height. Furthermore, the intervals of light stimulation were random.

As for the measurement system, as shown in *Fig.* 1, the amount of activity by each muscle was measured with active electrodes (BioLog DL140, S&ME, Inc., Tokyo), the load was measured using load cells (LU-500KE, Kyowa Electronic Instruments Co., Ltd., Tokyo) that had been placed on each corner of the plate to measure the floor reaction force, a data logger (BioLog DL2000, S&ME, Inc., Tokyo) was used for recording the data, and the data were then transferred to a personal computer.

5. Items analyzed

1) We measured the reaction time of the long fibular muscle, which always reacts first among the muscles that were measured in this experiment. The peak value of the muscle activity of the long fibular muscle was measured, and the muscle was deemed as having reacted at the point at which it reached 10% of the peak value, and the time until that point was measured.
2) Based on the values of the load cells on the plate for measuring floor reaction force, the time until the feet left the plate was measured as the physical movement response time.

These items were compared with two variables: non-gum chewing and gum chewing. Furthermore, we randomly recorded fifteen responses each for these two variables.

6. Analysis method

Regarding the values that were transferred to the personal computer, the data were collected using a data-recording software program (m-Biolog, S&ME, Inc., Tokyo) and then were analyzed using an analysis software program, AcquKnowledge (BIOPAC System Inc., CA, USA). Subsequently, Student's t-test was performed using the SPSS11.0J (SPSS Japan Inc.) statistical analysis software program.

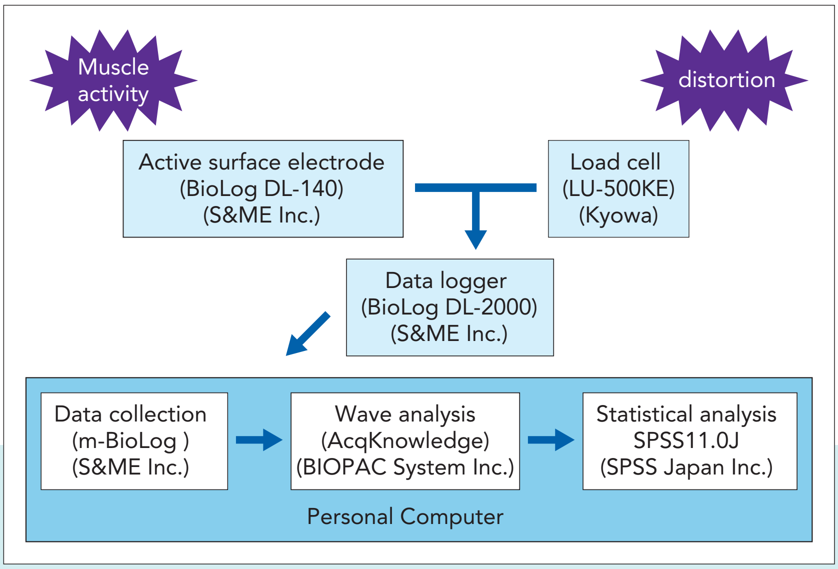

Fig. 1 Measurement and analytical system

Results

1. Waveform data

A typical example of a waveform is shown in *Fig.* 2. The far left side is set as the point at which the light stimulation was generated, and the arrow for the load cells indicates the point when the feet left the plate for measuring floor reaction force. The arrow for the long fibular muscle indicates the point when the muscle reacted.

According to this waveform, the muscles other than the masseter muscles all reacted before the feet left the plate for measuring floor reaction force. Moreover, in the five muscles that were measured (excluding the masseter muscles), the muscle that reacted first was the long fibular muscle.

2. Data of the physical movement response time

The mean values of the reaction times of the long fibular muscle in the 5 subjects are shown in *Fig.* 3. The test results are also shown in the figure.

The mean reaction times were 0.116-0.175 sec. for non-gum chewing and 0.0855-0.163 sec. for gum chewing when the subjects jumped with the main objective as speed and 0.136-0.188 sec. for non-gum chewing and 0.104-0.157 sec. for gum chewing when they jumped with the main objective as height. There were no significant differences in either set of means, but the time tended to be shorter with gum chewing.

Next, the values of the physical movement response time are shown in *Fig.* 4.

The mean values of the time were 0.372-0.510 sec. for non-gum chewing and 0.361-0.488 sec. for gum chewing when the subjects jumped with the main objective as speed and 0.522-0.633 sec. for non-gum chewing and 0.436-0.624 sec. for gum chewing when they jumped with the main objective as height. As with the long fibular muscle, there were no significant differences in either set of means, but the time tended to be shorter with gum chewing.

Discussion

Since the initial elucidation in human experiments that masticatory movement in-

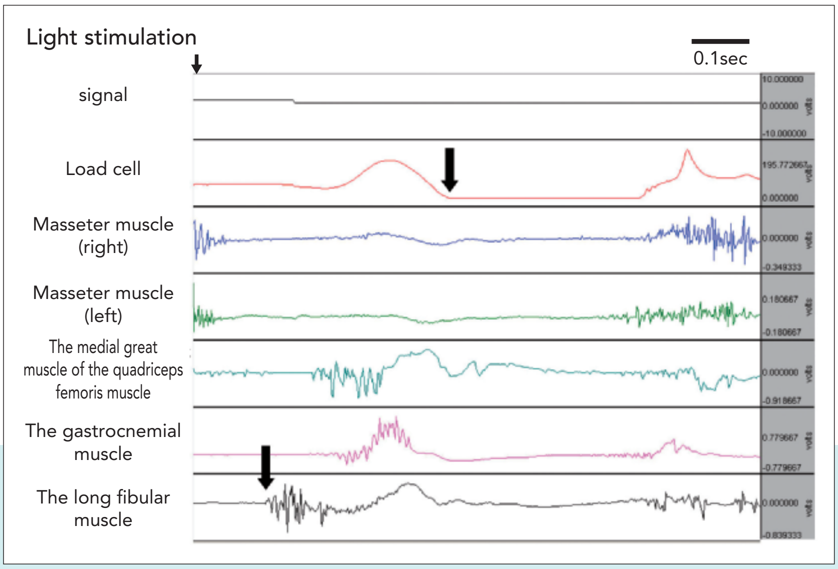

Fig. 2 Wave representation

creases blood flow to the brain,[4,5] a number of researchers have reported on the relationship between masticatory movement and general bodily functions.[6-12] It is said that increased blood flow allows for the sufficient supply of oxygen and nutrition that is necessary for cells and thereby promotes the activity of brain cells, and that kinetic and sensory information from the oral organs generated by masticatory movement activates the nerve circuits in the brain. Because of these effects, it is believed that masticatory movement enhances arousal levels[6] and cognition, indirectly facilitating an enhancement of physical capabilities. In animal experiments, it has been reported that the spacial cognitive ability of mice with masticatory failure due to a defective molar region decreases.[9] On the other hand, it has also been reported that masticatory movement produces such effects as a stress-reducing effect, a relaxing effect, and a stamina-increasing effect[10] as well as other mental effects.

Among these reports, as a report on a study on the relationship with response time, Matsunaga has reported that the time between the recognition of an object and the application of a brake (motor response time) was clearly shortened with gum chewing and speculated that information from the sensory organs that is generated by peripheral movement (i.e., gum chewing) enhanced the activity of the brain cortex and brain reticular formation.[13] Sabashi has analyzed the effects of gum chewing on brain function using endogenous elements of event-related potential as indices and has reported that gum chewing increased cognitive functions, including general levels of caution and arousal levels, and that it enhanced the degree of reaction in these cognitive functions while shortening response time.[14]

In this experiment, the jumping motion was used as a method of measuring the response time. This is because a jumping motion is often used as one of the items for measuring the physical fitness of athletes and the enhancement of jumping motion is closely related to the enhancement of performance results in sports, so we believe that it is an important performance factor in many sports. Therefore, we believe that a comparison of response time in jumping motion would provide practical results, and this experiment was conducted using jumping motion.

Moreover, Suzuki, et al. have reported that the hardness of gum causes changes in blood flow to the brain.[2] In their report, it is stated that chewing gum with a moderate hardness

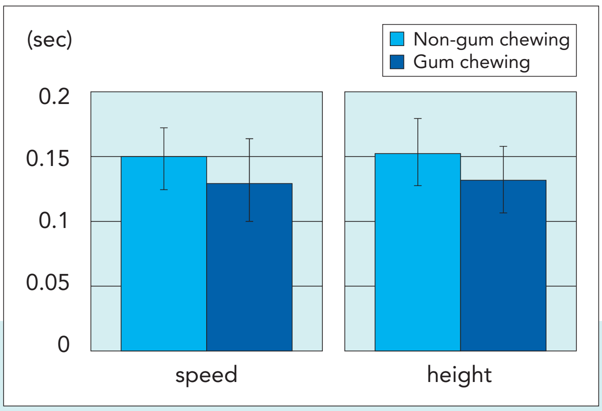

Fig. 3 Reaction time of the long fibular muscle

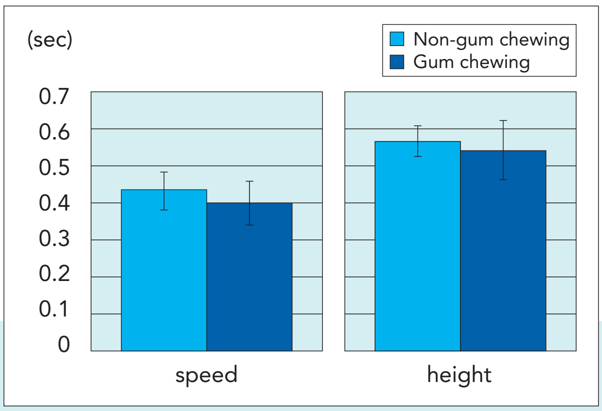

Fig. 4 Body reaction time

contributes more toward increasing blood flow in the brain than does gum that is too soft or too hard. Furthermore, it is believed that if the hardness of gum changes during an experiment, the experiment cannot be conducted under consistent conditions, so the results may vary to a large extent. We believe that we were able to conduct this experiment under consistent conditions, because the gum used for this experiment hardly changes in viscosity (i.e., hardness) even after being chewed for over 30 minutes.

In the results, no significant differences were observed in the time between initial stimulation and when the long fibular muscle reacted or the time until the feet left the plate for measuring floor reaction force, but the time tended to be shorter with gum chewing.

It is believed that this occurred due to mental elements such as an enhancement of concentration and a calming effect, etc., as well as organic changes such as increases in blood flow to the brain and blood pressure due to gum chewing.

Suzuki has studied changes in the blood flow to the brain caused by gum chewing[15] and has indicated that the blood flow increased by 35-60% at a resting state by 6 minutes after the initiation of chewing. Subsequently, a study of the tympanic temperature at a resting state and with gum chewing showed that the tympanic temperature increased as the hardness of the gum increased during gum chewing. It can be said that such increases in the blood flow to the brain are a prerequisite condition for increases in the level of arousal of the brain.

Moreover, Funakoshi, et al. studied the concentration of subjects with gum chewing using contingent negative variation (CNV)[16] and indicated that measurements of CNV without gum chewing showed the CNV to increase during prestimulation while decreasing once but then increasing again after 400-600 msec. However, measurements of brain waves during gum chewing showed the CNV values during prestimulation to clearly be higher than at a resting state without gum chewing and that these high values were maintained. We can therefore see that gum chewing increases the brain activity, thus enabling higher levels of concentration to be maintained.

Furthermore, Momose, et al. have reported on the extent to which gum chewing contributes to mental stability.[17] More specifically, a study on the relationship between gum chewing and mental stability using changes in adrenaline, noradrenaline, and plasma adenocorticotropic hormone as indices showed decreasing trends in adrenaline, noradrenaline, and plasma adenocorticotropic hormone after gum chewing. According to these results, it is hypothesized that gum chewing inhibits the activity in the sympathetic nerve system, thus resulting in reduced stress.

Based on our overall experience, gum chewing appears to reduce drowsiness while increasing levels of arousal. Nageishi et al. studied the subjective changes in the arousal level caused by gum chewing by using a questionnaire known as the UMIST Mood Adjective Checklist (UMACL).[6] They reported that the results showed a significantly higher energetic arousal scale during gum chewing.

According to the above, it is believed that gum chewing increases the level of activity in the frontal lobe of the brain, the oral region information makes the brain cortex more alert, and this alert state shortens the response time and thus positively affects sports performance.

Conclusion

The results of this experiment indicate that gum chewing shortens the body response time, provides the same mental effects as those previously reported, and may also provide a significantly positive effect on performance in sports.

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