

## Original Article

**Effects of original background music (BGM)  
on the mastication and swallow movements of elementary school lunch period**

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**Abstract**

**Purpose:** According to the 2015 Infant Nutrition Survey (Ministry of Health, Labour & Welfare, 2015), approximately 30% of Japanese children are unable to masticate effectively, and education to promote effective mastication movement in children with large individual differences in mastication ability is desired. The purpose of this study was to confirm whether mastication and swallowing education (MSE) using the original BGM for 10 minutes during a school lunch period consisting of a 20-minute meal time promotes masticatory and swallowing movements.

**Method:** The subjects were 100 children in three classes of first grade of elementary school (Kanagawa, Japan), and each class was divided into three groups: Group A) a control group with no BGM and no MSE, Group B) with BGM and no MSE, and C) with BGM and MSE, comprising of training for 3 weeks. The tempo of the original BGM was set to 120 beats per minute (BPM) based on the number of masticatory movements per minute (mastication speed); in this case, the average number was 58 times per minute. This average mastication speed was obtained from the quantitative data collected via video recording of the masticatory movement of the children who had participated in a previous study. The three groups were compared using the Kruskal-Wallis test along with the application of the Bonferroni correction to counteract the problem of multiple comparisons. The Wilcoxon signed-rank test was used for overall and quartile group comparisons.

**Results:** Between Groups A, B, and C post-intervention data, there was a significant increase in masticatory speed in a Group C ( $p < 0.05$ ). A significant increase in masticatory speed was observed in a Group C considering the pre-and-post-intervention same group data the intervention ( $p < 0.05$ ). In the pre-and post-quartile comparisons of each of the three groups, a significant increase in masticatory speed was observed only in a Group C, first group (low masticatory speed group) ( $p < 0.05$ ).

**Conclusion:** MSE with original background music created based on the human factor experiment conducted by Sakuma et al. reported in 'Int J of Social Sciences, 6(2), 193-207, 2020' improved children's masticatory speed. Especially, it was found to be particularly effective for children with slow masticatory speed, and we propose this as an educational method to promote mastication and swallowing movements during school lunch time for elementary school children.

**Keywords:** mastication and swallowing, background music, masticatory speed, school lunch, dietary and nutrition education

**Introduction**

Japanese households are increasingly using restaurant food and processed side dishes (Ministry of

Agriculture, Forestry & Fisheries, 2018) in their meals. Processed foods are often soft foods, and children who eat processed foods prefer soft foods (Laureati, 2017; Sakuma, 2020). Consequently, when chewy foods are

served in school lunches, the number of children who cannot masticate effectively increases (Sato, 2013). On the other hand, according to the mastication education research conducted in nursery schools, mastication varies greatly among individuals, and the oral Method of Teaching in groups for children with unstable masticatory ability is reported to have difficulty in improving mastication (Sato, 2013).

Masticatory and swallowing movements are rhythmically coordinated movements of the eyes, hands, and mouth (Shiraishi, 2006; Matthew, 2019). Although music enhances the effects of this exercise (Simone, 2018), there are no reports of coordinated masticatory swallowing movements being facilitated by music. Additionally, Lehmann (2017) demonstrated a learning method in which students listened to music lyrics with meaning deepened their understanding of the lyrics more than a written learning method; however, there is no report demonstrating that BGM with educational lyrics, where the lyrics expressed how to masticate and swallow and the benefits of efficient masticating, deepened the children's understanding of masticatory and swallowing movements. On the other hand, the KAP/KAB theory of education states that Behavioural and Practical change occurs through the acquisition of Knowledge, which leads to a change in Attitudes, (Ministry of Health, Labour & Welfare, 2013). In this study, we propose a method of improving the existing MSE with the addition of the original BGM with educational lyrics, with its tempo based on the masticatory speed of children who were allowed to masticate naturally (Sakuma, 2020) during the school lunch period. Subsequently, we confirm whether the children's masticatory and swallowing movements are promoted with the improved educational design.

## Methods

### 1. Target and Survey Period

The subjects of the study were 100 children from three classes of first grade of an urban elementary school with a nutrition teacher; the data included observations of 97 children with parental permission; The experiment was implemented for a period of 3 weeks during December 2019. The experiment included

playing the original BGM during the school lunch period of the children. After 3 weeks of training, the results were recorded by using a video camera (GoPro MAX CHDZH-201-FW), the same method used in previous studies (Figure 1). We compared the mastication speeds obtained via the quantitative data collection (obtained through these recordings). This study consisted of three steps: 'pre-evaluation by video recording', 'mastication and swallowing training', and 'post-evaluation by video recording'. Children who were absent on the recording day were excluded from the study.

### 2. Creating original BGM to promote masticatory and swallowing movements

#### 2.1 Tempo of the original BGM

The tempo of the original BGM was set to 120 BPM based on the average number of masticatory movements per minute (mastication speed). This average masticatory speed was obtained from the results of the May 2019 human factor experiment (Sakuma, 2020). In other words, 8 g bread crust from the school lunch was masticated naturally by the children in question, and the situation was recorded by a camera. Subsequently, the number of times they masticated and the duration of mastication were measured, and the average masticatory speed was calculated (58 times/ minute). The tempo of the original music was set to 120 BPM, which is approximately twice as fast as the measured mastication speed, because people tend to adapt their



Figure 1: Scenery of video recording of elementary school children's mastication and swallowing movements during a school lunch period.

coordinated movements to a two-beat rhythm (Maezawa, 2020).

## 2.2 Methods to improve masticatory and swallowing movements

(1) For the masticatory improvement method, we used the original BGM with the lyrics, we adopted the method of cutting food with incisors and grinding with molars. (Yasutomi, 2009). For the swallowing improvement method, we used the original BGM with the lyrics: 'Masticate well and swallow after it becomes small', since masticating food efficiently increases the saliva volume and makes swallowing easier (Takasaki, 2003).

(2) The lyrics we wrote included the message how masticating food efficiently improves digestion and absorption, in addition to helping us understand the taste of food.

## 3. Differences between the proposed method with the original BGM and teacher-led mastication and swallowing education

The differences between the three classes in which the original BGM was played and the teacher-led masticatory and swallowing education were as follows: Group A) a control group with no BGM/no MSE, Group B) with BGM/no MSE, and Group C) with BGM and MSE. In Group C, the homeroom teacher used original background music to educate the students on how to masticate and swallow. A poster stating 'Masticate your food well' was displayed on the blackboard every day in all three groups.

## 4. Statistical Analysis

The mastication speeds of the three groups were checked for non-normal distribution using the Shapiro-Wilk test; subsequently, the Kruskal-Wallis test was performed for comparing the data of the three groups. The results were subsequently corrected by using the Bonferroni correction to counteract the problem of multiple comparisons. The Wilcoxon signed-rank test was performed for each quartile of the same group and for the whole group. The statistical analysis software

used was IBM SPSS Statistics 27 (IBM Japan, Ltd.).

## 5. Ethical Approval

This study was approved by the Ethical Review Board for the use of human subjects at the Kanagawa Institute of Technology (No. 2018-072).

## Results

### 1. Pre- and post-training evaluation of three groups and the same group

The mean  $\pm$  standard deviation of the pre-training mastication speeds of the three groups was as follows: Group A)  $60.0 \pm 17.2$  ( $n = 32$ ), Group B)  $59.5 \pm 12.83$  ( $n = 31$ ), and Group C)  $56.9 \pm 11.2$  ( $n = 33$ ), with no statistically significant difference (Sakuma, 2020).

In the post-training period, the mean  $\pm$  standard deviation of mastication speeds of the three groups was as follows: Group A)  $55.3 \pm 11.8$  ( $n = 24$ ), Group B)  $55.3 \pm 10.7$  ( $n = 30$ ), and Group C)  $62.7 \pm 9.3$  ( $n = 28$ ); the masticatory speeds for the Group C increased significantly ( $p < 0.05$ ). Pre-post- comparison between the same groups showed no significant difference in

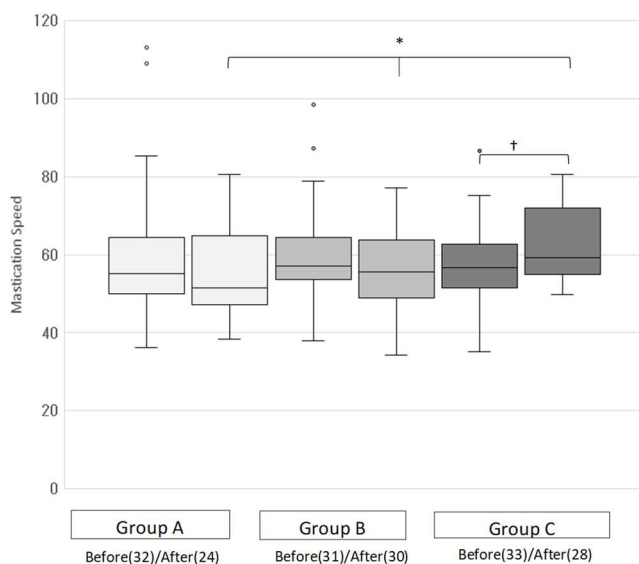


Figure 2: Comparison of the three groups and the same group pre - and post-training

\* Bonferroni correction the after the Kruskal-Wallis test, ( $p < 0.05$ )

† Wilcoxon signed-rank test, ( $p < 0.05$ )

( $n$ ) = Number of children

masticatory speed between members of Groups A) and B), while Group C) showed a significant increase ( $p < 0.05$ ) (Figure 2).

## 2. Pre- and post-quartile comparisons by group of quartiles between the same groups

Pre- post-comparison by quartile group of the same group showed that only the mastication speeds of the first group (low masticatory speed group) of Group C) increased significantly ( $p < 0.05$ ) (Table 1).

Table 1: Comparison of pre- and post-training by quartile group for Group C.

	Quartile	<i>n</i>	Mean±SD	<i>p</i> -value
1st	Before	7	48.2±3.9	0.018*
	After		59.5±8.6	
2nd	Before	4	52.9±0.7	0.144
	After		63.3±8.3	
3rd	Before	8	62.5±10.4	0.401
	After		59.6±2.5	
4th	Before	6	68.9±5.0	0.917
	After		68.8±10.2	

\* Wilcoxon signed- rank test

- (*n*)= Number of children
- Outliers from the created boxplots are excluded
- Three children with the same number as the boundaries of in the first quartile are included in the first quartile.

## Discussion

This study proposed an educational method for promoting efficient mastication and swallowing movements of children. This method included using an original BGM, designed based on the results of a previous study (Sato, 2013), which showed that it is difficult for a teacher to provide oral instruction regarding efficient mastication and swallowing to a group of children. Stroebele (2006) reported that eating time increases when slow music is played, indicating the

relationship between music tempo and eating time (Stroebele, 2006). On the other hand, school lunches, which are designed to provide children with the amount of nutrition they need to grow (Ministry of Education, Culture, Sports, Science and Technology, Standard of School Lunch Intake, 2013), have a 20-minute time limit. If the meal time is too long with slow music, the child will not be able to finish the meal within the allotted time and will not be able to take in all the nutrients necessary for growth. However, chewing too fast can lead to obesity (Ishibasi, 2015; Pedroni-Pereira, 2016; Samuel, 1984); therefore, it is necessary to investigate the appropriate chewing speed for children.

Therefore, this study created an original BGM with a tempo based on the average mastication speed (Sakuma, 2020) derived from a human factor experiment conducted for a previous study. Sakuma et al., (2020) investigated the natural masticatory movements of children. As Maezawa et al. (2020) reported that masticatory movement easily adapts to the coordinated movement of two beats, the tempo (120 beats/minute) was twice as fast as the average of the speed at which children naturally masticated (58 mastication movements/minute), so that one mastication is synchronised with two beats.

Studies on the influence of music on masticatory movement have reported that music can cause rhythmic movements in people. These movements correspond to the tempo of the music and promote the effect of the ongoing masticatory movement (Simone, 2018; Matthew, 2019). In this study, the tempo of the music was set to synchronise with the children's mastication and swallowing movements, and it was assumed that the children could perform rhythmic mastication and swallowing movements. Additionally, based on the results of Lehmann (2017), in which the students listened to music lyrics with meanings, they could understand the lyrics more deeply than in the written method, the lyrics of the original BGM included information regarding how to masticate and swallow and the benefits of efficient mastication. The original BGM and the teacher-led education may have helped the children to acquire knowledge regarding how to masticate and swallow food efficiently. Thus, from the acquisition of knowledge, the transformation of attitude

occurred, leading to the transformation of practice and behaviours (Ministry of Health, Labour & Welfare, 2013). Consequently, mastication and swallowing movements of children were promoted in this study, and the speed of mastication increased for children with large individual differences in masticatory ability (Sakamoto, 2020; Sakuma, 2020) and unstable masticatory ability (Saitoh, 2004). The method proposed in this study was especially effective for children whose masticatory speed was slow, whereas it did not increase the masticatory speed of children whose masticatory speed was naturally fast; therefore, this educational method did not promote fast eating. Thus, by combining the original BGM designed in this study and teacher-led mastication and swallowing education, children with slow masticatory speed were able to masticate faster; overall, fast eating was not encouraged by the original BGM.

One of the limitations of this study is that it cannot be generalised because it did not conduct a direct bite force survey. Additionally, as the target was one school in a metropolitan area, it has not been examined whether the results of this study can be applied to elementary schools nationwide. However, as this study is the first attempt in promoting children's mastication and swallowing movements during the school lunch period via the use of an original BGM, this study's findings should be further examined. In future, we aim to conduct research at many educational institutions, including kindergartens, nursery schools, and other grades other than the first grade of elementary school to confirm this study's findings. Additionally, since there is a report that rhythmic mastication exercise improves bite strength and activates serotonin nerves (Samuel, 1984), we also aim to investigate this finding in relation to our study's findings.

### Conclusion

Using the original BGM based on the mastication speed obtained from a previous study to educate children regarding mastication, a problematic task, since demonstrating efficient mastication is highly difficult, we can promote children's mastication and swallowing movements. Thus, we propose the use of the

original BGM designed for this study as an educational method to improve mastication and swallowing of children during the school lunch period.

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### Conflict of Interest

We report that there is no conflict of interest.

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