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Education for Improving Children's Behaviors during Eating in a Japanese Nursery School

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Abstract Nursery school is an important stage for improving children's eating behaviors because eating behaviors are established in early childhood. Thus, this study aimed to establish an adequate method for educating children regarding such behaviors during early stages of development. To this end, we elucidated the causal effects of children's behaviors during eating at a nursery school. Cross-sectional data were used. Behaviors during eating lunch, quantity of leftovers from meals, and children's preferences for school lunch were measured. Causal effects between the measured variables were analyzed using the Bayesian network analysis. The causes leading to time spent talking were turning sideways, playing, and standing up. Turning sideways, playing, and standing up depended positively on the time spent of talking (p=0.01). The times spent of talking affected the time spent of holding foods in one's mouth. The time spent of talking was positively depended by time spent of holding foods in one's mouth (p=0.02). Decreasing the time spent turning sideways, playing, and standing up might decrease talking, which in turn may decrease the time spent holding food in one's mouth. Instructing children not to turn sideways, play, or stand up would be an effective way to educate them on desirable behaviors during school lunch.

Keywords: *education, school lunch, nursery school, observation of behaviors, Bayesian network*

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1. Introduction

School lunch programs in Japan have been regarded as opportunities for providing children with their daily supply of nutrients, teaching them table manners, educating them on nutrition, and developing desirable food preferences through having lunch with classmates [1]. Parents' expect that nursery schools in Japan will provide instruction to their children regarding health, behavior and/or discipline, and diet [2]. Accordingly, one of the key aspects of the

school lunch program would be behavioral education. Nursery schools frequently provide instruction to children regarding their behaviors during eating [3]. Furthermore, adequate behavioral education could improve children's actual behaviors during early childhood [4]. Adequate education on eating behaviors is therefore one of the most important issues in nursery schools [3]. The need to establish adequate education for behaviors in nursery schools has also been emphasized in a previous study [4]. Thus, this study focused on education regarding behaviors during mealtimes at a nursery school.

Generally, high-quality education in childhood predicts better academic performance and cognitive function in later life [5]. Moreover, establishing better behavioral education in early childhood is expected to lead children to engage in adequate behavior in the future. Hence, children should receive behavioral education in the early stages of childhood, so that there is adequate time for learning [6].

The purpose of this study was to establish adequate education for behaviors while eating during early childhood (defined here as the nursery school stage) using a causal analysis of behaviors during eating.

2. Materials and Methods

2.1. Participants

Participants were all 3–5-year-old children attending the Kuise nursery school (Amagasaki city, Hyogo prefecture, Japan) and their parents. Informed consent was obtained from the parents of all the children. Of the 69 participating children, 37 were girls and 32 were boys (Table 1). They constituted the sample for the measurement of school lunch leftovers, and none dropped out from this part of the study (Figure 1). All children ate their school lunch at their table at the same specified time. They sat with friends at their own will. Furthermore, of the 69 participants, 12 children (6 girls and 6 boys) were randomly selected using a table of random numbers for observing their behaviors during eating. Video recordings were used for this.

The parents of all 69 children received a questionnaire asking them to assess their children's preferences for lunch served by the school. Of them, the parents of 29 children did not respond to the assessment questionnaire. Hence, the final sample to assess children's preferences for school lunch consisted of 40 parents (response rate of 58%). Of the participating parents, 31 were mothers (85%) and 9 were fathers (15%).

Table 1. Descriptive statistics for participating children

	Girls	Boys	3 years old	4 years old	5 years old	Total
Leftover meals	37	32	21	26	22	69
Questionnaire assessment	20	20	12	15	13	40
Observation of behaviors during eating	6	6		4	4	12

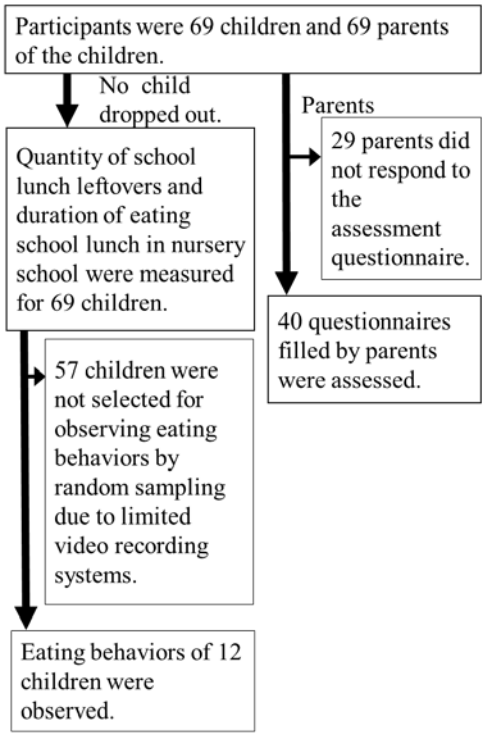

Figure 1. Description of the study population. The participants were 69 children. Causal effects using the Bayesian network were analyzed for 12 children for 6 days

2.2. Chemical Compositions of Meals from the School Lunches

Chemical compositions of meals from the school lunches were showed in Table 2. Chemical composition of meals from the school lunches were calculated from weights of ingredients of dishes and seasonings and standard tables of food composition in Japan using a software package (Excel-Eiyoukun) [7,8]. The measurement of chemical compositions of 3 meals per a day served under the school cooking and catering systems were repeated for three days.

Table 2. Chemical compositions of meals from the school lunches per one child in a day

	Mean	SE
Energy, kcal	385	26
Protein, g	12.0	0.6
Lipid, g	10.0	1.3
Carbohydrate, g	59.1	3.9
Calcium, mg	53.0	11.0
Iron, mg	1.3	0.1
Retinol equivalent, μg	38	6.8
Vitamin B_1, mg	0.13	0.01
Vitamin B_2, mg	0.11	0.01
Vitamin C, mg	9.5	1.8
Sodium chloride, g	1.3	0.0

SD: Standard deviation.
The number of repeats: 3.
The chemical compositions of the meals were calculated using the weights of the ingredients and seasonings of each meal.

2.3. Questionnaire

Between February 13 and March 9, 2015, parents completed a self-report questionnaire regarding their child's preferences for school lunch comprising two items established in a previous study (Table 3) [9,10]. The items were (i) "Does your child like school lunch meals in the school's cooking system (or the catering system)?" and (ii) "What kind of food does your child hate?" The responses to the first question were scale-based— "Hate," "Dislike," "Medium," and "Love"—which were given scores of 1, 2, 3, and 4, respectively, and the second question required free descriptive answers; see Table 3.

Table 3. Questionnaire items and response options.

Items	Options
Does your child like school lunch meals in the school cooking system (or the catering system)?	Hate: 1, Dislike: 2, Medium: 3, Like: 4, Love: 5
What kind of food does the child hate?	Free descriptive answer

2.4. Measurement of Temperature of Main Dishes

The temperature of all dishes was measured on three days under the school cooking system and three days under the catering system. We carried out a preliminary test and found no significant differences between the temperatures of different hot dishes within each system. In this study, we used the temperatures of the main dishes as representative values for the temperature of all hot dishes in the school lunch. The temperature of meals prepared under both systems was measured immediately before serving using a thermometer (AD-5625, A&D Corporation, Tokyo, Japan).

2.5. Observation of Behaviors during Eating on Video

A subset of 12 children participated in the observation of their behaviors during their school lunch in the classroom. For this, we used six video cameras (HC-230, Panasonic Corporation, Osaka, Japan) fixed on tripods. Recordings were carried out over 6 days for the 12 children; the total data sample included 72 video recordings. Each video camera recorded the behaviors during eating from the start to the finish of lunch of two participants who ate their meal at the same table and time. The following behaviors were recorded during children's eating: time spent playing, time spent standing up, time spent holding food in one's mouth, time spent talking, time spent turning sideways, time spent eating with one's hands, chewing speed, and number of times eating the same food successively.

Playing was defined as the child drumming on the plate or on the food with the chopsticks or playing with the chopsticks. Standing up was defined as the child leaving their chair. Turning sideways was defined as the child looking backward or sideways. Holding food in one's mouth was defined as the child having food in their mouth without chewing. For each behavior, the total time spent on that behavior was calculated as the sum of the duration of each occurrence of that behavior divided by the total period from start to end of the meal. The number of times eating the same food successively was divided by the total duration of the school lunch meal.

2.6. Measurement of Leftovers from School Lunch and Duration of Eating

The proportion of leftovers after the meal was measured on three days when lunch was served using the school cooking system and three days using the catering system. The proportion of leftovers was measured for all children by subtracting the weight of each dish after they finished eating from its weight before they started eating using an electronic weighing scale (KD-171m, Tanita Corporation, Tokyo, Japan). The mean of the three measurements of each child's proportion of leftovers on the three different days was separately calculated for meals served under the school cooking and catering systems.

The period elapsed between starting and finishing the school lunch was also measured for all children for lunches served under both the school cooking and catering systems via direct observation using a clock in the classroom. These measurements were performed by nine members of our research project team. Each member recorded the time of the day when the children started and finished eating their school lunch for six to eight participants. Subsequently, the duration of eating was calculated by subtracting the start time from the end time for each participant. The children were not pressured to finish their lunch quickly.

2.7. Presence of Disliked Ingredients in Meals

We identified the presence of ingredients disliked by children by using the parental questionnaire for each child. We obtained the menu from the school's dietitian. We tallied the foods on the menu with the list of disliked ingredients for each child to identify the presence of such ingredients in each meal observed. We confirmed the presence of disliked ingredients in the school lunch using the food material list from the menu and the abovementioned questionnaire on disliked ingredients obtained from the participants in advance.

2.8. Statistical Analysis

Causal effects were calculated using a Bayesian network. [11] A Bayesian network can indicate causal relationships using Bayes' theorem between variables without dependence on graph theory; thus, the Bayesian network shows causation between variables by using arrows in a graph. A Bayesian network is a directed acyclic graph that is composed of a set of variables $\{X_1, X_2, \ldots, X_N\}$ and a set of directed edges between the variables.[11] A variable has several possible states, for example, true and false. Bayesian networks are successful in probabilistic knowledge representation and reasoning. In Bayesian networks, the joint probability distribution function of all nodes can be calculated as follows:

$$P\left(X_1, X_2, \ldots, X_N\right) = \prod_{i=1}^{N} P\left(X_i \mid Pa_i\right),$$

where Pa_i is the set of random variables whose corresponding nodes are parent nodes of X_i.

A Bayesian network contains two elements: structure and parameters. In our study, each arc begins at a parent node and ends at a child node. Pa (X) represents the parent nodes of node X. X1 is the root node because it has no input arcs. Root nodes have prior probabilities. Each child node has conditional probabilities based on the combination of states of its parent nodes. Black circles represent discrete variables, and white circles represent ordinal variables.

Participants' results were presented as means and standard deviations. The time spent playing and turning sideways during meals was compared for meals with and without disliked ingredients and between both serving systems using Student's *t*-test; differences with $p<0.05$ were considered significant. The effects of the type of serving system and meals containing disliked ingredients were analyzed using two-way ANOVA; effects with $p<0.05$ were considered significant (Sample power=0.92). Statistical analyses were performed using SPSS Statistics with Advanced tool version 20 (IBM Japan ltd., Tokyo, Japan) and R version 3.2.0 (The R Project for Statistical Computing, Vienna, Austria).

This study was reviewed and approved by Kanagawa Dental University Ethics Committee (No. 381). We obtained informed consent from the parents and assent from the children.

3. Results

3.1. Causal Relationships between Behaviors during Eating

Figure 2 shows the causal effects between the variables measured, as calculated using the Bayesian network theory. Arrow heads and lines indicate effects and causes, respectively. The Bayesian network indicated that the factors affecting the time spent talking were time spent turning sideways, playing, and standing up (Figure 2). Time spent talking, in turn, affected time spent holding food in one's mouth (Figure 2). The presence of disliked ingredients affected time spent turning sideways, playing, standing up, and the proportion of leftovers (Figure 2).

3.2. Relationships of the Effects of Behaviors during *eating*

The time spent playing, turning sideways, and standing up significantly depended on the time spent talking ($p=0.01$, linear regression, Table 4).

The time spent talking positively affected the time spent holding food in one's mouth ($p=0.02$, linear regression, Table 5).

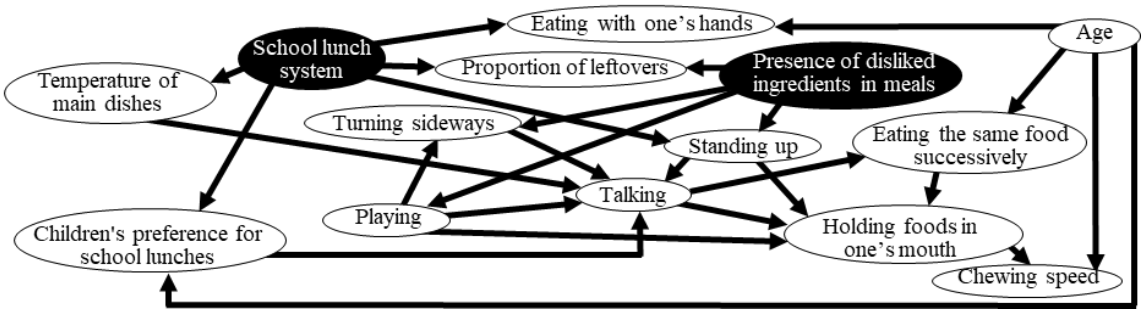

Figure 2. Causal effects between serving systems, proportion of leftovers, temperature of main dishes, duration between children's preference for school lunch, and time spent eating. Causal effects were analyzed using the Bayesian network analysis. Causes and effects are indicated by lines and arrowheads, respectively. Black circles represent discrete variables, and white circles represent ordinal variables

Table 4. Effects of behaviors during eating on time spent talking

Independent variables (s/min)	F-ratio	$p^{\S}$	Regression coefficient	SE	$p^{\S\S}$	Section	SE	$p^{\S\S}$
Time spent playing	4.9	0.030	0.46	0.20	0.03	0.12	0.01	< 0.001
Time spent turning sideways	10	0.002	0.58	0.17	0.002	0.12	0.01	< 0.001
Time spent standing up	19	< 0.001	5.6	1.2	< 0.001	0.12	0.01	< 0.001

Dependent variables: time spent talking (s/min). SE: standard error.
Repeated for 6 days with 12 children. Total number of repeats: 72.
[§]Probability calculated through linear regression analysis (residual degree of freedom=70).
[§§]Probability calculated through a linear line with least the square average method (n=72).

Table 5. Effect of talking on the time spent holding food in one's mouth.

Independent variables (s/min)	F-ratio	$p^{\S}$	Regression coefficient	SE	$p^{\S\S}$	Section	SE	$p^{\S\S}$
Time spent talking	5.5	0.02	0.14	0.1	0.02	0.03	0.01	0.01

Dependent variables: time spent holding food in one's mouth (s/min). SE: standard error.
Repeated for 6 days with 12 children. Total number of repeats: 72.
[§]Probability calculated linear regression analysis (residual degree of freedom=70).
[§§] Probability calculated through a linear line with least the square average method (n=72).

Table 6. Effect of talking on the same food eaten successively

Independent variables (s/min)	F-ratio	$p^{\S}$	Regression coefficient	SE	$p^{\S\S}$	Section	SE	$p^{\S\S}$
Time spent talking	4.2	0.04	-0.37	0.18	0.04	0.69	0.03	< 0.001

Dependent variables: same food eaten successively (count/min). SE: standard error.
Repeated for 6 days with 12 children. Total number of repeats: 72.
[§]Probability calculated through linear regression analysis (residual degree of freedom=70).
[§§]Probability calculated through a linear line with least the square average method (n=72).

Table 7. Effects of meals with disliked ingredients on behaviors during eating

Independent variables (s/min)	F-ratio	$p^{\S}$
Time spent playing	2.0	0.1
Time spent turning sideways	13	0.001
Time spent standing up	1.4	0.2

Dependent variables: meals with disliked ingredients.
Repeated for 6 days with 12 children. Total repeats: 72.
[§]Probability calculated in linear regression analysis (residual degrees of freedom=70).

Table 8. Quantile of time spent talking and proportion of talking during mealtime

	Minimum value	Second quantile	Median value	Third quantile	Maximum value
Time spent talking (s/min)	0.0	3.5	8.1	13.3	29.5
Proportion of talking during mealtime (100 s/min)	0.0	5.8	13.5	22.2	49.2

Repeated for 6 days with 12 children. Total repeats: 72.

The time spent talking was also associated with the frequency of eating the same food successively (p=0.01, linear regression, Table 6).

Longer time spent turning sideways was explained by the presence of disliked ingredients in meals (p=0.001, ANOVA, Table 7).

The median value of the time spent talking was 8 seconds per minute, and the maximum time spent talking was 29 seconds per minute (Table 8).

4. Discussion

For a detailed analysis and better visualization, we integrated the results of the Bayesian network (Figure 2) with the results of the linear regression (Table 3 – Table 5) and those of the analysis of variance (Table 6) into the schema in Figure 3, which shows causal relationships with quantitative relationships.

4.1. Causal Factors of Children's Behaviors during Eating

The factor affecting the time spent turning sideways, playing, and standing up, and the proportion of meal leftovers was the time spent talking (Figure 3). The time spent turning sideways, playing, and standing up positively affected the time spent talking (p<0.05, Table 3). The time spent talking was facilitated by longer time spent turning sideways, playing, and standing up (Figure 3).

Talking stimulated the holding of food in one's mouth (Figure 3). The time spent talking positively depended on the time spent holding food in one's mouth (p=0.02, linear regression, Table 4). Thus, talking would facilitate longer time spent holding food in one's mouth. Accordingly, decreasing the time spent turning sideways, playing, and standing up might decrease the time spent talking, which in turn might decrease the time spent holding food in one's mouth. Hence, discouraging turning sideways, playing, and standing up can decrease the displays of other undesirable behaviors during mealtimes.

4.2. Education for Improving Children's Behaviors during Eating

Discouraging turning sideways, playing, and standing up may decrease some other undesirable behaviors (see the subsection *Causal factors of children's behaviors during eating*). Instructing children not to turn sideways, not to play, and not to stand up may effectively decrease other kinds of bad behaviors during meals in early childhood.

However, instructing children how to behave during eating sometimes leads to depression in them [3]. High-frequency behavioral instructions in nursery school sometimes make children grumpy [13], thus, providing highly frequent and/or intense instructions to nursery schoolchildren should be avoided. Considering children's emotional sensitivity, a gentle instruction method regarding behaviors during eating would be optimal in nursery schools. Discouraging the three behaviors observed in this study (turning sideways, playing, and standing up) might be effective for reducing undesirable behaviors during mealtimes in children at the nursery school stage.

4.3. Talking during Lunch Time and Nursery School Teachers

Eating time was limited to 20 minutes at the Kuise nursery school, which is standard in Japan[1] but may be too short for the children in Japanese schools. However, the time schedule of the school lunch might be permanent in Japan. Therefore, one of the tasks of nursery school teachers is to ensure that children finish their lunch within the prescribed time [14], and this study suggests a

potential method to help them achieve this goal. The maximum time spent talking was 29 seconds per minute, which is almost 50% of the time evaluated; moreover, talking constituted the largest proportion of the entire time allotted for lunch. During lunch, 50% of talking time would be considerably long and would prevent a child from finishing their meal within the allotted time, given the short duration of mealtimes [1]. Talking also led to holding food in one's mouth for a longer time (Figure 3), which is considered bad behavior [12]. However, mealtimes should also be a time for talking with family or friends [14], so it would be unnatural to restrict it. Thus, we recommend discouraging three types of behaviors (turning sideways, playing, and standing up) to ensure adherence to the duration of mealtimes in Japanese schools; alternatively, the Ministry of Health, Labor and Welfare should control the schedule of mealtimes in schools in Japan.

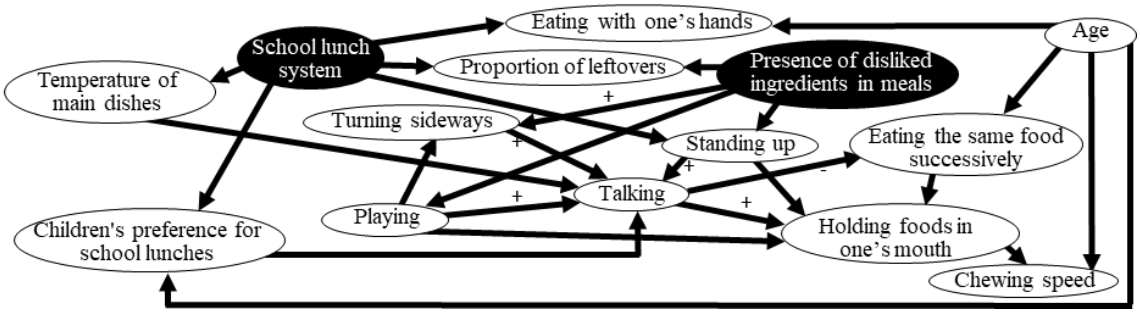

Figure 3. Summary of modulators of behaviors during eating. We integrated the results of the Bayesian network (Figure 2), the results of the linear regression (Table 3, Table 4), and the results of the analysis of variance (Table 5) into the schema. Arrows represent causations analyzed by Bayesian network. The "+" and "-" signs show positive relationships/higher and negative relationships/lower with $p<0.05$ (correlation or ANOVA), respectively

4.4. Nursery School Teachers and Instructions

In Japan, nursery school teachers have a highly physical workload [15], and nursery schools face a shortage of teachers because they feel insufficiently rewarded for their labor [2]. Effective methods for improving children's behaviors during eating in Japanese nursery schools might help relieve some of the teachers' workload through reducing work time for finishing lunch, encouraging them to continue their jobs, and thus avoiding shortages in nursery schools. This study presents an easy way of instructing children to adequately behave during the school lunch, that is, by discouraging three types of behavior (turning sideways, playing, and standing up).

4.5. Effects of Food Preferences on Eating Behavior

Presence of disliked ingredients in meals affected the time spent turning sideways, playing, and standing up (Figure 2), as well as explained the longer time spent turning sideways (p=0.001, ANOVA, Table 6). The presence of disliked ingredients in meals caused an increase in bad behavior; thus, the exclusion of disliked ingredients from meals might decrease the act of turning sideways. Children's dislikes appear the most under the following conditions: consuming eggs or confectionary more than once a day, eating a meal without grains, and skipping meals [16]. Educating children to consume confectionary less frequently, avoid meals without grains, and not skip meals in elementary school might decrease the occurrence of children's dislikes [17]. Further, educating them about eating less confectionary, avoiding meals without grains, and avoiding skipping meals might reduce turning sideways as well. To decrease the dislike of ingredients, desirable food preferences need to be developed in children simultaneously [18], as the presence of disliked ingredients increases the time spent turning sideways.

5. Conclusion

Discouraging turning sideways, playing, and standing up might decrease talking, which in turn will decrease holding food in one's mouth. Instructing children not to turn sideways, play, or stand during mealtimes may thus be an effective way to ensure the acquisition of desirable eating behaviors.

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Conflict of Interest and Funding Disclosure

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