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Using Sensory Stimulation to Analyze the Effect that Contact Frequency and Categories of Toy Vegetables Have on Young Children's Vegetable Preferences

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Abstract. This study explores whether children's experience and possession of toy vegetables have influence on their preference for vegetables by the frequencies of toys' visual and tactile stimulation. We also discuss the difference between different toys types of play. Furthermore, this study includes two stages of questionnaire. The first stage is about exploration of representative vegetables that children reject and the sensory cause of their rejection. The second stage points out identification of children's preference for vegetables. It even shows the experience and possession status of different types of toy vegetables. ANOVA and MANOVA are used for statistic. The research indicates as follows: (a) Visual stimulation can enhance preference. (b) High-frequency tactile contact has great influence on vegetables preference and main rejecting reason is the tactile sense. (c) Children possessing fluid-construction toy vegetables have highest preference, whereas children who don't have toys of sensor motor vegetables have the least preference.

Keywords: young children, toy vegetables, toy form, sensory stimulation, vegetable intake.

1. Introduction

Children's vegetable intake and preference are generally low. To increase children's vegetable intake, repeated tasting of foods probably increases the willingness of eating vegetables [1], [2]. In addition, early contact of children is highly effective. At the age between two to five years, food neophobia begins to affect children's intake willingness. Food neophobia is a biological protective mechanism to prevent children from eating something wrong by decreasing their willingness to eat unfamiliar foods. Food neophobia largely affects the intake amount of vegetables and meat [3]. Thus, increasing children's familiarity with vegetables early may reduce or avoid the occurrence of food neophobia.

Previous studies have indicated that through sensory stimulations relevant to vegetables other than gustatory stimulation can increase intake willingness [4]. de Droog, Buijzen and Valkenburg proposed that repeated reading of vegetable picture books improved children's intake amount of the mentioned vegetable in the picture book [5]. However, effective improvement was observed only in the intake amount of the said vegetable.

Nearly no study has explored the effect of toy vegetables on young children's diet. Given that toy vegetables exert the same effect of picture books, in addition to the visual stimulation, toys provide tactile stimulation. Stimulation frequencies could also be a reason that affects preference. Thus, we explored whether the frequency of vegetable stimuli (toy experience and possession) had an effect on young children's preferences for vegetables. Moreover, we discussed the difference between different types of toys and used the visual and tactile stimulations provided by toys as a perspective to analyze the effect that sensory stimulations had on young children's vegetable intake. The research objectives are listed as follows:

(1) Investigate the sensory factors leading to children's rejection to vegetables.

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(2) From the perspective of sensory stimulations, analyze whether the stimulation frequencies (experience and possession) of toy vegetables affect young children's vegetable preferences.

(3) From the perspective of sensory stimulations, analyze whether the experience and possession of toy vegetables under different types of playing methods affect young children's vegetable preferences.

2. Literature Review

2.1. Young Children'S Dietary Preferences and Influential Factors

In this study, we categorized the causes that affect children's vegetable intake into biological genetics, food experience (before and after birth), feeding method, food neophobia, and sensory stimulation.

2.1.1. Biological genetics

From the perspective of biological genetics, to increase the survival advantage, the gustatory sense is a measure to identify the nutritional level or toxin of foods, thereby influencing the intake willingness. A sweet taste represents high calories and a salty taste results from minerals. Thus, young children tend to choose foods with sweet and salty tastes. By contrast, sour and bitter tastes symbolize toxins, bacteria, or rotten foods; thus, children reject sour or bitter foods [6]-[8].

2.1.2. Food experience and feeding methods

Young children's food experience is closely related to intake. Galloway, Florito, Lee, and Birch reported that when the parents consumed low amount of vegetables and fruits, the children also consumed low amount of vegetables and fruits, thereby leading to children's fussy eating [9]. When the children are fussy about foods, pressure from the parents only exerts negative effects. In addition to family dietary habits, young children's intake experience in the mother's womb is the basis of food preference development. Because young children are able to smell and taste in the womb and experience the flavor of foods through amniotic fluid [10], a mother consuming little vegetable indirectly result in the young children's lacked experiences in early contact of vegetables, thereby subsequently contributing to the formation of food neophobia.

2.1.3. Food neophobia

The protective mechanism of biological evolution prevents children from tasting unfamiliar foods, which especially affects the intake amount of vegetables and meat [3]. Repeated tasting can increase children's intake willingness [1], [2]. However, through visual communication to the brain, food neophobia causes children's reluctance to taste the foods before even trying. It is not necessarily bad news that neophobia affects intake willingness through visual sensory stimulation, because such notion represents that neophobia can be influenced by sensory stimulation designs other than gustatory senses.

2.1.4. Sensory stimulation

The sensory stimulation brought by foods is a cause that affects young children's intake willingness. In particular, the gustatory sense is a critical condition influencing intake. Children are unwilling to eat vegetables because most vegetables contain bitter tastes [11]. Although gustatory and olfactory senses are crucial characteristics of foods, they cannot be changed in product design dimensions. The effect from auditory stimulation is the least [4]. Thus, visual and tactile senses were discussed in this study.

a. Visual stimulation: Visual stimulation of foods may be a critical factor influencing young children's dietary preferences because studies have verified that young children who experienced advertisement of high-calorie foods for a long time exhibited high preference to intake of high-calorie foods [12], [13]. Similarly, reading picture books regarding vegetables helps stimulate children's vegetable and fruit intake. However, such effect was only manifested to vegetables depicted in the picture book and was not extended to other types of vegetables [5].

b. Tactile stimulation: Tactile stimulation plays a crucial role in the texture of food characteristics and affects the dietary preference [14]. Regarding tactile stimulation of foods, foods with complicated mouthfeels are less favorable, probably because these foods are hard to be controlled inside the mouth [15]. However, early contact with the foods helps contribute to the intake willingness [16]. Nederkoorn, Jansen and

Havermans found that the tactile stimulation of foods have similar corresponding relationships with cutaneous stimulations of the hand [17]. Maybe providing repeated cutaneous stimulations to children can increase their acceptance of foods with diverse mouthfeels.

c. Summary: Stimulation from outside the vegetables can also effectively affect the vegetable intake preferences. Given that toy vegetables provide similar effects to that of vegetable picture books, toys provide additional tactile stimulations and variations, which possibly generate enhanced effectiveness on young children's vegetable intake. However, few studies have discussed the relation between toy vegetable stimulation and diet. Thus, we used sensory stimulation factors to explore whether toy vegetable stimulations affect young children's vegetable preferences. Furthermore, we explored the effects of different types of vegetables on young children's differed preferences for vegetables.

2.2. Toy Types

Young children need to learn through games in life [18]. Different toy types (playing methods) may result in diverse levels of influence on young children. We used the toy type category proposed by Juan according to Piaget theory, which are symbolic play materials, fluid-construction play materials, structured-construction play materials, sensorimotor play materials, and sign play-numbers and letters [19]. We explored and categorized commercial toy vegetables in the market. Consequently, vegetable dolls were defined as symbolic play materials. Vegetable clay models were defined as fluid-construction play materials. Vegetable jigsaw puzzles or toy bricks were structured-construction toys. The kitchen set of ingredient-cutting toys were defined as sensorimotor toys. Vegetable flash cards or picture cards were defined as sign play-number and letters.

3. Research Methods

The experiment in this study comprised two sections. The first section was exploration of vegetables rejected by young children and sensory factors to identify young children's vegetable preferences, sensory factors, and existing classification methods of vegetables. The second section explores the effect that toy vegetable contact frequencies and categories have on young children's vegetable preferences to understand the toy type classification and commercial vegetable toy types. Through questionnaire survey and statistical analysis, we understood how vegetable toy types affect young children's vegetable preferences. Two sections of explanation are provided as follows.

3.1. Exploration of Vegetables Rejected by Young Children and Sensory Factors

3.1.1. Participants

The participants were 23 young children aged between two to six years. Among them, 11 were boys, accounting for 47.82%. The age mean was 4.13 and the standard deviation (SD) was 1.51.

3.1.2. Tools

a. Questionnaire of vegetables rejected: This questionnaire was used to explore the vegetables that young children rejected. A total of three items were included. Open questions were used and the vegetables for answers were not limited. The items were the top three rejections of vegetables among young children. An answer of none can be filled in if the child had no rejection against vegetables. The answered vegetables were arranged in order according to the occurrence of answers. According to the edible parts classification of vegetables (digital teaching information portal Website of the Ministry of Education), we selected the representative rejection vegetables of each category.

b. Questionnaire of sensory factors for vegetables rejected: This multiple-response questionnaire was used to identify the sensory factors of the vegetables rejected. A total of three items were included. Differed from the open questions, the multiple response scale included options of visual, tactile, olfactory, and gustatory senses. Analysis of the multiple response items was also conducted to identify the sensory factors of different vegetables.

3.1.3. Procedure

The researchers directly distributed the questionnaire to parents at a rest area of a parent-child amusement ground. A group of parent and child was surveyed at one time. No participating remuneration

was provided. At first, the participants were informed that this questionnaire was an academic study related to young children's vegetable preferences. After we confirmed that the participants understood the purpose of the questionnaire, they began to answer the items and return the questionnaire after completion. The participants received a questionnaire regarding the top three rejected vegetables and sensory factors of rejection. The participants had 5 min to complete the questionnaire.

3.2. Effect of Vegetable Toy Types on Young Children' S Vegetable Preferences

3.2.1. Participants

The participants were 46 young children aged between two to six years. Among them, 17 were boys, accounting for 36.96%. The age mean was 4.00 and the SD was 1.42.

3.2.2. Tools

a. The vegetable preference scale: This scale was used to explore young children's vegetable preference. On the basis of 14 representative vegetables rejected obtained from the questionnaire of the previous stage, 14 vectors were divided, namely, carrot, sweet potato, onion, taro, cabbage, spinach, celery, cauliflower, garlic chives, pea, bitter gourd, eggplant, okra, and mushroom. One item was assigned for each vector, totaling 14 items. A Likert five-point scale was adopted; "1" represented strongly dislike and "5" represented strongly like. If the young child had not eaten the vegetable, the preference level for the vegetable could be left empty.

b. Vegetable toy experience and possession level scale: This scale was used to identify whether the young children had toy vegetable experience and possession. Five vectors existed in this scale, which were symbolic play materials, fluid-construction play materials, structured-construction play materials, sensorimotor play materials, and sign play-numbers and letters. Two items were designed for each vector, totaling 10 items. The answers were provided in a form of yes or no.

3.2.3. Procedure

The researchers directly distributed the questionnaire to parents at a rest area of a parent-child amusement ground. A group of parent and child was surveyed at one time. Before the questionnaire administration, the children received a gift worth of NT$12-15 to strengthen the parents' motive to respond. At first, we informed the participants that this is an academic study related to young children's vegetable and toy preferences. After we ensured that the participants understood the questionnaire purpose, they began to answer the questionnaire and returned the questionnaire after completion. The participants received a questionnaire regarding vegetable preferences, vegetable toy experience and possession. The participants had approximately 10 min to complete the questionnaire.

4. Experimental Results

The first section of the experiment identified the top three vegetables that young children rejected and the particular sensory factors of rejecting the vegetables. The second section of experiment determined the young children's vegetable preferences and toy experience and possession. In addition, we conducted analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA).

4.1. Survey of Rejected Vegetables and Sensory Factors

In the first stage of survey in this study, the content included the vegetables children rejected and sensory factors of rejection. Among the 30 questionnaires returned, 23 valid questionnaires were obtained. According to the edible parts classification of vegetables (digital teaching information portal Website of the Ministry of Education), the top three vegetables that young children rejected were identified by categories. The mostly rejected vegetable of each category was identified by proportion, which were carrot of taproot type, onion of terrestrial type, cabbage of fresh edible vegetable, spinach of cooked use, celery of spicy type, cauliflowers of flower or bud type, pea of legume type, bitter gourd of melon and fruit type, eggplant of solanaceous type, okra of others type, and mushroom of edible fungi. Because the open items of vegetables rejected by young children did not mention tuberous, subterranean stem, and hepatica vegetables. Sweet potatoes, taros, and garlic chives were defined as commonly seen vegetables. The results of the valid questionnaire were organized as shown in Table 1.

Table 1: Proportion of vegetables rejected and sensory factor items

Name	Proportion of rejection	Factor of rejection (%)			
		Visual	Olfactory	Gustatory	Tactile
Carrot	13.0	25	75	100	50
Sweet potato	-	-	-	-	-
Onion	8.7	0	33.3	100	66.7
Taro	-	-	-	-	-
Cabbage	17.4	0	16.7	50	100
Spinach	21.7	16.7	16.7	83.3	50
Celery	17.4	0	25	75	75
Cauliflower	4.3	0	25	75	75
Garlic chives	-	-	-	-	-
Pea	13.0	0	25	25	100
Bitter gourd	47.8	0	21.4	100	35.7
Eggplant	34.8	9.1	27.3	45.5	81.8
Okra	8.7	0	50	50	100
Mushroom	8.7	33.3	33.3	100	66.7
Mean	-	7.4	30.5	74.7	66.3

Table 1 indicates that among the factors for young children to reject vegetables, the taste accounted for 74.7%, followed by tactile sense (mouthfeel) of 66.3%, olfactory sense of 30.5%, and visual sense of 7.4%. Young children rejected carrots (100%), onion (100%), spinach (83.3%), bitter gourd (100%), and mushroom (100%) mostly because of gustatory senses. The primary factor of rejecting cabbage (100%), pea (100%), eggplant (81.8%), and okra (100%) was the tactile sense (mouthfeel). Young children rejected celery (75%) and cauliflower (75%) because of gustatory and tactile factors. Visual and olfactory senses were not primary factors causing young children's rejection of vegetables.

4.2. Survey of the Current Situation of Vegetable Preference and Toy Vegetable Forms

The survey contents of this study involved vegetable preferences, young children's toy experience and possession state of various types of toy vegetables. Toy types comprised symbolic play materials (vegetable dolls), fluid-construction play material (vegetable clay model), structure-construction play material (vegetable jigsaw or toy bricks), sensorimotor play material (kitchen set of ingredient-cutting toy), sign play-numbers and letters (vegetable flash cards or picture cards). Among the 51 questionnaires returned, 46 valid questionnaires were obtained. The valid questionnaire contents were organized as shown in Table 2 to Table 7.

Table 2: Means and SDs of vegetable preferences

Vegetable preference	Mean	SD		Vegetable preference	Mean	SD
Carrot	3.35	1.186		Cauliflower	4.26	.873
Sweet potato	3.50	1.081		Garlic chives	2.88	.963
Onion	2.68	1.167		Pea	3.27	1.158
Taro	2.92	1.038		Bitter gourd	1.84	1.092
Cabbage	3.10	.792		Eggplant	2.38	1.077
Spinach	3.39	.984		Okra	2.87	1.318
Celery	2.51	.993		Mushroom	3.70	1.400

Table 3: ANOVA of vegetable preference and toy experience and possession

Vegetable preference	Toy experience	Toy possession
Carrot	.038*	.033*
Sweet potato	.496	.030*
Onion	.693	.504
Taro	.465	.949
Cabbage	.672	.078
Spinach	.241	.859
Celery	.575	.543
Cauliflower	.554	.041*
Garlic chives	.726	.606
Pea	.607	.017*
Bitter gourd	.776	.668
Eggplant	.790	.314
Okra	.632	.900
Mushroom	.006*	.287

Table 3 shows the one-way ANOVA of vegetable preferences and toy experience and possession. The vegetable toy experience was significantly correlated with carrot and mushroom preferences. Toy possession was significantly correlated with carrot, sweet potato, cauliflower, and pea.

Table 4 shows the descriptive statistics of the effect of vegetable toy experience on carrot and mushroom preferences. Children having played toy vegetables had higher carrot and mushroom preferences than children who did not played toy vegetables.

Table 4: Descriptive statistics regarding vegetable toy experience and carrot and mushroom preferences

	Possession	Preference for carrots	Preference for mushroom
Toy vegetable experience	Yes	3.90	4.26
	No	3.33	3.11

Table 5 depicts the descriptive statistics of vegetable toy possession and carrot, sweet potato, cauliflower, and pea preferences. When children possessed toy vegetables, their carrot, sweet potato, cauliflower, and pea preferences were higher than children who did not have vegetable toy s.

Table 5: Descriptive statistics of vegetable toy possession and carrot, sweet potato, cauliflower, and pea preferences

	Possession	Preference for carrots	Preference for sweet potatoes	Preference for cauliflowers	Preference for pea
Toy vegetable possession	Yes	4.02	4.12	4.39	3.98
	No	3.59	3.69	4.02	3.43

Table 6 shows the MANOVA of vegetable preferences and individual variables. Different types of vegetable toy experience were not significantly correlated with any vegetable preferences. Possession of different types of toy vegetables exhibited significant correlation with pea preference.

Table 6: MANOVA of vegetable preferences and different types of toy experience and possession

Vegetable preference	Different types of toy experience	Different types of toy possession
Carrot	.684	.818
Sweet potato	.944	.775
Onion	.972	.931
Taro	.882	.075
Cabbage	.992	.644
Spinach	.575	.962
Celery	.860	.928
Cauliflower	.658	.053
Garlic chives	.782	.577
Pea	.643	.045
Bitter gourd	.731	.259
Eggplant	.931	.562
Okra	.979	.995
Mushroom	.721	.793

Table 7 shows the descriptive statistics of possession of different types of toy vegetables and pea preference. The children possessing fluid-construction toy vegetables had the highest pea preference, whereas the children who did not possess sensorimotor toy vegetables exhibited the lowest preference for pea.

Table 7: Descriptive statistics of possession of vegetable toy types and pea preference

Toy type	Possession	Pea preference	Possession	Pea preference
Symbolic play material	Yes	4.17	No	3.50
Fluid-construction play material	Yes	4.57	No	3.23
Structured-construction play material	Yes	3.78	No	3.64
Sensorimotor play material	Yes	4.25	No	2.88
Sign play-number and letters	Yes	3.53	No	4.20

5. Conclusion and Discussion

5.1. Conclusion

5.1.1. Sensory factors of rejecting vegetables

Among the factors of young children rejecting vegetables, the primary cause was the taste (74.7%), followed by tactile sense (mouthfeel; 66.3%), olfactory sense (30.5%), which is related to gustatory sense, and visual sense (7.4%).

The influence of visual rejection was the least. This result suggested that manufacturing toys in the form of vegetables did not cause rejection from children. Thus, children's visual stimulation can be enhanced through toy vegetables. The rejection factor of gustatory sense was the highest; however, the taste cannot be altered through toy design. The second highest factor was tactile sense, which might enhance children's vegetable preferences by designing toys with multiple tactile feelings.

5.1.2. Effect of vegetable toy experience and possession on young children's vegetable preferences

Children who played with toy vegetables had higher preferences for carrot and mushroom. A possible explanation was that these two types of vegetables are commonly molded as toy vegetables. Thus, we inferred that children's preference for vegetables that have particular shapes and are not rejected because of tactile (mouthfeel) factors can be enhanced through visual stimulation.

Young children possessing toy vegetables had higher preferences for carrot, sweet potato, cauliflower, and pea. The primary reason of rejecting cauliflower and pea was the tactile feeling. Thus, we inferred that the preference for vegetables that were rejected by children primarily because of the tactile sense (mouthfeel) require multiple tactile stimulations to improve.

5.1.3. Effect of different types of vegetable toy experience and possession on young children's vegetable preferences

Different types of vegetable toy experiences did not have effect on young children's vegetable preference. This could be caused by low contact frequencies.

Possession of different types of toy vegetables affected the pea preference. The young children possessing fluid-construction toy vegetables (vegetable clay models) had the highest preference for pea. The young children who did not possess sensorimotor toy vegetables (kitchen set ingredient-cutting toy) had the lowest preference for pea. We inferred that this result was because vegetable clay model and kitchen set ingredient-cutting toys provide young children long time of tactile stimulations.

Lynch proposed a role play game of toy foods. Through the interactive question and responses with parents, the children's dietary preference may be influenced [20]. The kitchen set ingredient-cutting toy possibly covered the influence of interaction. In summation, to develop toys that promote young children's vegetable preferences in the future, the toy appearance must express the clear features of vegetables, combined with multiple tactile feelings. Regarding the playing method, sensorimotor play materials can be used as the primary method, integrated with fluid-construction play materials to achieve the optimal effectiveness in enhancing young children's vegetable preferences.

5.2. Limitations

(1) Because sweet potatoes, taros, and garlic chives were not chosen in the open item of vegetables rejected, these the rejection sensory factors for these vegetables were not explored.

(2) Vegetable preferences were correlated with dietary habits and feeding methods. However, relevant discussion was not provided in this study.

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