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## Identification of basic tastes in foods before and after training among 4-6 year old children – a pilot study

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**Introduction:** Human beings have an innate preference for sweet taste and aversion towards bitter. However, the individual perception of taste differs to a great extent and is due to both the ability to detect basic tastes and to the taste concentrations<sup>1</sup>. It is known that children can perceive basic tastes more or less to the same extent as adults<sup>2</sup> but unlike adults small children face a challenge: to put into words what they taste. The ability to identify and describe taste experience contributes to a more diversified and healthy diet, and makes the children more able to express their preferences and discuss the food they eat<sup>3,4,5</sup>. Testing young children's taste sensitivity and preferences require a study design that takes into account their age and development, endurance and concentration. In practice this means that sensory tests with children need to be relatively short, easy to understand and fun to the children<sup>5</sup>.

A method that has shown to increase children's awareness of the (basic) tastes and gives them an expanded vocabulary to put a name on their taste experiences is Sapere<sup>6</sup>. The Sapere method allows children to explore and get to know the sensations of food through school-based training. About 80 per cent of one- to five-year-olds attend preschool in Sweden. The education in Swedish preschools aims at children acquiring and developing knowledge and values and the early Childhood Education and Care is expected to promote children's development and learning and a lifelong desire to learn<sup>7</sup>. The implementation of taste training to aid the development of a varied diet, and children more able to express their preferences could thus be in line with the ambitions of Swedish preschools. Taste preferences and identification as well as verbalization of the taste experience may be improved by learning, either more or less conscious via the

socialization processes or via strategic learning procedures. The aim of this pilot study was to examine 4-6-year old children's abilities to identify basic tastes in foods before and after training with basic taste solutions. Further, to note the children's abilities to verbalize their taste experiences before and after the training.

**Methods:** A method triangulation was used by combining quantitative objective results on basic taste tests with qualitative studies of individual knowledge and reflections<sup>8</sup>. Eleven children aged 4-6 years participated in the study conducted at a Swedish preschool. The age limit of the participating children was based on that the test required both patience and concentration why children younger than four years were deemed too young to participate<sup>5</sup>. The children were divided into two groups of five and six children. All children (n = 11) who participated completed all parts of the test.

The study was designed as an iterative training process consisting of four steps:

- 1) A general discussion with the children about basic tastes initiated the training.
- 2) Basic taste was discussed also in the second step but now limited to ten selected foods that were tasted.
- 3) In the third step the children learned to recognise the basic tastes sweet, sour, salty, bitter and umami by tasting basic taste solutions.
- 4) The last step of the iterative training process was a basic taste test in which the children were asked to answer which basic tastes they could identify in ten different foods, the same foods that were tested in the second step.

During the entire training process it was noted how the children verbalised the tastes of the foods. The entire training process including the four steps took 40 minutes per group session.

**Training process design, Step 1:** During the initial semi-structured group interview the test leader prompted the following two questions to the children:

- 1) What is a basic taste?
- 2) What basic tastes can you think of?

**Training process design, Step 2:** Ten selected foods were introduced to the children. Each of the ten foods was selected due to a dominant basic taste, with two foods per

basic taste. See Table 1. The children discussed their taste experiences with the test leader.

**Table 1. Ten selected foods used in step 2**

Food 1	Food 2	
<b>Sweet</b>	Beetroot (boiled) <i>ICA, Spain</i>	Pears (Conference) <i>ICA, Netherlands</i>
<b>Sour</b> <i>Garant Eko., Egypt</i>	Green grapes	Lemon <i>Garant Eko., Turkey</i>
<b>Salty</b> (Saltiner)	Salty crackers	Hard cheese (extra aged, 'Prästost') Grapefruit
<b>Bitter</b> <i>Lindt, Germany</i>	Chocolate (90 % cocoa) <i>ICA, Israel</i>	
<b>Umami</b>	Soy sauce <i>Kikkoman, Japan</i>	Sundried tomato (natural) <i>Fontana, Greece</i>

**Training process design, Step 3:** In the third step of the process the conditioning took place. Five basic taste solutions were served to the children (Table 2). The solutions were prepared with high concentrations of basic tastes<sup>2</sup>. For sweet, salty and sour solutions the concentrations were twice the detection threshold, according to ISO-standard (3972:2011). Tonic water was selected for the bitter solution instead of caffeine and dark brown bouillon was selected for the umami solution instead of monosodium glutamate.

**Table 2. Basic taste solutions used in step 3**

Basic taste	Chemical substance	Concentration (g/l water)
Sweet	Sucrose	48
Sour	Citric acid	2,5
Salty	Sodium chloride	8
Bitter	Tonic water ( <i>Schwepes</i> )	Not diluted
Umami	Dark brown bouillon	Acc. to instructions

The taste solutions were tasted in order to keep the children focused and give them a chance to reflect on and understand what they actually tasted. The basic tastes were paired to coloured symbols to add a logical and educational link to the taste they represented, for example, salt was symbolized by a white plate with a salt shaker on.

**Training process design, Step 4:** In the concluding fourth step the children were asked to taste the same ten foods as in step 2 but this time they were to indicate, individually, which basic taste that they experienced was the dominating basic taste in the food. The indication was made by providing each child with 5\*5 symbols of the basic tastes that they placed in a container next to the food. The symbols were the same as the ones used in step 3. Every symbol was marked with the child's unique ID number. The children had access to the basic taste solutions introduced in step 3 if they wanted to compare the foods to a solution they experienced.

Even though the ten selected foods had a typical dominating basic taste, more than one basic taste was usually prevalent. E.g. lemons are primarily sour but also sweet and slightly bitter. To evaluate the taste test a scoring system was established, see Table 3. A paired t-test was used to analyse the children's abilities to identify tastes both before and after training.

**Table 3. Scoring system to evaluate basic taste test in step 4**

5p- dominating basic taste, 3p- present but not dominating, 1p – might be detectable,  
0p – wrong answer

	Sweet	Sour	Salty	Bitter	Umami
Beetroots	5	0	0		0
Pear	5		0		0
Grapes	3	5	0		0
Lemon	3	5	0		0
Salty crackers	0	0	5	0	0
Cheese		3	5		
Chocolate	3	3	0	5	0
Grapefruit		3	0	5	0
Soy sauce			3		5
Dried Tomatoes		3	3		5
<b>Total</b>	<b>23</b>	<b>24</b>	<b>16</b>	<b>17</b>	<b>11</b>

**Results:** The iterative training process consisted of four steps where the results from the first two steps provided data regarding the baseline i.e. the children's abilities to identify basic tastes before the conditioning. The training took part in step three and the results from the conditioning were measured in the fourth step.

**Before conditioning (baseline):** In the initial group discussion (Step 1) the children were asked to discuss 'taste' and tastes they were acquainted to. Children's perception of which "taste" (In Swedish: Smak) included varied widely. Some of the children gave vague answers and seemed to be puzzled by the question. Descriptions as "good," "disgusting," "strong," "healthy" and "not healthy" were mentioned. Sweet, sour and bitter were the basic tastes that the children could reason their way to with help of follow-up questions and discussion. No one mentioned salt or umami.

In the following first tasting (Step 2) the children showed a good ability to perceive not only taste but also texture e.g. "juicy" and "dry". The spontaneous, initial valuation of a food though tended to concern descriptors as "tasty" or "disgusting". The basic taste sweet was used by the children as a synonym for "tasty," regardless of whether the food in question actually tasted sweet or not. Those children who explicitly appreciated the pungent salty hard cheese tended to describe it in terms of sweet and tasty. See Table 4 for a summary of the comments.

**Table 4. Comments during taste trial of 10 different foods (before conditioning)**

Food	comments
Beetroot	earth, salad, tasty, sweet
Salty crackers	Dry, flour, salty, tasty
Chocolate	Strong, dry, licorice, sweet, sour, disgusting, tasty
Cheese	sticky, tasty, sweet, candy
Grapefruit	tasty, bitter sour, sweet, as an orange but more
Pear	tasty, juicy, candy, delicious, sweet
Tomatoe	Strong, sour salt, tasty
Grapes	primarily sweet, water, tasty, sour, sugary
Soy sauce	salty and tasty, disgusting
Lemon	tasty, sour, juicy, sugary

**After conditioning:** After the training session (Step 3) the basic taste test (Step 4, similar to Step 2) was performed.

All children recognized the most dominant basic taste in pear, lemon and salty crackers but only a few could recognize the dominant basic taste in soy sauce and dried tomato. See Table 5.

**Table 5. Ability to recognize the most dominant basic taste in ten foods**

Child	Sweet		Sour		Salty		Bitter		Umami		Sum (max)
	Beets	Pear	Grape	Lemo	Saltine	Chees	Choc o-	Grap e-	Soy sauc	Tomat	
1		D		D	D						3
2		D	D	D	D						4
3	D	D	D	D	D		D	D			7
4	D	D	D	D	D	D	D	D		D	9
5	D	D	D	D	D		D	D	D		8
6		D	D	D	D	D	D				6
7	D	D	D	D	D	D	D	D			8
8	D	D	D	D	D	D	D	D	D		9
9	D	D	D	D	D	D	D	D			8
10	D	D	D	D	D	D	D	D			8
11	D	D	D	D	D	D	D	D	D		9
<b>Sum</b>	<b>8</b>	<b>11</b>	<b>10</b>	<b>11</b>	<b>11</b>	<b>7</b>	<b>9</b>	<b>8</b>	<b>3</b>	<b>1</b>	

When studying how the children performed on ability to recognize all the prevalent basic tastes in the ten tested foods it was clear that the children differed in abilities to recognize basic tastes (Table 6). The child that recognized the most basic tastes recognized 69%, and the child that recognized the least recognized 33%.

**Table 6. Individual differences in ability to recognize basic tastes**

Child	Sweet 23 p	Sour 24 p	Salty 16 p	Bitter 17 p	Umami 11 p	Total score 91 p
1	13	8	8	1	0	30
2	10	17	8	1	0	36
3	13	19	8	11	0	51
4	11	17	13	10	5	56
5	14	10	8	14	5	51
6	8	13	16	6	0	43
7	14	20	16	11	0	61
8	17	13	16	12	5	63
9	17	13	16	11	0	57
10	13	19	16	12	0	60
11	13	19	13	11	5	61
<i>Mean</i>	<i>13</i>	<i>15,3</i>	<i>12,5</i>	<i>9,1</i>	<i>1,8</i>	<i>51,7</i>

The results from a paired t-test showed that the children had a significantly higher ability to identify salty taste compared to the other basic tastes, both before and after training. Training did improve the children's abilities to detect and verbalize all basic tastes after basic taste training. Due to verbalization the children went from naming the tastes as "tasty" or "disgusting" to being able to put words on, and to identify many of the basic tastes in each food.

**Discussion:** A strategy to make children more curious and interested of foods and tastes is to conduct training sessions with basic taste solutions. This may benefit young children gaining a positive approach towards new tastes and flavors and also to foods in general. In this pilot study, children often referred to products' physical characteristics, such as "dry" and "juicy" when asked regarding basic tastes. The children tended to associate tastes with specific foods. The basic tastes that was mentioned by the children during the discussion was the sweet, sour and bitter tastes. "Sweet" seemed to be used as an equivalent to "good". Several studies show that sweet and bitter are the evolutionarily most important basic tastes for human to recognize as they represent edible and inedible why the children connecting "sweet" with "good" is natural<sup>9,10,11,12</sup>.

The children showed a significantly improved ability to both identify and verbalize basic tastes in food after the basic taste training, suggesting that even a very brief taste education can provide obvious improvements in the child's ability to learn to sense what the food tastes, and give them an expanded vocabulary to express themselves<sup>3</sup>. This is in line with the objectives of the Sapere method, which is shown to have very positive impact<sup>4</sup> on children's attitudes to food and eating<sup>3,4</sup>. Unlike the Sapere method that require dozens of teaching sessions<sup>4</sup>, this study shows that forty minutes is enough to achieve, albeit short-term, observable improvement in children's ability to both identify and express taste experiences.

The aim of this small sample pilot study was not introduce a quicker alternative to the Sapere method but to explore a way to examine children's abilities to identify basic tastes in foods before and after training with basic taste solutions. The examining methods and training intervention needs further studies to certify that the outcome measures is not confounded with intervention and to adapt it to preschool pedagogues for implementation. Taste training have shown to have an impact on the development of a healthy varied diet and children's abilities to express their preferences why preschools ought to find it promoting children's development and learning and a lifelong desire to learn<sup>7</sup>.

Due to the competition of a multitude of other activities done in preschool the challenge is to make the taste training and discussion as easy and fun as possible to all parties to perform. The measuring of the progress of the children may be one key to visualize the outcome of taste training.

**Conclusions:** From the results it could be concluded that the children had a significantly higher ability to identify salty taste compared to other basic tastes, both before and after training. Improved abilities both to detect and to verbalise all basic tastes after basic taste training were shown. Due to verbalisation the children went from naming the tastes as “tasty” or “disgusting” to being able to put words on, and to identify, many of the basic tastes in each food.

A simple strategy to make children more curious of foods and tastes is to perform training sessions with basic taste solutions. This may benefit young children by contribution of a more positive approach towards new flavours and foods in general.

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