Norwegian University
of Life Sciences

Master's Thesis 2021 30 ECTS
Faculty of Chemistry, Biotechnology and Food Science

Liking and taste responsiveness across PROP-taster groups in children

Marie Stensvold
Food Science (Production and Development)

Abstract

Overweight and obesity and the associated health risks are a growing concern globally. Research has shown that people who are obese early in life and especially in preadolescence have a high risk of also being obese in adulthood. It is therefore extremely important to form healthy food habits from childhood.

The objective of this thesis is to investigate the associations between children's taste intensity perception and their hedonic responses. This was done by highlighting taste responsiveness, PROP (6-n-propylthiouracil) responsiveness, stated and actual liking of foods, as well as food familiarity. 148 preadolescences aged 11 to 13 years old completed a sensory consumer test at schools where instructions were given from a remote location. The participants answered a questionnaire about familiarity and stated liking of 28 food items. The children also performed a tasting of four samples of grapefruit juice with different levels of sugar added, and four samples of vegetable broth samples with different levels of salt added. Samples were tasted twice, once for liking and once for taste responsiveness, respectively. PROP responsiveness was recorded using a paper disc test.

The results showed a significant and positive correlation between stated liking and familiarity of the 28 food items. When tasting samples, children reported differences in liking of grapefruit juice samples; the samples were more liked as sugar content rose. For vegetable broth samples, no differences in liking were recorded between samples across children, but PROP phenotypes liked vegetable broth samples significantly different, with non-tasters liking samples significantly more than the other PROP phenotype groups. Several differences in taste responsiveness were found between PROP phenotypes, both for basic taste responsiveness and liking of samples. Familiarity, responsiveness to sweet taste and PROP responsiveness were significant in predicting liking of grapefruit juice samples. The results from this study add to the understanding of food choices in children in relation to taste sensitivity perception, familiarity, and how remote testing can be utilized in sensory evaluation with preadolescents.

Sammendrag

Overvekt og fedme og tilknyttede helseproblemer er et økende problem over hele verden. Forskning har vist at mennesker med fedme tidlig i livet og spesielt tidlig i ungdomstiden har høy risiko for å ha fedme også i voksen alder. Dermed er det ekstremt viktig å skape sunne matvaner fra barndommen.

Målet med denne oppgaven er å undersøke sammenhengene mellom hvordan barn opplever smak og deres hedoniske respons. Dette ble gjort ved å legge vekt på barnas smaksrespons, respons for PROP (6-n-propylthiouracil), oppgitt og opplevd liking av matvarer, og kjennskap til matvarer. 148 barn fra 11 til 13 år (tidlig ungdom) deltok i en sensorisk forbrukerundersøkelse gjennomført på skoler hvor instruksjoner ble gitt fra en ekstern lokasjon. Deltakerne svarte på en spørreundersøkelse hvor de ble spurt om kjennskap til og oppgitt liking av 28 matvarer. De gjennomførte også en smakstest av fire prøver med grapefruktjuice tilsatt ulike mengder sukker, og fire prøver med grønnsaksbuljong tilsatt ulike mengder salt. Prøvene ble smakt på to ganger, en gang for liking og en gang for å registrere smakssensitivitet. PROP respons ble registrert gjennom en papirdisktest.

Resultatene viste en signifikant positiv korrelasjon mellom oppgitt liking og kjennskap til de 28 matvarene testet. Svarene fra smakstesten viste forskjeller i liking av grapefruktjuiceprøvene; prøvene ble mer likt ettersom sukkerinnholdet økte. I grønnsaksbuljongprøvene ble det ikke funnet forskjeller i liking når gjennomsnittsscore fra alle barn ble sett på, men det ble funnet signifikante forskjeller for hvor godt PROP fenotypene likte grønnsaksbuljongprøvene, hvorav ikke-smakerne likte prøvene signifikant mer enn de andre PROP fenotypene. Det ble funnet forskjell i smaksrespons mellom PROP fenotypene, både i grunnsmakene og i liking av prøver. Respons til PROP og søt smak samt erfaring med grapefruktjuice var signifikante variabler for å forutse liking av produkt ved smaking. Resultatene fra denne oppgaven er med på å utvide forståelsen av matvalg hos barn ved å legge vekt på smakssensitivitet, kjennskap til matvarene, og se hvordan ekstern testing kan brukes ved sensorisk evaluering med barn i tidlig ungdomstid.

Acknowledgments

From first learning about sensory evaluation in courses at NMBU, I knew I wanted to write my thesis in this field. This process has taught me a lot, from preparations and executing a sensory consumer test, statistical analysis, to the writing process.

Firstly, I want to thank my supervisors, Valerie Almli and Ervina. Your knowledge and insight has impressed me greatly through this year. Your thoroughness is something I will remember and aspire to live up to. Thank you for your support and insight, and the time you have put into helping me through the process. Your feedback has been wonderful. Thank you for believing in me and letting me take part in this study. I would also like to thank Julia Sick, who made the questionnaire and together with Ervina were essential in conducting the consumer test.

Thank you to all teachers that were willing to participate in this test and make the extra effort it took to take part in a test like this during a pandemic. A big thank you to all children who participated in this test.

Lastly, I would like to express my gratitude to my friends and family for always being there for me and giving support through my studies, especially this springtime.

I hope you will enjoy reading this.

Ås, June 11th, 2021

Marie Stensvold

Table of contents

Figures

Tables

Photos

Preface

This dissertation concludes a 2-year master's degree in food science from the faculty of Chemistry, Biotechnology and Food Science at the Norwegian University of Life Sciences (NMBU), Ås.

From September to November 2020, 148 children completed a consumer test with instructions given remotely, which gave results presented in this master thesis. The study was performed with the department of innovation, consumer, and sensory sciences at Nofima AS. This research is a part of a European research project, Edulia. Edulia receives funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 764985. Edulia's goal is to find ways to reverse the increasing trend in obesity in children, by promoting healthy eating habits through choice (Edulia, n.d.).

There is still much research to be done to understand food choice in children, and how to influence this in a healthy way. The background for this study was to see differences in taste responsiveness in preadolescents, and the role of familiarity on food acceptance. This study also researched what variables affected actual liking of samples.

1 Introduction

Overweight and obesity is a growing concern and is described as a pandemic, which killed more than four million people in 2017 alone, but also is responsible for severe health problems like diabetes, cardiovascular disease, musuloskeletal diseases and some cancers (WHO, 2020). The prevalence of obesity in children is growing, and their nutritional intake is moving away from the recommendations (Holsten, Deatrick, Kumanyika, Pinto-Martin, & Compher, 2012).

“Eating habits are formed in early childhood, and remain stable through adolescence and into young adulthood” was stated by Lanfer et al. (2013). This supports the findings from a meta-analysis by Simmonds, Llewellyn, Owen, and Woolacott (2016) that included measurements of body mass index (BMI) of a total of 200 777 participants over time. This analysis showed that obese children were more than five times as likely to be obese in their twenties than non-obese children. Adolescents that were obese had an 80% chance of being obese in their twenties. Equipping children with healthy eating habits and relationships with food will have a positive effect on health throughout their lifetimes.

Food preferences is influenced by many factors, of which taste perception is key (Cox, Hendrie, & Carty, 2016; Pagliarini et al., 2021). Taste perception is often researched by placing participants into groups based on taste responsiveness for the bitter compound PROP (6-n-propylthiouracil). High PROP responsiveness is connected to high sensitivity towards other basic tastes and affects food choice (Keller, Steinmann, Nurse, & Tepper, 2002). Food familiarity another important driver of liking (Aldridge, Dovey, & Halford, 2009). It has been shown that repeated exposure has led to increased acceptability of unfamiliar foods and liking of previously rejected foods in children (Heath, Houston-Price, & Kennedy, 2011). Understanding how children’s food preferences are formed and how their taste perception works is essential in order to change the growing trend of childhood obesity.

The aim of this thesis is to investigate the associations between children’s taste intensity perception and their hedonic responses. Responsiveness towards PROP, basic tastes and sample liking was used to highlight this. Additionally, the connection between food familiarity and stated liking was researched. Lastly, whether familiarity, stated liking, PROP responsiveness and taste responsiveness are valid predictors of liking of grapefruit juice was investigated. To answer these research questions, a sensory consumer evaluation with preadolescents (11-13 years old) was performed. Instructions were given from a remote location. A questionnaire was answered, and samples of grapefruit juice and vegetable broth were tasted to record hedonic responses and taste responsiveness. PROP phenotyping was done using a paper disc test.

2 Theory

2.1 Overweight and obesity

Overweight and obesity is defined as “abnormal or excessive fat accumulation that presents a health risk” and is characterized by body mass index (BMI) values; a BMI over 25 is considered overweight and over 30 is considered obese (WHO, n.d.). In 2016, over 1.9 billion adults (39% of the global population) were overweight, and more than 650 million of these were obese. 350 million children and adolescents between the ages of five and nineteen were overweight or obese. In 2019, 38 million children under the age of five were either overweight or obsese (WHO, 2020). Youth have the most rapid growth in severe obesity in the United States (Browne et al., 2021). In Norway, there has also been an increase in overweight and obesity in children. From 1993 to 2000 the amount of children in the eight grade that were overweight rose with 57% for boys and 47% for girls, while obesity rates rose with 108% for boys and 83% for girls (Helsedirektoratet, 2010).

There are several causes of obesity, of which dietary habits are fundemental. Dietary habits that can cause obesity include high intake of energy dense foods, sugary drinks, having large portion sizes, snacking and low intake of vegetables and fruit (Aggarwal & Jain, 2018). Taste perception also has an effect on body weight as individuals percieve tastes differently, which effects food preferences. Obese individuals experience sweetness as less intense and have a higher preference for fat than non-obese people (Linda M. Bartoshuk, Duffy, Hayes, Moskowitz, & Snyder, 2006). A study by Maffeis et al. (2008) showed that obese prepubertial children ate more savoury snacks than non-obese children. A review by (Cox et al., 2016) showed suggestive evidence of the relationship between fat and salt preference and obesity.

2.2 Food preference

Food choice is determined by many factors such as biology, psychology, physiology as well as social and cultural influences. Food preference and liking is the most important factor affecting the foods we choose to eat (Beckerman, Alike, Lovin, Tamez, & Mattei, 2017; Monteleone et al., 2017). There are however many other factors that shape food intake, like availability, cost, health, convenience (Monteleone et al., 2017), environment, cognitive development and demographics (Bajec & Pickering, 2010).

Beckerman et al. (2017) made an overview of factors influencing food preference in children. They reported four categories of influence; child, parent, community and the macro enviroment. The most influential category was the child itself, with its innate preferences, food exposure and familiarity. Parents were the second most important, and factors in this category included maternal diets, rewards, restrictions and role modelling. The community was the next category, showing that school and daycare, healthcare, the grocery stores and workplace plays a role in food preferences. Lastly, the fourth category was the macro enviroment, including cultural norms, food prices and policy, food marketing as well as food production and distribution systems.

2.2.1 Food preference development

The foundation of food preferences is built early in life, and carries through to adolescence and adulthood (Russell, Worsley, & Campbell, 2015). Preference is continually developing through a person's lifetime. For this reason, it is vital to establish good dietary habits and preferences from a young age.

The acceptance of novel foods starts forming in fetuses when nutrients are absorbed through the umbilical cord *in utero*. From week 11 the fetus is able to perceive flavors, and the foods the mother eat become familiar and can influence the child's preferences later (Beckerman et al., 2017). Food acceptance is influenced by the length of the breastfeeding period, which influences fruit and vegetable intake later in life. A survey of four European cohorts by De Lauzon-Guillain et al. (2013) found that preschool (two to four years old) children who were breastfed for three to six months ate more vegetables than children who were never breastfed or breastfed for less than three months. Introduction to novel foods during the first year of life has been shown to have a higher impact on later food acceptance than the second year (De Cosmi, Scaglioni, & Agostoni, 2017). Birch, Gunder, Grimm-Thomas, and Laing (1998) reported that in their first year a child doubles consumption of a food after just one exposure.

Increasing children's acceptance for fruit and vegetables is challenging (Beckerman et al., 2017). It is therefore vital to start introducing these food groups early. Exposure to a new food leads to decreased food neophobia (Aldridge, Dovey, & Halford, 2009; Dovey, Staples, Gibson, & Halford, 2008). Food neophobia is the avoidance of eating new foods (Birch & Fisher, 1998, as cited in Dovey et al., 2008). Being presented with a novel food can bring fear and is a reaction in children to avoid eating potentially toxic foods. It makes the child unwilling to eat foods that it has no previous experience with, based on the way the food looks. Food neophobia increases as the child becomes mobile, and peaks between the ages of two to six years old (Dovey et al., 2008), when the child becomes able to find foods to consume on its own (Heath et al., 2011).

Parents are probably the strongest influence for food preference in young children (Ventura & Birch, 2008). A study by Wardle, Carnell, and Cooke (2005) showed that the two factors that have the biggest influence on children's (age two-six) fruit and vegetable consumption are parental fruit and vegetable intake and food neophobia. Parents use several strategies that form children's food preferences and can promote healthy or unhealthy relationships with foods as well as food neophobia. Examples of strategies that promote healthy and unhealthy relationships are encouraging the child to try a small amount of food and cooking separate meals for children, respectively (Russell et al., 2015). Parents should be careful not to force children to try foods, as negative experiences when tasting novel foods can lead to dislike of the food and refusal to try it again (Tuorila & Mustonen, 2010). Further, not allowing children to eat certain foods has been showed to increase their preference to it, so enforcing strict rules against unhealthy foods is counterproductive. Having free access to vegetables and fruits is a more effective way to give children a healthy relationship with nutritious foods (Beckerman et al., 2017).

The reasons for why humans choose to accept or reject foods has been shown to change over time. Dovey et al. (2012) found that children rejected fruit based on sight, while adults rejected based on tactile feel. Coulthard, Palfreyman, and Morizet (2016) found that younger children (seven years old) rejected food based on sight, while older children (11 years old) rejected based on smell. Similarly, Dovey et al. (2012) found that children decided to try a novel fruit (guava) based on the way it looked, while adults used tactile feel to decide whether to try it or not. Additionally, children were more willing to try guava when they were also presented with a similar looking, familiar fruit (apple).

2.3 Food familiarity

Food familiarity is the experience a person has with a food, and can be either from having tasted or seen a food item, or similar foods (Aldridge et al., 2009). Familiarity is a driver of food liking, and is a very important factor in food preference in young children (Aldridge et al., 2009). It influences how likely the child is to try new food items and how they expect novel foods to taste, and if they will eat the same food again (Aldridge et al., 2009).

For preschool aged children, 10-15 exposures are optimal to increase liking of unfamiliar foods (Heath et al., 2011). However, in a study by Anzman-Frasca, Savage, Marini, Fisher, and Birch (2012), preschool children were repeatedly exposed to initially non-liked vegetables. Most children's liking of the vegetables significantly increased after six exposures to the vegetable. Additionally, their intake rose significantly from the first tasting. A study by Coulthard et al. (2016) on children aged seven to eleven showed that a familiar vegetable (carrot) was overall rated negatively compared to a novel vegetable (celeriac). Additionally, fewer children tried the novel vegetable than the familiar vegetable.

2.4 Sensory evaluation

Sensory evaluation is a scientific field that uses the senses of taste, smell, touch, sight and hearing to "evoke, measure, analyze and interpret responses to products" (Lawless & Heymann, 2010, p. 2). There are three main classes of sensory tests: difference testing, descriptive testing, and affective testing. Discrimination tests are used to research if there are perceivable differences between samples, and can be done with trained panelist or consumers (Lawless & Heymann, 2010, p. 5). Descriptive tests are used to see what specific attributes make samples different from each other, and is done with trained panels (Murray, Delahunty, & Baxter, 2001). Affective tests (also called hedonic tests) are done to get responses from consumers, to see how much a product is liked or disliked (Lawless & Heymann, 2010, p. 7).

When doing tests with consumers, many participants (75-150) are required. This is because individual preference is recorded, and this varies a lot between individuals; in order to make statistical analysis reliable and the answers representative for a wider population, many answers are needed (Lawless & Heymann, 2010, pp. 7-8).

2.4.1 Scales used in consumer tests

The nine-point hedonic scale is the most common scale used in affective consumer tests (Lawless & Heymann, 2010, p. 326). It is used to measure the liking or disliking of samples or products (Lawless & Heymann, 2010, p. 7). This scale offers subjects nine phrases that express liking/disliking of a product or sample, and the subjects choose the alternative that best fits their liking/disliking of the product/sample. Affective responses can also be gathered using line scales.

2.4.1.2 Line scales

Line scales consist of a line that can have anchor phrases on each end, and they can also have intermediate anchors spread out across the line for reference. The respondent answers by marking any point on the scale (Lawless & Heymann, 2010, pp. 162-163).

The Labeled Magnitude scale (LMS) was the first line scale in use, developed by Green, Shaffer, and Gilmore (1993). The LMS scale is a category-ratio scale, which means it contains verbal descriptors placed on ceratin points on the line for reference, and the answers give ratio/magnitude information. The LMS scale is used for measuring perceived taste intensity or taste responsiveness. The line is presented vertically. The anchor at the bottom of the line is “barely detectable” and the anchor at the top of the line is “strongest imaginable”. The intermediate anchors are “weak”, “moderate”, “strong” and “very strong” (Lawless & Heymann, 2010, p. 163). The line represents a score from zero to one hundred, and is roughly logarithmic (Green et al., 1993). The generalized magnitude scale (gLMS) is similar to the LMS scale, but the anchors apply to any sensory experience; the bottom anchor is “no sensation” and the top anchor is “strongest imaginable sensation of any kind”. It is well suited for making comparisons across PROP phenotype groups (L. M. Bartoshuk et al., 2004).

The Labeled affective magnitude (LAM) scale was developed by Schutz and Cardello (2001). It was developed as a hedonic version of the LMS scale because the nine-point hedonic scale “suffers from problems related to unequal scale intervals and the underuse of end categories” (Schutz & Cardello, 2001), leading to problems in differation between products that are either extremely well liked or extremely disliked. The LAM scale is a line scale with the anchors “greatest imaginable like” at the top and “greatest imaginable dislike” at the bottom. It includes the nine anchors used in the traditional hedonic scale between these anchors (Lawless, Popper, & Kroll, 2010). The length of the line scale has an effect on how it is used;

when it is short, people tend to place their mark close to the anchors, practically using it as a category scale (Lawless & Heymann, 2010, p. 163). The LAM scale has been reported as more favorable than the traditional nine-point hedonic scale when rating well liked foods, because respondents used more of the scale than in a nine-point scale, leading to better discrimination between foods that were well liked (Lawless & Heymann, 2010; Schutz & Cardello, 2001). However, a study by Lawless et al. (2010) comparing the LAM scale, the nine-point hedonic scale and an 11-point category scale for rating acceptability of well liked products showed no difference in performance between the three scales.

Line scales have been found more useful in finding segments of consumers and for product differentiation than the traditional hedonic scale (Lawless & Heymann, 2010, p. 330). Kalva, Sims, Puentes, Snyder, and Bartoshuk (2014) support this, stating that the traditional hedonic scale is suitable for comparing liking of different products, as within-subject comparisons. When across subject/group comparisons are made, the traditional scale is not as suitable as a line scale. This is because the categories typically used are perceived differently between users and scales are not used in the same way by everyone.

2.4.2 Sensory testing with children

When testing on children it is important to consider the children's age and cognitive development. The complexity of scales used in tests with children should be modified according to the participants in the test. In hedonic tests, between seven and nine points is the most common number of categories or anchors, but more or fewer can be used. For very young children (36-47 months old), three-point scales have proven effective. Facial scales can be used when performing sensory tests with children, with or without addition of verbal descriptors (Lawless & Heymann, 2010, pp. 152-154; 333). If children need to use a complex scale, they require a "training" session to have a good understanding of the scale measurement.

Presenting children with long questionnaires can be a challenge, as children's attention span is low. They are also more likely to be influenced by the experimenters (Jilani, Ahrens, Buchecker, Russo, & Hebestreit, 2017), and be influenced by wording in questions. To keep children's attention span, gamification method can be used. Gamification in sensory evaluation is when a test is design in a game-like fashion. Instructions include a small story. Gamification can make children almost forget that they are participating in a test (Jilani, Peplies, & Buchecker, 2018). Children should also feel comfortable in the testing enviroment, which can be obtained by testing in a location that is familiar to them rather than bringing the children to a remote test location. A familiar place like school setting were preferred over a laboratory setting (Jilani et al., 2018). Additionally, children from two to seven years old tend to focus only on one attribute when asked to rate foods instead of evaluating all aspects of the food item. Understanding of language and comprehension of tasks can also be challenging (Guinard, 2000).

2.4.2.1 Cognitive development

A list describing cognitive development in children was made by ASTM's committee 18, published by Guinard (2000). It separates children into six different age groups: infants (birth-18 months), toddlers (18 months-3 years), preschoolers (3-5 years), early readers (5-8 years), pre-teens (8-12 years) and teenagers (12-15 years). The age groups have different cognitive development and abilities to partake in sensory evaluations. According to this list, pre-teens can express themselves adequately, and are able to read and write at a level which makes them able to administer tasks mostly without help. They can also make complex decisions, and understand most scales given sufficient instructions. Challenges when conducting sensory evaluation with pre-teens are keeping interest over time and avoiding influence from peers.

2.5 Bitterness sensitivity and PROP

Humans are naturally inclined to like sweet and salty tastes, and reject sour and bitter tastes. The disliking of bitter foods might be an instinct humans have to avoid eating toxic plants that are bitter-tasting (Deshaware & Singhal, 2017; Mennella, Pepino, Duke, & Reed, 2010). Some bitter plants are poisonous (e.g. ricin) while other bitter plants (e.g. turnips) can be eaten without consequences (Mennella et al., 2010).

The ability to taste bitterness can be quantified by the ability to taste phenylthiocarbamide (PTC) and PROP (Dinehart, Hayes, Bartoshuk, Lanier, & Duffy, 2006). PTC and PROP are chemically related, and the ability to taste the compounds is highly correlated (Guo & Reed, 2001). Because PTC has a tendency to give off flavour and is potentially toxic, PROP is being used instead of PTC (Lawless & Heymann, 2010, p. 33).

2.5.1 PROP-taster phenotypes

People can be placed in one of three phenotype groups, based on their PROP-taster status. These are PROP super-tasters (ST), PROP medium-tasters (MT) and PROP non-tasters (NT). ST are the most sensitive towards the bitterness in PROP, NT are the least sensitive, and MT have intermediate responses to PROP bitterness.

From a genetics point of view, PROP/PTC sensitivity is close to a Mendelian recessive trait, with two alleles, T and t, which represent “tasting” (TT or Tt) and “non-tasting” (tt) phenotypes (Guo & Reed, 2001). Sensitivity towards bitterness is controlled by genes in the TAS2R family, wherein TAS2R38 is the most widely studied of these genes (Deshaware & Singhal, 2017). Other genes than TAS2R38 have also been found to take part in PROP phenotype (Hayes, Bartoshuk, Kidd, & Duffy, 2008). The amount of fungiform papillae on the tongue has also been associated with PROP taster status, with NT the lowest density and ST having the highest density of fungiform papillae (Melis & Tomassini Barbarossa, 2017).

Screening for PROP phenotype can be done in two ways; by measuring threshold or suprathreshold. The threshold screening measures the lowest concentration the subjects can recognize. It separates subjects into two categories, tasters and NT. NT are not able to recognize bitter taste from PROP at all, or only in high concentrations. Tasters include both MT and ST. The suprathreshold method makes subjects rate PROP bitterness on a LMS or gLMS scale after tasting samples either in the form of filter paper or water solution. This method places individuals into one of three groups; NT, MT or ST. A NaCl paper disc might also be used as a reference response measurement to make sure subjects are put in the right group, especially if their response to PROP is close to cutoff values (Tepper et al., 2017)

2.5.2 Distribution of PROP phenotypes

In a study by Zhao, Kirkmeyer, and Tepper (2003), participants were 27% NT, 42% MT and 31% were ST, which they considered expected frequency. About 1/3 of Caucasian people are NT, according to Lawless and Heymann (2010). According to Deshaware and Singhal (2017), the porportion of phenotype taster groups are different in different parts of the world; 3 % of people in West-Africa, between 6 and 23 % of Chinese people and around 30% of Northern American Caucasians are NT.

PROP phenotyping has been used with children as well. Goldstein, Daun, and Tepper (2007) found 31% NT, 35% MT and 34% ST in nine years old children. In some studies done with children the threshold method has been used, only separating participants into NT and tasters. Keller et al. (2002) reported 64% tasters and 36% NT in preschool aged children. Keller and Tepper (2004) reported 66 % tasters and 34% NT in children aged four to five. Mojet, Christ Hazelhof, and Heidema (2001) found that sensitivity for basic tastes decreases with age, and that men are more prone to this change than women. Mennella et al. (2010) also stated that younger individuals who have participated in studies have shown more sensitivity towards PROP and PTC.

2.5.3 PROP taster status effect on perceived taste intensity, food intake, and BMI

Wether PROP phenotype has an effect on food choice, calorie intake and body weight has been discussed. PROP taster status has an effect on perceived taste intensity of many compounds, which leads to lower acceptability of these foods, for example high-fat salad dressings, beer, bitter vegetables and sucrose (Bajec & Pickering, 2010; Tepper, Christensen, & Cao, 2001). People who are sensitive to PROP are also more sensitive towards sweetness from different sweeteners (Dinehart et al., 2006; Kalva et al., 2014). Dinehart et al. (2006) and Schonhof, Krumbein, and Brückner (2004) found that percieved bitterness and sweetness in vegetables predicted their intake, with high percieved bitterness lowering the intake and high percieved sweetness increasing the vegetable intake. ST are also more sensitive towards and have lower acceptance of salty taste (Hayes, Sullivan, & Duffy, 2010). Additionally, Melis and Tomassini Barbarossa (2017) found that PROP super-tasters were more sensitive towards umami taste than non-tasters and medium-tasters.

Food preferences effects intake, and consequently BMI. Whether PROP is connected to this has been discussed. A study by Goldstein, Daun, and Tepper (2005) is one example of this; they reported higher BMI and body fat percentage in NT than in ST women. Moreover, a study by Tepper, Neilland, Ullrich, Koelliker, and Belzer (2011) had healthy, lean women eat freely at buffets. NT ended up consuming more calories than ST, but fat intake was not different between the groups. Studies have also reported that there is no relationship between weight and PROP (Deshaware and Singhal, 2017) or weight and sensitivity towards sour, bitter, sweet or salty taste (Cox et al., 2016).

3 Materials and methods

This chapter describes details regarding the way this study was conducted. The design of the study, samples, methods, and data analysis will be highlighted.

Figure 1 shows a summary of the steps this study consisted of. In the protocol development phase, parts of the questionnaire used in this study were adapted from a study by Monteleone et al. (2017), translated from Italian to Norwegian, and modified to fit a study with preadolescents. The protocol was adjusted based on pretest and pilot test results. Local schools were contacted and nine seventh grade classes were recruited. As this test was performed with instructions given remotely, teachers were given instructions in advance about their part in the test and their responsibilities before and during the test. All children in the nine classes were invited to participate and were given consent forms with information about the test that required a signature from the child and a legal guardian before participation was allowed. After the consumer test was completed, statistical data analysis was conducted.

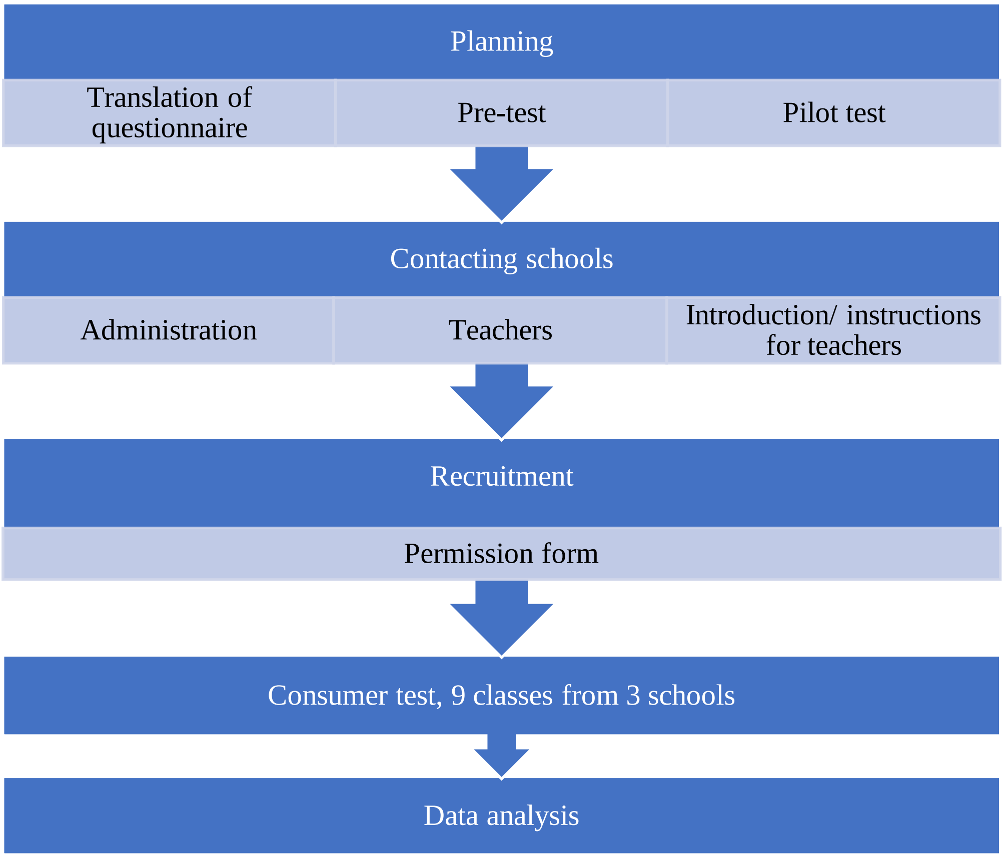

Figure 1. Overview of the steps this study consisted of.

3.1 Recruitment and participants

3.1.1. Selection

Three schools in Nordre Follo were invited to participate in this test. All children in the seventh grade in these schools were invited. Two of these schools participated in a different sensory research project with EDULIA in 2019. As the teachers and children were acquainted with some of the responsible researchers and already familiar with sensory testing, this made recruitment as well as running the test easier despite the Covid-19 situation. The third school had not been part of a sensory evaluation before; however, this was not problematic as sufficient information and instructions were provided. A total of nine classes participated, with a total of 165 participants.

3.1.2 Exclusion criteria

Out of the 165 participants, the results from 17 children were excluded. Exclusion of data happened when data was missing from a participant. Nine children failed to finish the test either because of time constraints or not wanting to complete the test. Eight children had allergies towards one or both samples. This resulted in 148 completed questionnaires.

3.1.3 Ethics and privacy

After an agreement was made between Nofima, the schools' administrators and teachers, an informed consent form was sent out to all children (see Appendix 1). This form informed about the study, the samples, how the test would be conducted and privacy/data protection in an age-appropriate format. Information about the safety measures concerning Covid-19 was also included. Information regarding allergens in the grapefruit juice and vegetable broth used in the study was given. A question about whether the child had any relevant allergies had to be answered, and a signature from both the child and a legal guardian was collected before participating in the study was allowed. Children with allergies could partake in the test, skipping only the tasting of non-tolerated samples. During the oral instructions on the day of the test the children were reminded that participation was voluntary, and that they were allowed to quit the test at any time if they wanted to, without any consequences.

A short demographics section was included in the test including children's age, gender, school, and class. The children's names were also collected but were deleted after the data was coded in an anonymous form. For statistical analysis and data storage, only individual code numbers were used. This study was approved by the Norwegian Center for Research Data (NSD), with reference number 715734 (see Appendix 2).

3.1.4 Teacher instructions

Before conducting the consumer tests, all teachers responsible for participating classes were sent a sheet with information (see Appendix 3) and had video meetings with the researchers. As researchers were not allowed in the school's facilities due to Covid-19 pandemic restrictions, these meetings were essential to make sure the teachers knew their role and responsibilities before and during the test.

During these meetings teachers were informed about the project, the consumer test, and the timing for each part of the test. Teachers were instructed about their role in the test; making sure every participant handed in their consent form in advance, how to arrange the equipment used during the test on the desks, that they should fill and refill water cups before and during the test when necessary and clearing the desks from previous samples after completion of each part of the test. They were also asked to place children in the classroom in a way that would reduce disturbance, by for example placing noisy children far away from each other. In this meeting the precise timing for the test was also agreed on, making sure that it aligned well with each class' schedule. What the children should do after finishing part one was also agreed on; some teachers wanted the children to read or draw, others wanted them to go outside and have a break, and some preferred using the riddle provided by researchers.

3.2 Samples

3.2.1 Grapefruit juice samples

Grapefruit juice (GF) was used in this study to test the basic tastes sweet, bitter, and sour. To create samples with different intensities of these tastes, sugar was added in four different levels.

The grapefruit samples were made from Bama Cevita Grapefrukt, shown in Figure 2. The juice was strained twice to remove pulp and separated into four bowls. Different amounts of sugar were added to the bowls according to Table 1. The sugar was stirred in until it was completely dissolved. Twenty mL of juice was added to closed containers with three-digit codes according to Table 1. Samples were tasted at room temperature.

Figure 2. Bama Cevita Grapefrukt, the grapefruit juice used in the test with differing amounts of sugar added (Photo: Bama, n.d.).

Table 1. Grapefruit (GF) juice samples with corresponding codes and sugar added.

Sample name	**Sample codes**		**Sugar added**
	Detective set A	Detective set B	
GF0	134	370	0 g/L
GF40	195	381	40 g/L
GF80	188	311	80 g/L
GF160	137	352	160 g/L

3.2.2 Vegetable broth samples

The vegetable broth (VB) samples were added different amounts of salt to represent different intensities of salty taste. The samples were made from Maggi Suppebuljong, shown in Figure 3. Fourteen grams of vegetable broth powder was added into one liter of hot water (80°C), followed by the addition of salt, as described in Table 2. The mixture was then stirred until broth powder and salt mixed evenly. The broth was then strained to remove vegetable pieces and excess fat formed as layer on the top of samples. Twenty mL of broth was added to closed containers with 3-digit codes according to Table 2. Samples were tasted at room temperature.

Figure 3. Maggi Suppebuljong, the vegetable broth used in the test with differing amounts of salt added. (Photo: allematpriser, n.d.)

Table 2. Vegetable broth (VB) samples with corresponding codes and salt added.

Sample name	Sample codes		Salt added
	Detective set A	Detective set B	
VB0	240	499	0 g/L
VB3	298	447	3 g/L
VB6	271	410	6 g/L
VB12	223	405	12 g/L

3.2.3 PROP paper disc

PROP paper discs for this study were prepared in advance following the method from a study by Zhao et al. (2003). They were placed in closed containers.

3.2.4 Detective sets

The sensory test had two replicated sets of samples, called Detective sets, that were tasted and rated for liking in part one and for basic taste intensity in part two in the test. Each set had four samples of grapefruit juice and four samples of vegetable broth (as described in Table 1 and Table 2). For palate cleansing, one package of gluten and lactose-free crispbread (Wasa Gluten- og laktosefri Naturell) was included in Detective set A (see Photo 1 (top)). Napkins were also included in the Detective sets, as well as a sticker with an individual login username and password. In addition, one paper cup for spitting and one plastic cup with water were provided for each child. All contents of Detective sets are shown in Table 3.

Photo 1. Detective set A (top) and B (bottom) before sealing, complete with samples, palate cleanser and PROP paper disc.

Table 3. The contents of Detective sets A and B used in the sensory tests.

Detective set A	Detective set B
4x grapefruit juice (GF0, GF40, GF80, GF160)	4x grapefruit juice (GF0, GF40, GF80, GF160)
4x vegetable broth (VB0, VB3, VB6, VB12)	4x vegetable broth (VB0, VB3, VB6, VB12)
Napkin	Napkin
Crisp bread	PROP paper disc
A label with username & password for login	

Each child was also provided a post-it sticker where they were instructed to write down their own unique login code. This was done to prevent losing the codes as Detective set A was removed from the desk after finishing part one of the questionnaire.

Because researchers were not allowed in the schools, samples were prepared in Nofima's sensory lab in Ås in the afternoon prior to each consumer test to ensure freshness. Extra precautions were taken to reduce risk of spreading Covid-19; face masks and gloves were used, and all surfaces were washed using disinfecting ethanol. Each sample drink was served in a closed container with lid and the complete detective sets were sealed (see Photo 2) in the packaging hall at Nofima, Ås using Multivac200.

Photo 2. Detective set A sealed and labeled. Each child received an individual code used for login, as well as a paper cup for spitting and a plastic cup with water.

3.2.5. Distribution of samples

Detective sets were delivered by researchers to the participating schools in the morning of the test. Teachers placed both detective sets, one paper cup and one plastic cup with water on each child's desk (Photo 3; Photo 4). Preferably, this was ready before children entered the classrooms. However, some classes were not ready when the meeting started and instructors, with the help from teachers, made sure that everything was in order before the test session could start. The instructor double checked remotely via screen (online) that all children had the required items ready before the test started.

Photo 3. Desk setup. Both detective sets, the paper cup and plastic cup with water were placed on each desk before children entered the classroom.

Photo 4. One of the classrooms used for the consumer test. Children were placed with space between them, all facing the front of the classroom. Instructions were given through Teams, shown on the classroom's smartboard.

3.3 Questionnaire

The questionnaire was prepared in an online platform, Compusense Cloud (Compusense, Inc., Guelph, Ontario, Canada), and children used their laptops or tablets to complete the questionnaire.

The test consisted of three parts, as shown in Figure 4. Part one recorded demographics, familiarity and stated liking of 28 food items, and tasting of samples for liking. Additionally, stated liking was recorded using CATA and emojis, and a curiosity questionnaire was answered, however these sections were not used in this thesis. In part two the children were instructed to taste the samples again to record the intensities of the basic tastes in each sample. Questionnaires about food neophobia, BIS/BAS and sensation seeking were also answered, but not used in this thesis. Part three of the test recorded PROP taster status, using a paper disc placed on the anterior part of the tongue. It took around one hour and 45 minutes for children to finish the entire test. A proper break was given (around 15-30 minutes) after completing the first part.

The questions were originally written in English. They were back-translated, i.e., translated to Norwegian, then back to English, to ensure that the meaning of the questions and words did not get changed in translation. Marie Stensvold did the translation to Norwegian, and afterwards two other Norwegian native speakers and one fluent English speaker, all working at Nofima, read through and commented on the translation.

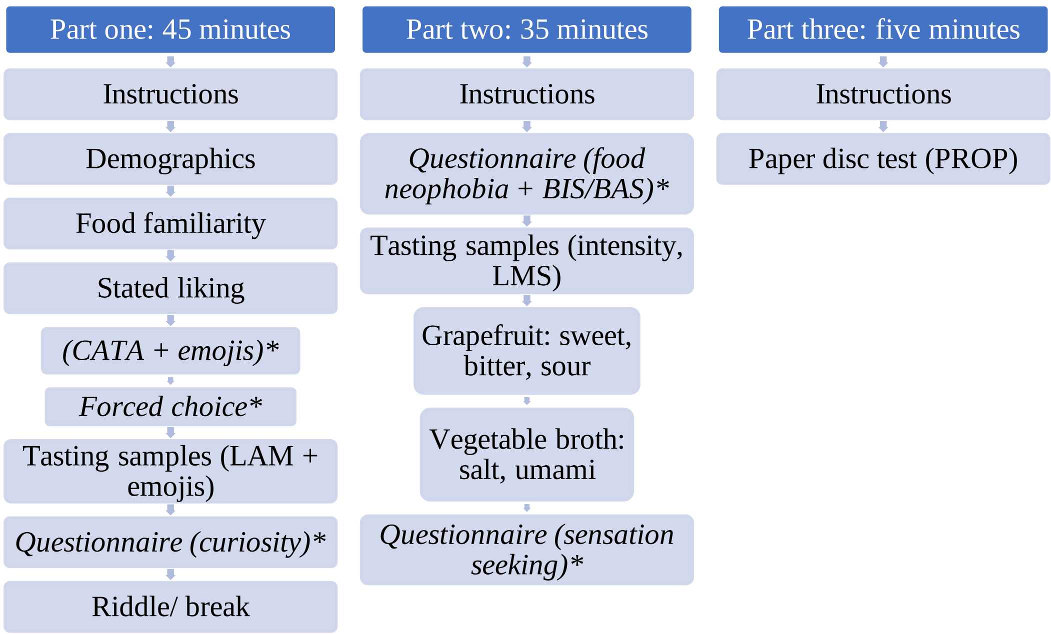

Figure 4. Overview of the questionnaire in the sensory test. **These parts were not used in this master's thesis.*

3.4 Familiarity

The children were asked to answer how familiar they were with 28 different food items and how much they liked it. The food items consisted of fruits (10 items), vegetables (10 items), and juices and desserts (8 items). These foods were chosen to have a representation of the basic tastes sweet, sour, and bitter. Vegetable choice was based on a publication by Dinnella et al. (2016), identifying vegetables familiar to adolescents in Europe. Familiarity was recorded with a 5-point category scale ranging from 1= “I do not know what it is” to 5= “I eat it often”, see Figure 5. The order of the food items was randomly rotated across children.

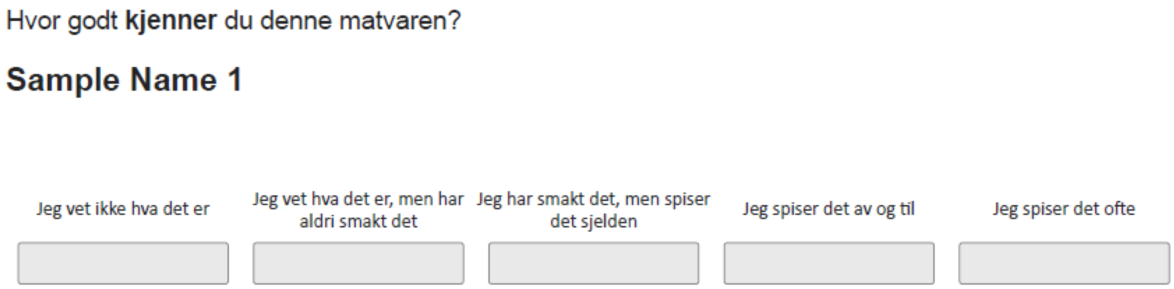

Figure 5. Screenshot of familiarity question used in the test. All food items were randomly rotated in the “Sample Name 1” place.

3.5 Stated liking

Stated liking was evaluated for the same 28 food items as for familiarity. Stated liking was recorded using a 7-point likert scale, ranging from 1= “strongly dislike” to 7= “like very much”. The option “I have never tasted it” was also available. See Figure 6. Children who answered that they had never tasted a food item before (score 1 or 2 in familiarity questionnaire) were not asked for stated liking of the unknown food items. The order of the food items was randomly rotated across children.

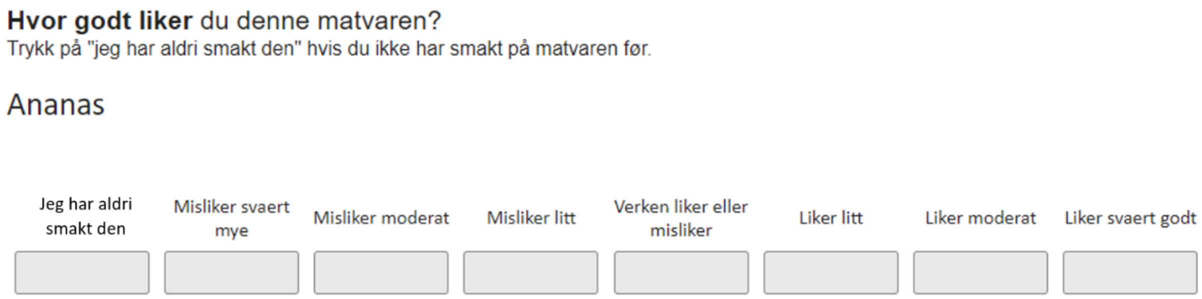

Figure 6. Screenshot of one food item used in recording stated liking. All food items were randomly rotated in the “Ananas” place.

3.6 Sample liking

All samples of grapefruit juice and vegetable broth (Table 1; Table 2) were tasted. Children answered how much they liked each sample with LAM scales, ranging from "The worst imaginable" to "The best imaginable", as shown in Figure 7. The children were explained the use of the scale prior to the evaluation by using examples of foods that are generally liked (pizza) and generally disliked (broccoli) by the children, and shown examples of how these could be placed, emphasizing that everyone should answer according to their own liking.

Figure 7. LAM scale used to identify children's liking of samples.

3.7 Measurement of taste sensitivity

To measure the children's sensitivity towards the basic tastes, they tasted samples with different amounts of added sugar or salt (Table 1; Table 2). LMS scales (Figure 8) were used for this. The scale ranged from "No sensory experience" to "The strongest sensory experience imaginable". Examples of different sensory sensations were given (strong taste, strong smell, strong lights etc.) to illustrate how the scale works. In addition, children were also presented different food pictures with different taste intensity (i.e., fresh lemon and lemonade for sourness) with examples of how they could be placed on the scale. They were reminded that everyone should give answers for themselves, and that no answer is right or wrong. For grapefruit juice samples, the children were asked to rate how intense the perceived bitter, sweet, and sour tastes were in all samples. For the vegetable broth samples, the intensity of salty and umami taste in all samples was rated.

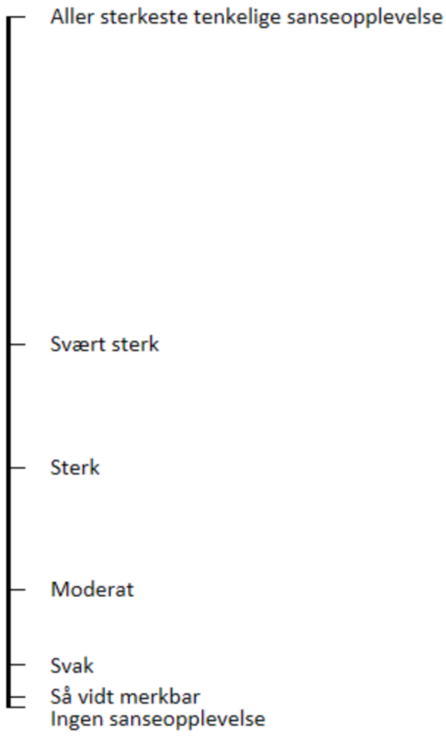

Figure 8. LMS scale used for taste sensitivity and PROP responsiveness.

3.8 PROP responsiveness

Paper discs were used to quantify the children's responsiveness to PROP. The disc was placed on the anterior part of the tongue and held in the mouth for 25 seconds, then taken out and after 20 more seconds the perceived bitterness was recorded with a LMS scale (Figure 8). An automatic timer was displayed in the online questionnaire to ensure correct countdown for each child.

3.9 Design

Order or positional bias is a psychological error where the person participating in a sensory test judges samples or products differently when they are presented in one order than in another order (Lawless & Heymann, 2010, pp. 219-221). To minimize this effect and average the bias out throughout the participants, randomization was used throughout the questionnaire. Within each sub-part of the test, children were given questions in different, random order. Tasting of samples was also done in random order; half of the children tasted grapefruit juice samples first, the other half tasted vegetable broth first. The order in which the different concentrations were tasted was also randomized. Blinding was used, as all samples looked identical and were assigned three-digit codes.

3.10 Instructions

Instructions were given orally by Marie Stensvold to the whole class prior to each part of the test. Instructions were given through online meeting via Teams. The instructor together with the other researchers were seated in a conference room at Nofima Ås. In the schools, the instruction via online meeting was projected on the smartboard in front of the classroom. The use of a PowerPoint presentation was employed to make the instructions clear and easy to follow for the children. Figure 9 shows a screenshot of one PowerPoint slide used in the presentation, as seen in the Teams meeting. Before children started each part of the questionnaire, instructions on how to answer the different types of questions and how to use the scales were given with examples.

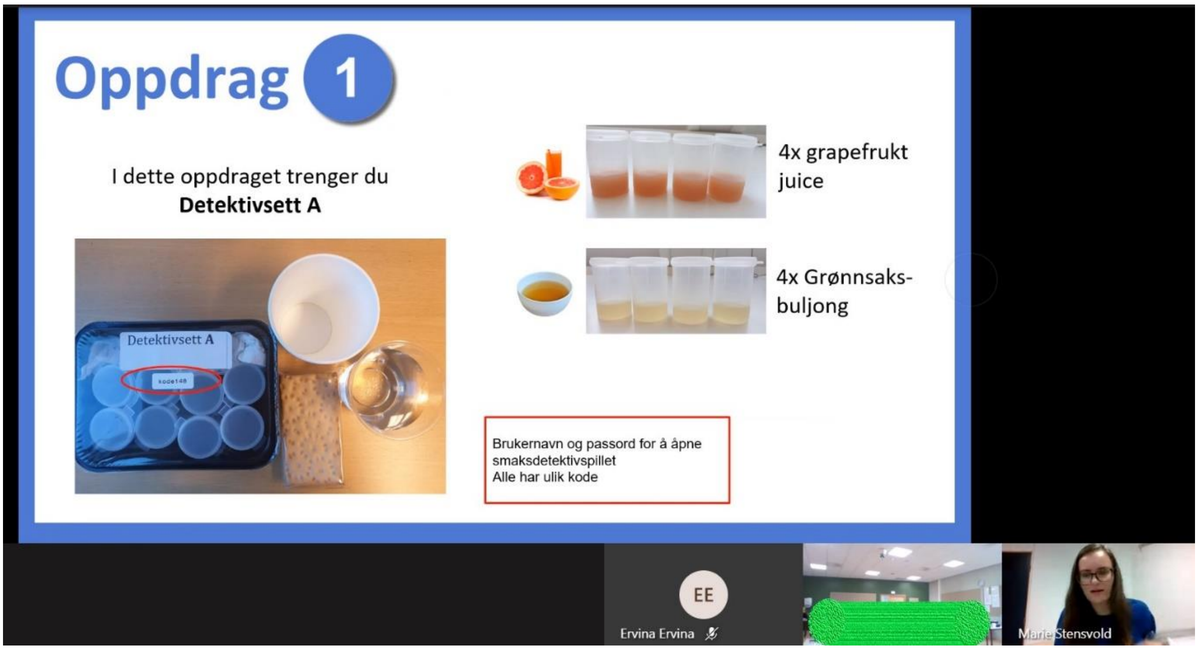

Figure 9. Screenshot from the instructions from part one, as seen by the participants in the Teams meeting. The classroom with participating children were visible to the instructors but were redacted later for privacy reasons.

The oral instructions for part one included a brief introduction of the study and the Detective sets. Children were reminded that they could quit the test at any given time if they did not want to finish, that palate cleansers were available and should be used appropriately. It was emphasized how each child's response was valuable and how it was important to answer individually, without interrupting others and making noise during the test. What to do after finishing part one was also explained, as agreed on with the individual teacher.

Part three (PROP test) was explained after all children finished part two in the first classes. As the test had a long total duration, many children lost patience when waiting for instructions for part three. This led to instructions for part two and three being given right after each other for the rest of the classes, which resulted in more focused children throughout the test.

All necessary instructions required during the test were also included in the test itself with brief explanations on how to answer questions and taste samples, and reminders of palate cleansing.

3.11 Gamification

To make the test more exciting for the children, a gamification approach was used. Each subtest was called a mission, and each child was referred to as a taste detective. Illustrations and colors were included both in the online questionnaire and in the PowerPoint presentation of instructions to make the look of the test more exciting. Illustrations included a detective (Figure 10) which many children recognized from the 2019 test and could make them think back on the previous test.

Figure 10. Taste detective illustration.

3.12 Preparation tests

3.12.1 Pre-test

After the test was programmed in Compusense, the researchers ran through the test in Compusense with prepared samples, to see if the test ran smoothly. Some errors were caught in this step and corrected before the pilot test. The PowerPoint instructions were also reviewed several times in this session.

3.12.2 Pilot test

Before the main data collection, a pilot test was conducted, using Nofima employees' children. Eight children from the fourth to ninth grade participated (9-14-years old). Having a slightly broader age group than the target group gave a wider perspective on how children with different reading and comprehension skills understood the questions. One child spoke Norwegian as his second language, which further helped in testing how easily interpreted the questions were.

The pre-test was used as practice for instruction giving and for seeing how well preadolescents understood the questions in the test. It showed if there were difficulties understanding the questionnaire and the instructions, which could have led to misunderstandings. How many minutes each part took was also recorded. All participants were either at home or at a friend's home for the pre-test. An adult (the mother of one of the children) was present to distribute the samples, answer questions, and report observations of any type of difficulties to the researchers.

After the pre-test, some modifications were made. Instructions were made more concise. Wording was changed on questions that the children misunderstood or had to ask about for clarification.

3.13 Data analysis

3.13.1 Familiarity

The familiarity answer options were changed into scores from one to five, according to Table 4.

Table 4. The answer options used in the questionnaire to record familiarity with 28 food items and score given for each option for the data analysis.

Answer option	Score
I don't know what it is	1
I know what it is, but I never eat it	2
I have tasted it, but I rarely eat it	3
I eat it occasionally	4
I eat it often	5

To see the mean familiarity of the food items and significant differences between food items, ANOVA with Tukey's pairwise comparison tests was run. Collected familiarity scores was employed as the dependent variable while the different food items were employed as the explanatory variable.

3.13.2 Stated liking

The seven answer options used for measuring stated liking were turned into scores from one to seven, according to Table 5.

Table 5. The answer options used in the questionnaire to record stated liking of 28 food items and score given for each option for the data analysis.

Answer option	Score
Dislike strongly	1
Dislike moderately	2
Dislike slightly	3
Neither like or dislike	4
Like slightly	5
Like moderately	6
Like very much	7

Children who had not tasted the food previously had a blank answer for liking, therefore some cells did not have any information. The children that did not have a stated liking score were removed before running this analysis. To see the mean stated liking of the food items and significant differences between food items, ANOVA with Tukey's pairwise comparison tests was run. Collected stated liking scores as the dependent variable and the food items as the explanatory variable.

Familiarity and stated liking were also compared. This was done using figures and using Pearson correlation in XLStat, also deleting scores from children with no stated liking score.

3.13.3 Sample liking

Liking of samples was found by converting the points chosen by children on the continuous LAM scale into scores, from zero at the bottom anchor to one hundred at the top anchor. Box plots were made to show the distribution and the range of the answers, for both grapefruit juice samples and vegetable broth samples. ANOVA with Tukey's pairwise comparison test was also run, using liking score as the dependent variable and samples with different concentrations as the explanatory variable.

3.13.5 PROP and taste sensitivity

Based on answers given on the LMS scale from tasting the PROP paper discs, children were categorized into phenotypes according to Zhao et al. (2003) as either NT (≤ 13 mm), MT (14-67 mm) or ST (>67 mm).

Taste sensitivity was found by converting the points chosen by children on the continuous LMS scale into scores, from zero at the bottom anchor to one hundred at the top anchor. To see whether PROP taster status has a significant effect on taste sensitivity, the results from the sensitivity test and PROP paper disc test were run in ANOVA, with taste sensitivity as the dependent variable and PROP phenotype as the explanatory variable. Tukey's pairwise comparison was also used to see if the PROP phenotypes results were significantly different from each other.

To test differences between taste sensitivity and liking of each phenotype towards all basic tastes in all samples, ANOVA was run for each phenotype for each sample, and these results as well as the mean scores were compared using bar charts.

3.13.4. The influence of taste responsiveness, stated liking and familiarity on the liking of tasted grapefruit juice samples

The test collected data on the actual liking (i.e., liking after tasting) of grapefruit juice samples, PROP responsiveness, taste responsiveness towards the basic tastes notable in grapefruit juice (sweet, sour, and bitter), as well as familiarity and stated liking of grapefruit juice.

Results from these questions were organized in an Excel sheet. Each child's mean score for responsiveness towards sweet, sour, and bitter and liking was calculated using scores from all tasted grapefruit samples. Familiarity and stated liking were added to the sheet. For stated liking, 82 observations were missing because children had not tried grapefruit juice before. To avoid cells with missing observations, the mean stated liking of each food item was calculated, and this score was pasted into the cells without information. Linear regression was used on the data to see how much positive or negative effect each of these variables had on actual liking of samples.

3.13.5 Software

Data analysis was done with the data from the questionnaire. The analysis was conducted in Microsoft Excel (version 16.0.1301.20366) using the add-on XLStat Basic (2021.1.1, Addinsoft, New York).

3.13.6 Significance level

For all statistical analysis in this thesis, 95% confidence interval was used with significance level 0.05.

4. Results

4.1 Participants

A total of 9 classes participated, with a total of 165 participants, wherein 148 provided complete data used for the analysis. Each class/session had between 14 and 21 children. The gender distribution in the consumer test was balanced; 71 (48.0 %) participants were boys, 77 (52.0%) were girls. All participants were in the seventh grade. 16 children (10.8%) were 11 years old, 130 children (87.8%) were 12 years old, and two children were 13 years old (1.4%).

More than half (55.4%) of the children had participated in the consumer test completed the year before (Table 6).

Table 6. Overview of participants in the study.

Variables	**Note**	**n**	**%**
Gender	Boys	71	48.0 %
	Girls	77	52.0 %
Total		148	100.0 %
School	1	40	27.0 %
	2	47	31.8 %
	3	61	41.2 %
Age	11 years old	16	10.8 %
	12 years old	130	87.8 %
	13 years old	2	1.4 %
Mean age + SD	11.91 ± 0.34	148	100%
Participated in last year's "taste detective" study	Yes	82	55.4 %
	No	66	44.6 %
Total		148	100.0 %

4.2 Stated liking and familiarity

Stated liking and familiarity of 28 food items was collected (section 3.4 and 3.5). The mean score from ANOVA test of stated liking score per food item and familiarity score per food item for all children was put in one figure (Figure 11). Food items were ordered by liking score, with the most liked item on the left.

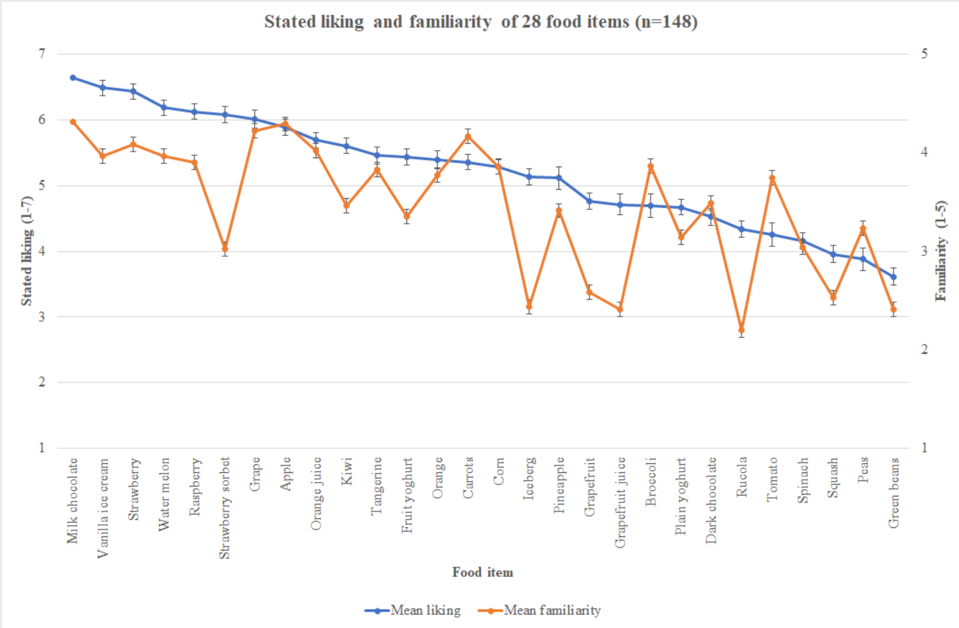

Figure 11. Mean stated liking and familiarity of 28 food items, with standard error. Foods are ordered after stated liking, from high to low.

There was a similar trend for mean stated liking and mean familiarity of food items, in that the most familiar foods were generally well liked and many unfamiliar foods generally scored low on liking. However, many points deviated from this trend. Especially peas, tomato and broccoli scored high on familiarity (mean familiarity=3.2, 3.8 and 3.9, respectively) but were not liked much by the children (mean liking=3.9, 4.3 and 4.7, respectively). On the contrary, strawberry sorbet stood out as being much liked (mean liking=6.1) but not very familiar (mean familiarity=3.0).

4.2.1 Stated liking

As shown in Figure 11, milk chocolate was the most liked item, with a mean score of 6.6 (SD= 0.8). Tukey's pairwise comparison of all samples showed that the mean liking score of vanilla ice cream, strawberry, watermelon, raspberry, and strawberry sorbet were not scored significantly different from milk chocolate. The group with the lowest stated liking consisted of rucola, tomato, spinach, squash, peas, and green beans. Green beans had the lowest score, with a mean score of 3.6 (SD= 1.6). Grapefruit juice received the mean score of 4.7 (SD=1.6). The R^2 in this analysis was 0.24. Thus, this model did not explain much of the variation in responses, although the p-value is <0.0001.

Across subjects, all food items were given the minimum score (one) as well as the maximum score (seven); except grape, iceberg salat and strawberry sorbet which were rated from two to seven, and milk chocolate which had a minimum score of three and maximum of seven.

4.2.2 Familiarity

The average number of food items tried by children was 23 out of the 28 proposed items. Twenty-six food items were the most common number of foods tasted. The lowest number of food items tasted was ten (one child), and twelve children (i.e., 8.1%) had tasted all foods from the list. The food that these children were most familiar with, that was eaten the most often by the children on average, was milk chocolate with a mean score of 4.3 (SD=0.6). Tukey's pairwise comparison of all samples showed that the mean familiarity score of apple, grape, carrot, strawberry sorbet, orange juice, vanilla ice cream and watermelon were not significantly different from milk chocolate. The sample the children were the least familiar with was rucola, with a mean score of 2.2 (SD= 1.2). Squash, iceberg salat, grapefruit juice and green beans were not significantly different from rucola. Grapefruit was low in mean familiarity (mean=2.6) but showed a high standard deviation (SD=1.3) (Figure 11).

R^2 for familiarity of food items was 0.34 which is higher than for liking but still does not explain most of the variability in responses. However, the P-value obtained was <0.0001, showing a significant effect of different food items on familiarity score.

Figure 12 shows what percentage of children had tried the food items. All children had tried milk chocolate and apple. Sixteen food items had been tried by more than 90% of the children. Grapefruit (tasted by 54.1%), green beans (tasted by 47.3%), iceberg lettuce (tasted by 46.6%), squash (tasted by 46.6%), grapefruit juice (tasted by 44.6%) and rucola (tasted by 44.6%) stood out as the items the least children had tasted.

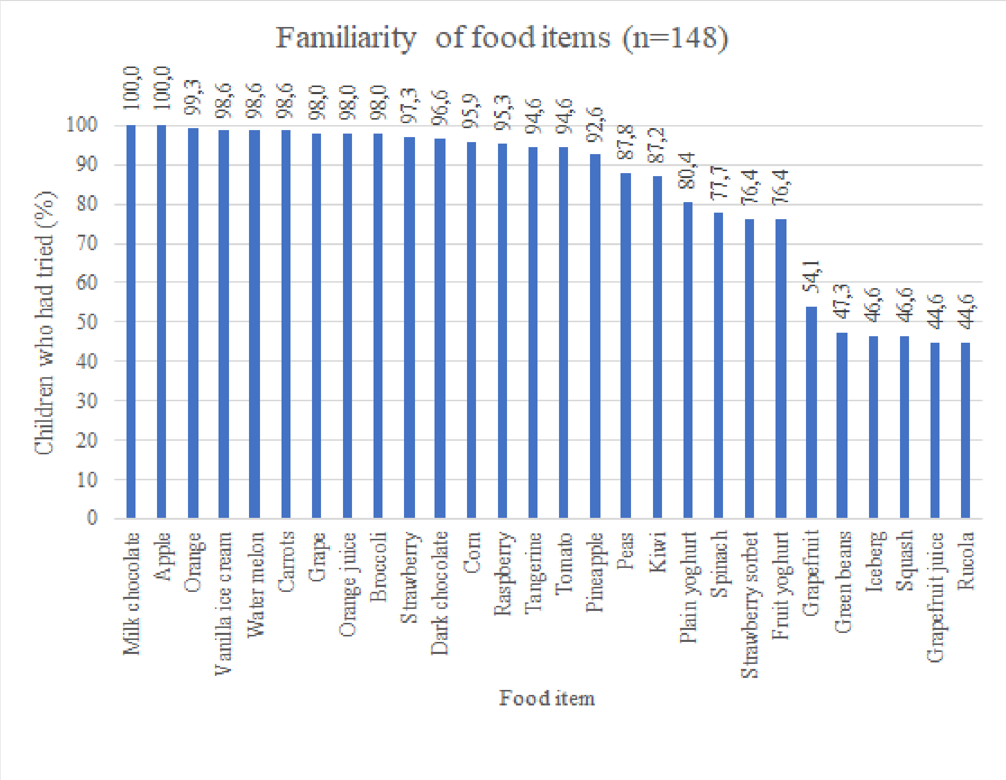

Figure 12. Percentage of participating children who had tasted the 28 food items.

4.2.3 Familiarity and stated liking

To see if there is a connection between stated liking and food exposure, ANOVA and Pearson correlation test were also computed. Pearson correlation between familiarity and stated liking score was computed. The correlation obtained was 0.63, which further implies that these two variables were positively correlated with each other.

An ANOVA test compared the number of food items tasted per child (i.e., familiarity score between three and five) and the average stated liking over all food items in the questionnaire per child. There was a trend (R^2 = 0.35) showing that the more food items the child had tried, the higher the stated liking of all foods were, as shown in Figure 13 (left). One outlier stood out, who had tried 10 foods only but scored these foods high in liking. When the outlier was removed, the R^2 rose to 0.67 (Figure 13, right).

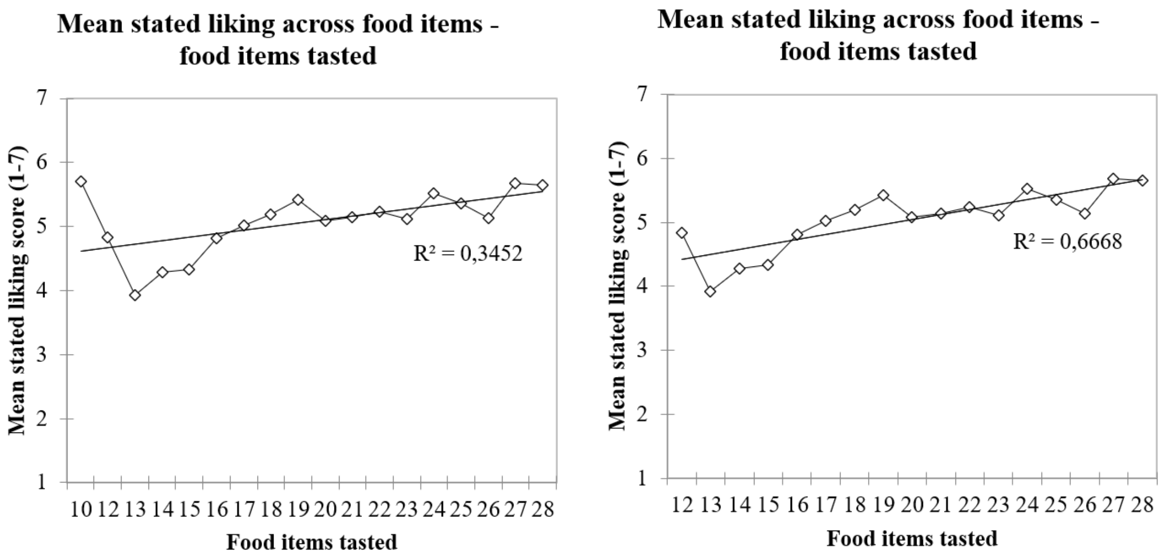

Figure 13. The number of food items tasted and stated liking score across 28 food items. Left: all children (n=148). Right: One outlier removed (n=147).

4.3 Liking

4.3.1 Grapefruit juice samples

Figure 14 shows a box plot of liking of grapefruit juice with addition of sugar in four varying amounts. The dispersion across children is large, and all samples acquired the minimum as well as the maximum liking score. Mean liking increased as sugar content increased. Thus, the sample with 0 g/L added sugar (GF0) was the least liked, with a mean score of 32.4 (SD= 26.3), while the sample with 160 g/L added sugar (GF160) was the most liked, with a mean score of 46.5 (SD= 29.4). ANOVA analysis of sample (x) and liking score (y) gave a R^2 of 0.032, so most of the variance in liking is not explained by the samples. P-value was <0.001, showing that the liking differed significantly between samples, and Tukey's pairwise comparison test showed that GF0 was liked significantly less than GF80 and GF160. GF40 was not significantly differently liked from any other sample.

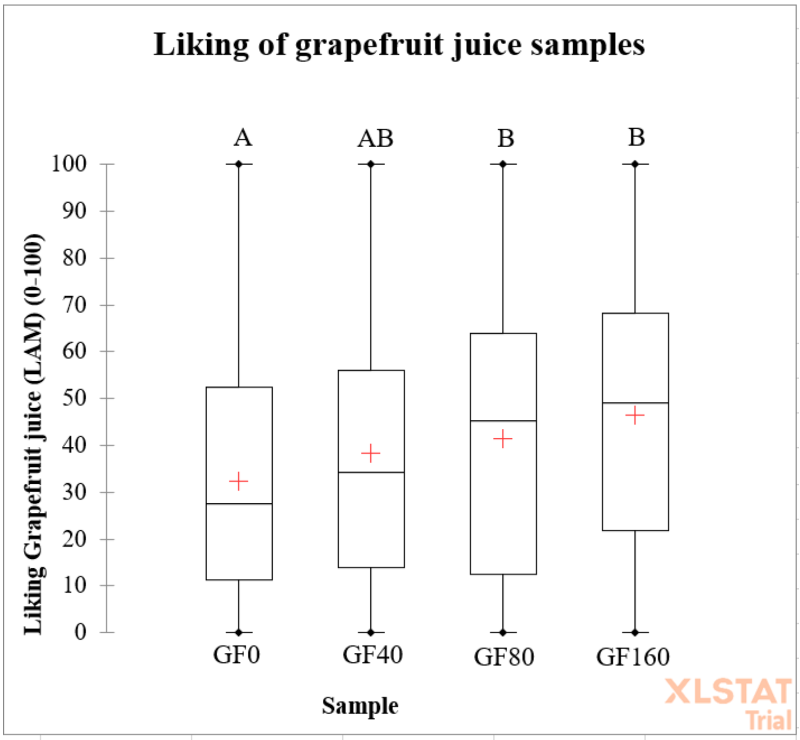

Figure 14. Box plot of the liking of grapefruit juice samples with different amounts of sugar added. Tukey groups are shown at the top; samples showing different letters are significantly different from each other ($p<0.05$). n=148.

4.3.2 Vegetable broth samples

Figure 15 shows a box plot of liking of vegetable broth with addition of salt in four varying amounts. The dispersion is large, and all samples acquired the minimum and the maximum score. There was no significant difference between liking of the samples; all samples' mean liking was between 35 and 37. The least liked sample was VB12, which had the highest amount of salt added. ANOVA analysis showed a R^2 of 0.00, so this model explains none of the variance. The p-value was 0.97, confirming that there were on average for all children no significant differences in liking of vegetable broth samples with varied salt content.

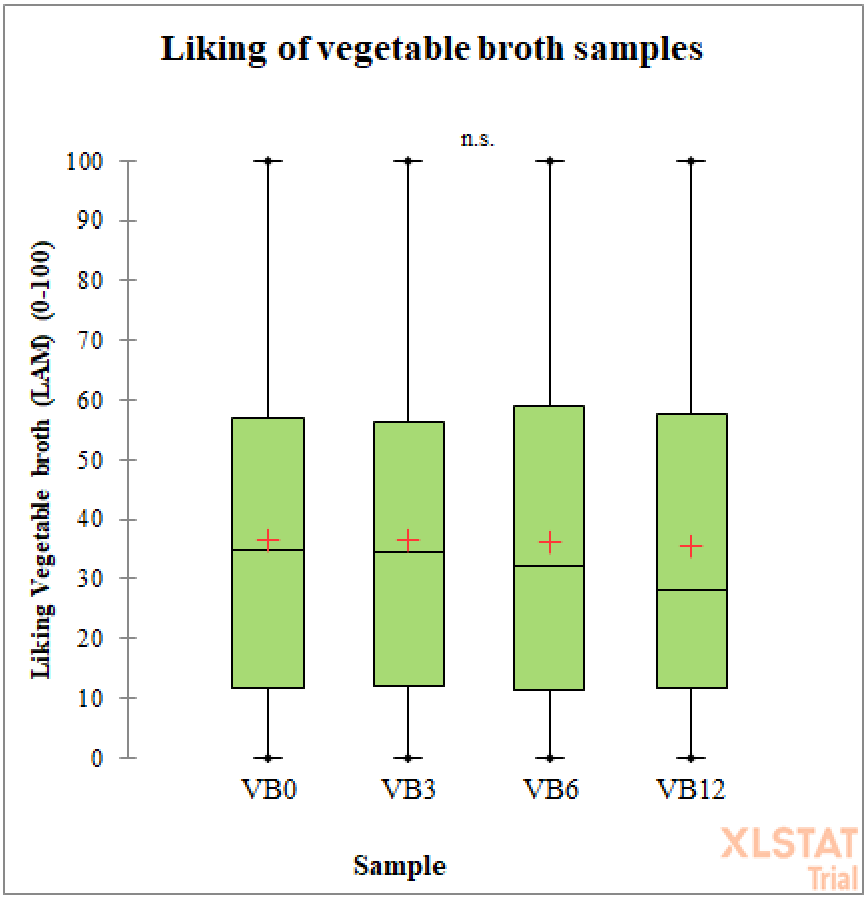

Figure 15. Box plot of the liking of vegetable broth samples with different amounts of salt added. n.s.: not significant, no samples were significantly differently liked ($p<0.05$). n=148.

4.4 PROP phenotype, taste responsiveness and liking

4.4.1 PROP phenotype

Out of the 148 children that participated in this questionnaire, 28 (19%) were NT, 77 (52%) were MT and 43 (29%) were ST.

4.4.2 Taste sensitivity and liking in relation to PROP phenotype: overview per basic taste

Figure 16 shows the mean taste sensitivity and liking across samples tested for each PROP phenotype. For each basic taste, there is a trend of NT being the least sensitive, followed by MT, and ST being the most sensitive. For sweet and salty the phenotype groups were not significantly different in sensitivity. For bitter and umami there was no significant difference between NT and MT, and ST scored significantly higher. For sour, NT and ST were significantly different, with ST being more sensitive.

NT liked grapefruit juice and vegetable broth samples more than ST and MT. For the grapefruit samples, there was no significant difference between NT and MT, and both these groups liked grapefruit juice samples significantly more than ST. All groups were significantly different in vegetable broth liking, with NT liking vegetable broth samples the best followed by ST, while MT liked the vegetable broth samples the least.

The standard error of NT is higher than the other phenotypes, showing that there is a bigger difference in taste sensitivity for the basic tastes and liking in the NT group than in the other groups.

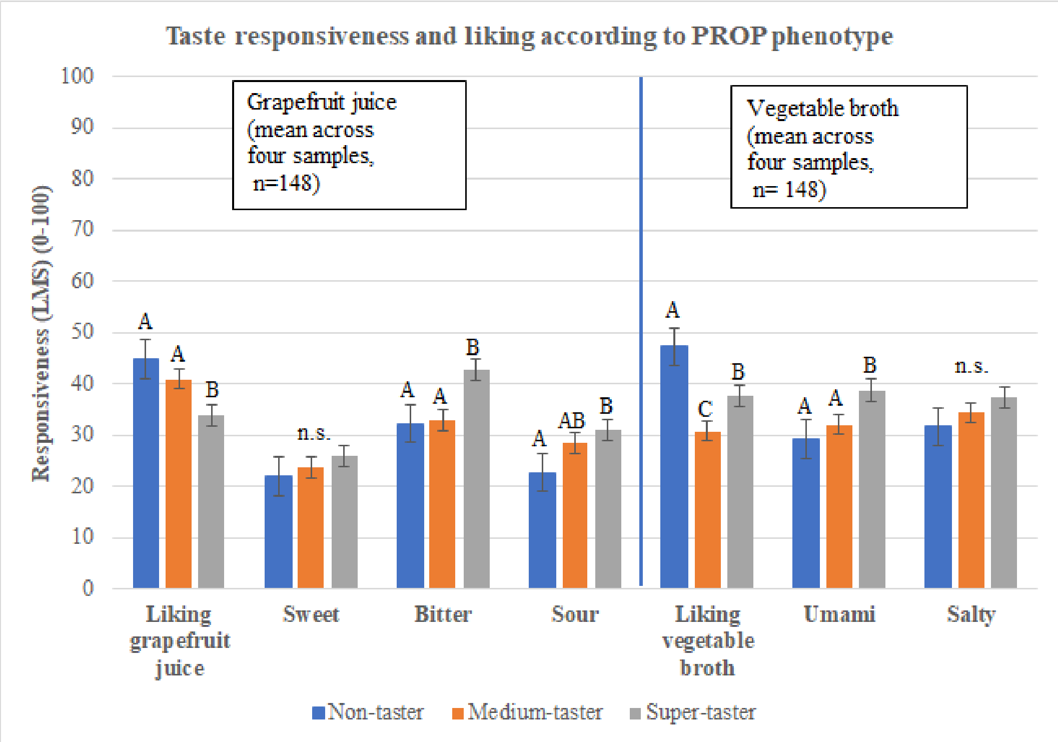

Figure 16. Mean scores from all samples for basic tastes responsiveness and liking for the PROP phenotypes. Tukey groups are shown at the top; samples showing different letters are significantly different from each other (p<0.05).

4.4.3 Taste responsiveness per concentration in grapefruit juice

The responsiveness data was separated according to PROP phenotype and ANOVA analysis was done for each phenotype for each sample. Results from basic tastes responsiveness in grapefruit juice (sweet, bitter, and sour) and liking are presented in Figure 17. Results from basic tastes responsiveness in vegetable broth (salty, umami) and liking are presented in

Figure 18. There are differences in basic taste responsiveness as well as in liking across the different PROP phenotypes.

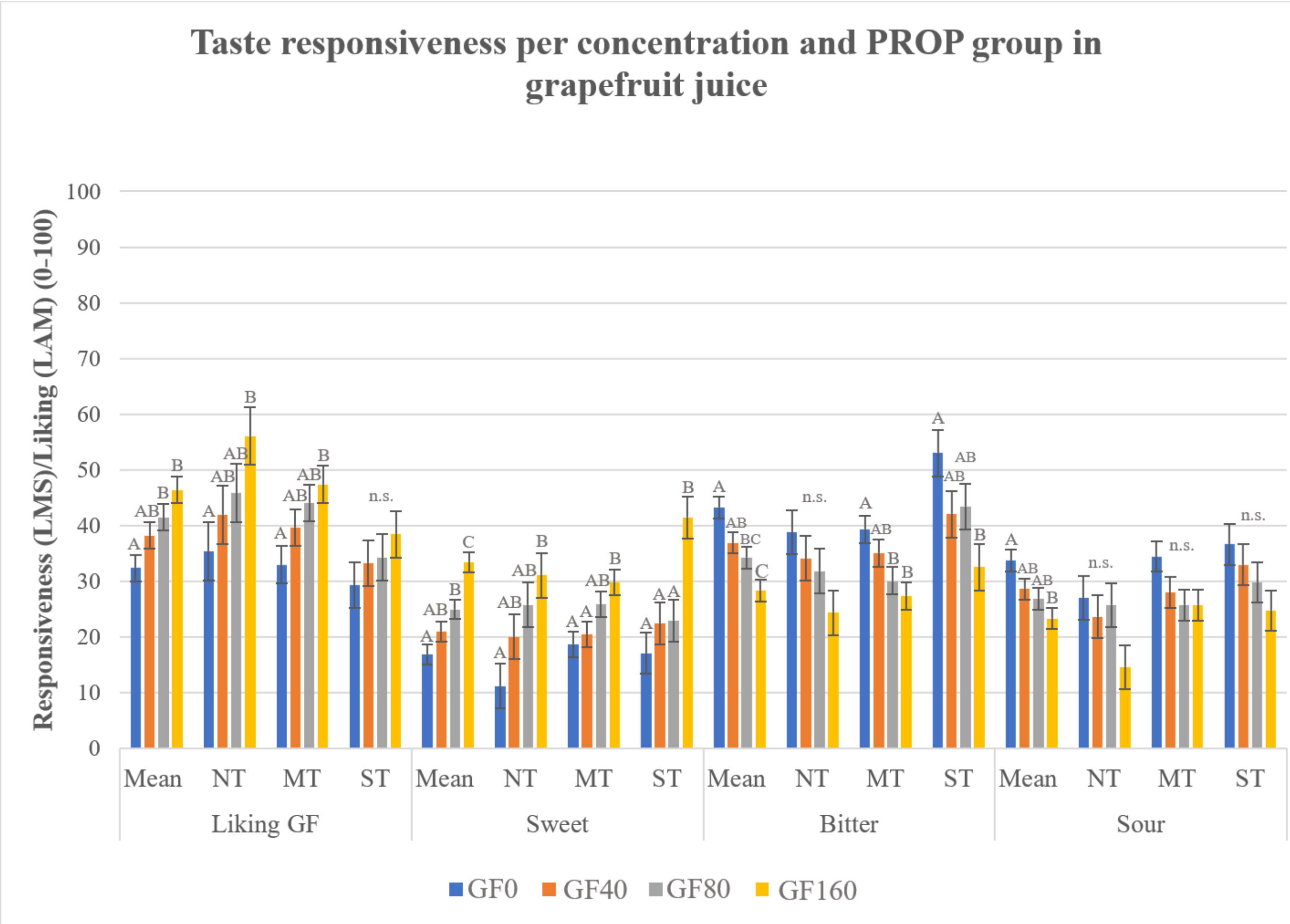

Figure 17. Responsiveness and liking scores given to each sample of grapefruit juice by PROP phenotypes. Error bars are shown. NT: non-taster, MT: medium-taster, ST: supertaster. Tukey groups are shown at the top; samples showing different letters are significantly different from each other ($p<0.05$). n.s=not significant. GF0-GF160: grapefruit juice samples with 0-160 g/L added sugar.

4.4.3.1 Liking

The liking of grapefruit juice samples was showed as the highest in the NT group, followed by MT while ST liked the grapefruit samples the least. In GF160, there were clear differences between PROP phenotypes; the mean liking of NT was 56.1 (SD=31.0), MT' mean liking was 47.4 (SD=28.8) and ST' mean liking was 38.5 (SD=27.0).

4.4.3.2 Sweetness

All taster phenotypes detected an increase of sweetness along with the increase of sugar content in grapefruit juice samples. Two samples that stood out were GF0 to NT and GF160 to ST. GF0 scored a 11.2 (SD=14.6) which was much lower than the other samples according to the NT. By ST, GF160 was given a mean sweetness score of 41.5 (SD=30.0) while GF40 and GF80 scored 22.5 (SD=22.0) and 23.0 (SD=21.1), respectively.

4.4.3.3 Bitterness

All phenotypes demonstrated that the sample without added sugar was the most bitter and GF160 was the least bitter. ST were generally more sensitive towards bitter taste and scored all samples higher than NT and MT. There was a big difference between the bitterness detected especially in GF0; ST scored it 53.0 (SD=29.8) whereas NT scored it 38.8 (SD=21.9) and MT scored it 39.4 (SD=23.8). ST did not perceive a difference in bitterness between GF40 and GF80, while NT and MT tasted a gradual decrease in bitterness as sugar content increased.

4.4.3.4 Sourness

For sour taste, NT generally were the least sensitive compared to MT and ST. GF160 tasted the least sour to all phenotypes, especially NT answered that this sample was low on sourness, scoring it 14.6 (SD=11.8) as opposed to MT and ST, who scored this sample 25.8 (SD=24.4) and 24.8 (SD=21.4), respectively. NT did not perceive a difference between the sourness in GF0, GF40 or GF80, while MT did not perceive a difference between GF40, GF80 and GF160. ST registered a gradual decrease in sourness as sugar content rose.

4.4.4 Taste responsiveness per concentration in vegetable broth

The differences in liking and responsiveness between the PROP phenotypes for the vegetable broth samples are shown in Figure 18. As previously shown, the differences between the samples were smaller in vegetable broth than for the grapefruit juice samples; none of the phenotype groups liked or disliked one of the vegetable broth samples more than the other samples.

No significant differences in umami taste were found between samples in any phenotype. For salty taste, VB0 rated differently by NT and tasters. VB0 was given a mean of 20.9 (SD=17.6) by NT, while MT and ST scored this sample 28.4 (SD=25.5) and 29.0 (SD=19.3), respectively. NT and ST registered an increase in salty taste as salt concentration rose and tasted significant difference between VB0 and VB12. MT did not register any significant difference in salty taste between samples.

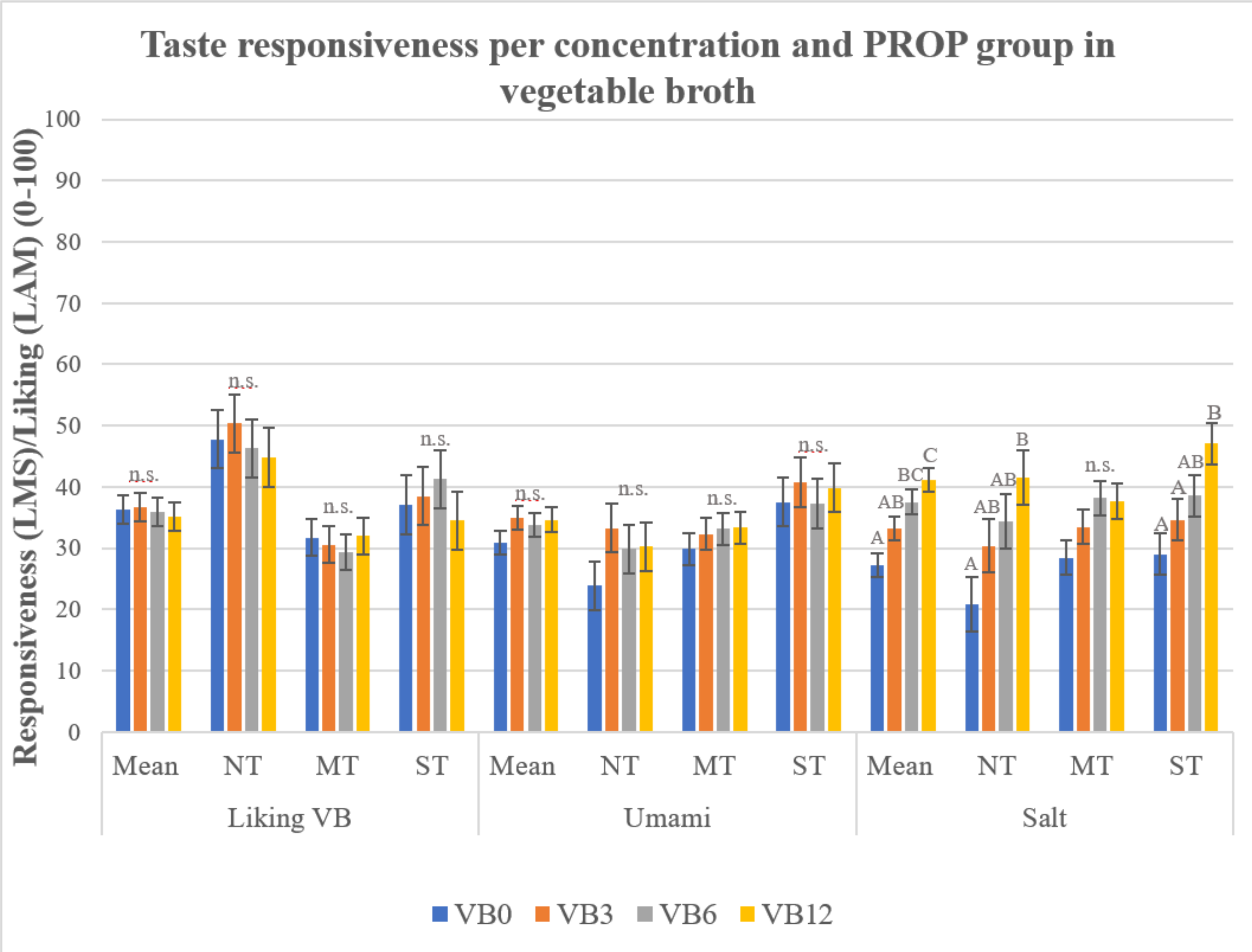

Figure 18. Responsiveness and liking scores given to each sample of vegetable broth by PROP phenotypes. Error bars are shown. NT: non-taster, MT: medium-taster, ST: supertaster. Tukey groups are shown at the top; samples showing different letters are significantly different from each other (p<0.05). n.s=not significant. VB0-VB12: vegetable broth samples with 0-12 g/L added salt.

4.5 Variables affecting real sample liking of grapefruit juice

The effect of familiarity, PROP responsiveness, stated liking, responsiveness to sweet, bitter, and sour tastes on liking of grapefruit juice samples is shown in Figure 19. Familiarity (p=0.044), PROP (p=0.039) and responsiveness towards sweet taste (p<0.0001) were significant drivers of liking. Familiarity and sweetness responsiveness had a positive effect, while high PROP sensitivity had a negative effect on liking of grapefruit juice.

Responsiveness towards bitter and sour had a negative effect on liking, while stated liking had a positive effect on liking. R^2 in this analysis was 0.21.

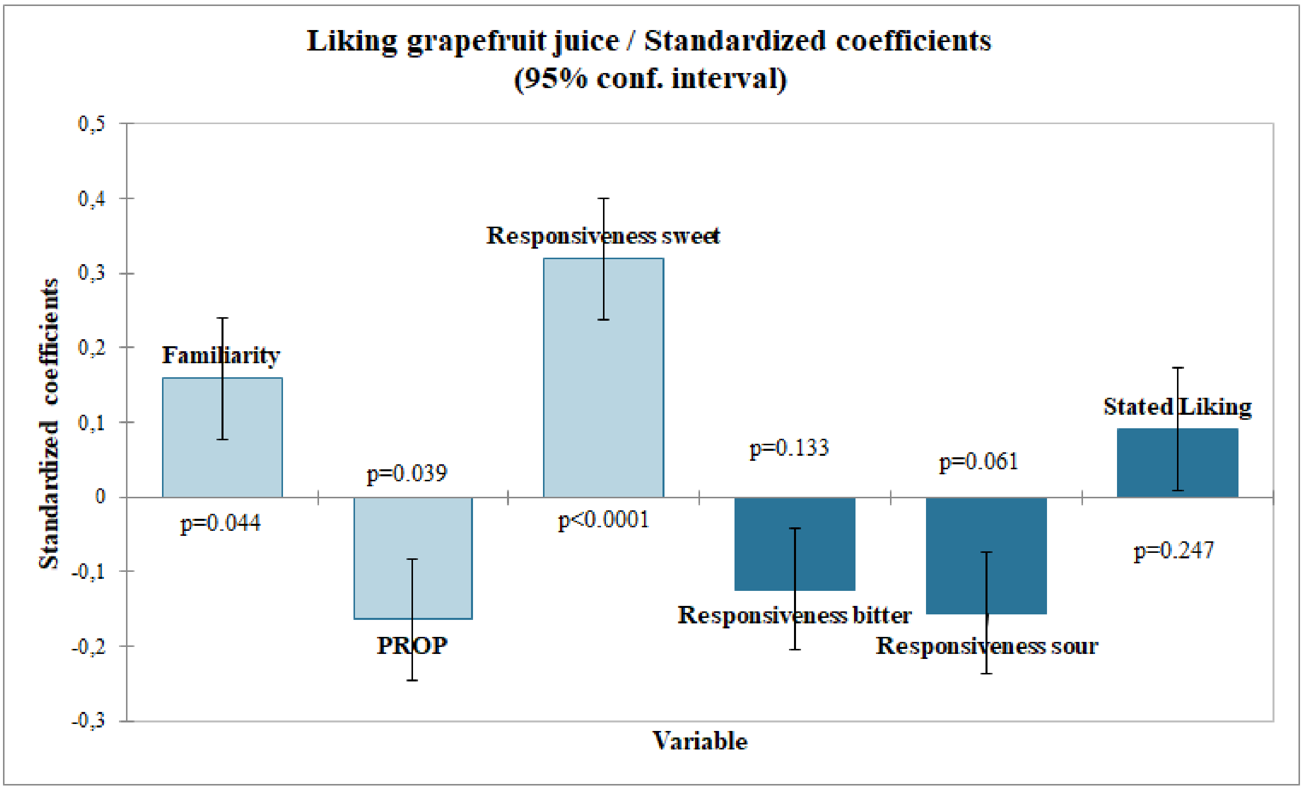

Figure 19. Standardized coefficients of variables influencing actual liking of grapefruit juice of all children across samples, including SE.

The same model was used to see if there were differences on the variables' effect on individual samples (GF0, GF40, GF80 and GF160). The trend for individual samples was the same as the trend across samples and did not give any additional information. Consequently, results are not shown. The same model was also used to see differences between the PROP phenotype groups. For NT, only responsiveness towards sweet taste had a significant positive effect. For MT, familiarity and responsiveness towards sweet taste had significant positive effect. For ST, none of the variables had any significant effect.

4.6 Gender effects

ANOVA tests were computed to investigate whether there were significant differences between boys and girls regarding their taste sensitivity for each basic taste and in liking of grapefruit juice and vegetable broth. There was no significant difference in any of these categories and the results are therefore not shown.

5. Discussion

Many factors influence children's acceptance and rejection of foods. The objective of this thesis was to investigate the relationships between children's food liking and their taste responsiveness, looking at PROP phenotypes, stated liking and food familiarity. This chapter will discuss the results considering research questions, as well as the remote testing approach.

5.1 Participants

For central location tests, more than 100 participants are recommended (Stone & Sidel, 2004, p. 265). Lawless and Heymann (2010, pp. 7-8) states that 75-150 participants are needed to get statistically viable results. In this test 148 participants in the seventh grade finished, meaning the results should be representative for this age group. Moreover, as taste sensitivity and liking is very individual, results were overall very spread out with high standard deviations. It was therefore beneficial to have many participants to see statistical significance in the analysis performed.

All children were recruited from one county in Norway. Ethnicity was not recorded, but most children were Caucasian. Diets are different throughout the world (Zhang et al., 2015), across different cultures and ethnicities, so results from this study are not representative of all children.

5.2 Effects of PROP phenotype on liking and taste responsiveness

PROP phenotype distribution was approximately like stated in previous literature. About 30% of Caucasians in North America are NT (Deshaware & Singhal, 2017). This test had 19% NT, which is low. A reason for this might be the age of the participants, as bitter sensitivity decreases with age (Mojet et al., 2001), and are more sensitive towards PROP/PTC (Mennella et al., 2010). However, studies with children have recorded approximately 1/3 NT (Keller et al., 2002; Keller & Tepper, 2004), which is the same as in adults. The group participating in this test were more MT and less NT than the general population. Tepper et al. (2001) reported that when using PTC filter tests for taster group phenotyping, a disadvantage is that there can be false positives, i.e., less people being placed in the NT group than the actual number of NT. There is a possibility that this happened during this test, and that some NT gave an answer that placed them in the MT group. Children could also have understood use of the LMS scale differently, and a training session similar to the one described in Pagliarini et al. (2021) for gLMS prior to the test could have made a difference in phenotype distribution.

The children varied greatly on how much they liked the samples provided in the test. Every sample tasted received the top and bottom possible score, and the dispersion of liking scores was big. People have different food acceptance, and the variation in responses during this test highlights this. Children have different previous experience with the foods sampled in this test, foods similar to the ones sampled in the test, and different upbringings which has given each child individual systems for food acceptance/rejection. Parents and cultural factors could have played a part through role modeling, in what extent and how novel foods have been introduced to the child through their lives, as well as the variety of foods available in the home. An additional possible reason for the large dispersion of answers could be that the children understood how to use the LAM scale differently.

Taste sensitivity also plays a part in food acceptance, demonstrated by PROP phenotype in this study. NT scored lowest on perceived taste intensity across all basic tastes, and ST highest. For bitter and umami taste, the difference between ST and NT/MT was significant. The increased bitterness sensitivity of ST is expected, as bitter taste in PROP was used to establish the phenotype groups and ST is highly associated with subjects that have high sensitivity to bitterness.

5.2.1 Vegetable broth samples

Vegetable broth is typically used as an ingredient in dishes and not consumed on its own, for that reason it is an unfamiliar food item for most Norwegian children. The liking of vegetable broth samples was not significantly different when looking at all children. This result was not expected, as humans have a natural drive to consume salt, and children have been shown to like salty foods more than adults (West, Liem, Booth, Nowson, & Grimes, 2019). Mennella, Finkbeiner, Lipchock, Hwang, and Reed (2014) found that children (5-10 years old) liked vegetable broths more as salt concentration increased, also contradicting the results found in this test. A possible explanation for the results found in this test is that the salt concentration was too high for children's liking from the first sample. However, saturation threshold was not met as the children were sensitive towards increased salt concentration in the samples, where NT and ST rated VB0 as least salty, followed by VB3, VB6, and VB12 was rated most salty. MT tasted no difference between VB6 and VB12, suggesting their saturation threshold for salty taste was met with the addition of 6 g/L salt.

A clear difference in liking was seen between the PROP phenotype groups for vegetable broth samples; NT liked the samples much better than MT and ST. For vegetable broth samples, PROP phenotype group had a bigger impact on sample liking than the different samples had. This underlines the importance of considering taste sensitivity to understand liking in children.

Umami is the least familiar taste (Nakamura et al., 2011). Many Norwegians are not aware of umami taste (Singh, 2011). Mustonen, Rantanen, and Tuorila (2009) reported that children aged 7-11 found umami and bitter taste the most difficult taste to identify. Ervina, Berget, Nilsen, and Almli (2020) performed a test of the ability of 10–11-year-old Norwegian children to identify basic tastes. In their test, umami was excluded because pre-test showed that familiarity of umami was low. Hence, it was not expected to find big differences in umami perception between samples in this test. No differences were found between samples within the different PROP phenotype groups, but ST were generally more sensitive towards umami taste than NT and ST. The findings from this test do however substantiate the gap in knowledge of umami taste in children stated in literature.

5.2.2 Grapefruit juice samples

ST liked all grapefruit juice samples significantly less than NT and MT. ST perceived bitter taste significantly more intense than NT and MT. ST were also significantly more sensitive towards sour taste than NT. As children naturally dislike sour and bitter taste and these tastes are prominent in grapefruit juice, this is expected. Similarly, Drewnowski, Henderson, and Shore (1997) researched the connection between PROP phenotypes and acceptability of grapefruit juice in adults. They reported lower acceptability of grapefruit juice in ST than in NT and MT and explained the difference in liking entirely by their increase in bitterness responsiveness. This study shows that sour taste also could contribute to ST's lower liking of grapefruit juice.

All phenotypes liked GF0 the least, followed by GF40, GF80 and the most liked was GF160, hence liking of samples followed sugar concentration. This is expected, as children prefer sweet foods. Mustonen et al. (2009) reported that out of the basic tastes, sweetness is the easiest taste to identify by children aged 7-11. In line with this, children were able to notice significant difference in sweetness intensity in GF0, GF80 and GF160 across phenotypes. Interestingly, when looking at the average sweetness responsiveness across samples (Figure 16), there was no significant difference between the PROP phenotypes. When looking at the different samples (Figure 17), it is apparent that there are in fact differences in sweetness perception between the different phenotypes, which highlights the importance of investigating samples separately to see and understand differences in perception across PROP phenotypes.

For ST, the sweetness in GF160 was very much more intense than the other samples, and the bitterness of GF0 was much more bitter than the other samples, which are examples of the increased sweetness and bitterness sensitivity in ST stated in literature (Dinehart et al., 2006; Kalva et al., 2014).

5.3 The relationship between stated liking and food familiarity

All methods showed trends that food familiarity leads to higher liking, as shown in several studies, e.g. Laureati, Bergamaschi, and Pagliarini (2014).

5.3.1 Stated liking

Children have an innate preference for sweet, high-fat foods and dislike for bitter and sour foods (Dinnella et al., 2016). The children who participated in this study gave stated liking scores for food items that fit this: milk chocolate and vanilla ice cream were given the highest scores and are both sweet, high-fat foods. The foods that followed in high liking scores were sweet berries and fruits. The bitter foods grapefruit and dark chocolate were also scored low, as well as sour plain yoghurt.

Vegetables were generally the food group that received the lowest stated liking scores. Vegetable consumption in children is lower than the recommended amount (Dinnella et al., 2016; Heath et al., 2011), leading to overweight and obesity. It is therefore important to find solutions on how to increase liking and intake of these food groups. Low familiarity, without the needed number of exposures to increase liking could be a reason for vegetables scoring low on stated liking for some children in this test.

When answering questions about stated liking, the scores will generally be higher than when food items are tasted. Giving stated liking of foods gives participants emotional responses and associations to previous experiences with the foods in question, of which positive experiences are more commonly thought about (Cardello et al., 2012). In this study, children gave high stated liking scores, with the lowest scoring food being between “dislike slightly” and “neither like or dislike”. I.e., no foods were disliked on average. Dinnella et al. (2016) researched both stated and actual liking of peas, with stated liking receiving higher scores. Similarly, in this study grapefruit juice was given scores for both stated liking and actual liking. For stated liking, the average score was close to “like slightly”, which is slightly positive. Oppositely, in the results from tasting the average liking score across samples and children was slightly negative.

5.3.2 Familiarity

Less than half the children had tried the least familiar vegetables: rucola, grapefruit juice, squash, iceberg, and green beans. Dinnella et al. (2016) showed that stated liking and familiarity of vegetables is country specific. Carrots was among the most familiar and liked vegetables in their study and was also the most familiar vegetable in this test. In France, green beans was the most familiar vegetable, while in Denmark it was among the least familiar. Norwegian children ranked it as the second least familiar, only rucola was less eaten by the Norwegian children. Grapefruit juice was chosen as one of the two samples for tasting in this study, based on it not being very familiar to the children, and this was confirmed as this was the third least familiar food among this questionnaire’s list of 28 items.

Iceberg lettuce was the fourth least familiar food. Iceberg lettuce was the most eaten lettuce and among the most eaten vegetables in Norway in 2018 (Opplysningskontoret for frukt og grønt, 2019). There was some confusion around the name “isbergsalat” (iceberg lettuce), which was the name in the questionnaire. Several children asked questions about what it was. They knew what it was after explanation, but the name was unfamiliar. It is often referred to as just “salad”, but this can also refer to a mix of vegetables or different types of lettuce. The question also came up in the pre-test, but researchers kept it unchanged to have all children give answers for the same vegetable. Low recognition of the name and not asking for clarification might be the reason why familiarity of iceberg lettuce was low in this test. A possibility for making the question clearer could have been to include pictures of the food items in the questionnaire.

The group with the most familiar food items consisted of milk chocolate, several fruits, carrots, and vanilla ice cream. This means children eat more sweet and sugary foods than vegetables on average. This is very interesting and could mean children are missing out on important nutrients found in vegetables. Additionally, vegetables are low in calories, and an increase in intake could have a positive effect on BMI in children. That milk chocolate, which is very high in sugar, fat and calories was the most familiar food across children is a reason to worry in a public health perspective.

5.3.3 Connection between stated liking and familiarity

The correlation between scores given for food familiarity and stated liking of all food items tested was strong, showing a positive effect on overall food liking when the child had tasted many food items. Additionally, the more food items the children had tasted, the higher the liking across food items was. Here, the model explained much of the variance in answers, and R^2 was higher than for any other analysis done in this thesis. This is interesting, and a clear indication that to increase food acceptance across food items, children should taste many different foods.

Some food items received relatively high scores for familiarity and low liking score. This was the case for mostly bitter vegetables. A reason might be that parents are less sensitive towards bitter taste in food (Stein, Nagai, Nakagawa, & Beauchamp, 2003), and want to eat healthy foods, therefore they feed their children vegetables for shared meals. As previously shown, there were more ST children in this test than normal, and these are highly sensitive towards bitter taste. Bitter taste is associated with rejection of foods and is a possible contributor for the low liking scores given to the bitter vegetables.

5.4 Prediction of food liking

Familiarity, PROP responsiveness and responsiveness towards sweet taste had significant effects on liking of grapefruit juice samples. The equation provided in section 4.4 can be used to predict liking of grapefruit juice. Familiarity had a positive effect on liking; children who were familiar with grapefruit juice liked the samples more than children who were not familiar with the drink. This further supports previous research on the connection between food familiarity and liking. That responsiveness to sweet taste was significant means that sugar had a big effect on liking of foods for these children. This was also seen in the food items that were the highest ranked in stated liking, which were mostly sweet food items.

Responsiveness to PROP influenced liking of grapefruit juice. High responsiveness led to lower liking. Bitterness sensitivity also had a negative effect on liking; however, this was not significant. The bitter taste of PROP is not the same as in grapefruit juice, where the flavonoid that is responsible for bitter taste is naringin. This can explain differences in PROP and bitterness responsiveness that were found.

Stated liking was expected to have significant positive effect on actual liking of samples. It did have a positive effect; however, this was not significant, and was the variable with the lowest p-value. This supports that stated liking does not necessarily represent actual liking, like previously discussed.

5.5 Methodological approach

5.5.1 Samples

Due to the impossibility to prepare samples at the schools right before testing, not all foods/beverages could be used for a remote test like this, and several considerations were done before choosing samples. The samples used in the study were stable and quality was not worsened during refrigeration overnight. They could be kept and served in room temperature without any health risk. Samples that are served cold or hot could not have been used in the study.

Children were not able to discriminate between vegetable broth samples. Hence, vegetable broth is not recommended for future research on salt and umami responsiveness in preadolescents. Additionally, children did not notice differences in umami taste across samples. Due to low knowledge and experience with umami, a training session should be performed beforehand to familiarize children with this taste modality.

5.5.2 Code randomization

Samples should be labeled with randomized, three-digit codes to prevent bias (Lawless & Heymann, 2010, p. 66). The samples in this test were given three-digit codes. However, these were not fully randomized, as the first number was the same for grapefruit juice (1xx and 3xx) and vegetable broth (2xx and 4xx) samples. This is common practice at the University of Florence, where the researcher who developed this test is a student. For future sensory tests, fully randomized codes should be used.

5.6 Remote testing

To our knowledge, this was the first sensory testing study with preadolescents conducted in a remote setting. Overall, remote testing went well. Out of many participants, a very low percentage did not want to finish the test. Additionally, most children were able to keep concentration and focus throughout the test, without disturbing peers.

Keeping preadolescents' focus over time and avoiding peer influences is a known challenge (Guinard, 2000), but in this study most children showed ability to partake in a test with a long duration. It was however essential to include a long break (ideally 30 minutes), for children to unwind and reset before continuing. It was noticeable that concentration levels decreased when the break was approaching and were higher after the break.

The participants gave mostly positive feedback and thought it was exciting to take part in the study. Based on the experiences from this study, some reflections and recommendations for future sensory consumer tests with instructions given from a remote location follow.

5.6.1 Samples

Samples were chosen before researchers knew they would not be able to be physically present in the schools. This realization did not change the selection of samples, but it did influence the way samples were presented to the children. Sealing of samples was necessary to make sure they were not contaminated before usage and that no spilling happened under transportation. Samples were poured into closed containers and the items needed for each child in the test was placed in the sealed Detective sets. The boxes used as Detective sets were the appropriate size so that samples stood upright, and the sets did not take up more space than necessary.

5.6.2 Remote instructions

Giving instructions over Teams calls was a successful practice. Presenting instructions using PowerPoint worked well, and the children paid attention even though researchers were not physically present. There was a lot of information that needed to be communicated, chatter beyond essential was kept to a minimum. Some instructions were repeated as the children were doing the test, like “you do not have to drink the whole sample”, “swallowing is optional” and “please only focus on your test, do not look at the others” as reminders for children. In Compusense, researchers could follow the children’s progression throughout the test. Further, during the Teams meeting researchers were able to see and hear the classroom through web camera on the teacher’s computer. This gave valuable insight to how the children were acting during the test and how to give instructions to help them as well as to monitor how the entire test progressed.

5.6.3 Technological difficulties

Some teachers were not used to using Teams and needed technological assistance on the test day. One example of trouble met in this study was how to make the sound from the computer audible on the classroom speakers. This caused delays for some classes, which interfered with breaks or their next class. For future sensory test done using remote instructions, a test of the sound and picture in the room that will be used in the test in advance is recommended. The teacher or other person in charge on the test day should partake in this test.

5.6.4 Teacher

The person/people in the room during the test greatly influenced the test. Some teachers were very eager to participate in the test and to make sure everything ran smoothly. They had Detective sets, paper cups and plastic cups with water ready before the Teams meeting begun and made sure the children stayed quiet and paid attention throughout the test, also while waiting for others to finish. Other teachers were not as prepared, handing out the sets after the meeting begun and not having as much discipline over the children. Some teachers were present during the test in two classes. This was useful, as they knew what was expected and needed, and how to answer questions. Some classes had two adults supervising the test, while others had only one. The two were either teachers or one teacher and one assistant. The presence of two adults made a big difference in both being able to answer questions and keeping the children focused on the task and not interrupting each other.

Recommendations for future tests regarding teacher/adult supervision include giving a clear overview of the test and responsibilities, preferably using teachers that are interested (not passive) and the same persons for several classes.

5.6.5 Future possibilities

As remote testing with preadolescents was a success, this gives opportunities for the future. It can make sensory evaluation possible for far-away consumers, which can yield valuable insight from groups that have not been reachable before. With participants from more areas, results can be more generalized to populations. For this to happen, samples need to be selected carefully (section 5.5.1) and sealed properly (section 5.6.1).
Transportation possibilities must also be in place.

A prerequisite for conducting a consumer tests in schools using remote instructions is that the teachers and children can use digital communication. As the Covid-19 pandemic has forced schools to be closed for long periods of time in Norway in 2020, both teachers and children have become (even more) experienced with digital communication. They can use meeting software, and children are used to getting instructions or lectures through a screen. Classrooms are also equipped in a way that makes remote testing possible, with digital smartboards and laptops available for children's use.

5.7 Implications and future perspectives

Results from this study reinforced the previously shown importance of food familiarity for food acceptance. There was a clear connection between children who had tasted many food items, and overall food liking. Familiarity and stated liking were also positively correlated. To instill healthy food habits in children, awareness of these connections can be used actively. As parents are important in forming eating habits in children, they should use strategies that promote healthy relationships with food and encourage tasting of novel foods. If the children in this test are representative, especially familiarity of vegetables should be increased to heighten liking and intake. Vegetables scored low in familiarity overall, and as previously stated low vegetable consumption is one of the main problems in children's diets. This means more, or different, ways of increasing intake are needed.

Results also confirm that there are differences in taste perception in children, and these lead to differences in food acceptance. For parents it would be valuable to know this to understand why their children react in certain ways when being fed for example bitter foods. Parents being aware of their children's PROP phenotype and basic taste sensitivity could make serving healthy foods that will be accepted by their children easier.

There is still much research needed to understand food perception in children. Umami is still largely unfamiliar to the general population, and its role in food preference in children needs more investigating. Looking at predictors of liking of different food items might also give a deeper understanding of overall food acceptance in children. The discrepancy between stated and actual liking is also very interesting and should be researched further.

6 Conclusion

This aim of this Master thesis was to further investigate preadolescents food preferences in light of taste responsiveness, food familiarity and stated liking. As far as researchers are aware, it was the first sensory consumer test done on preadolescents with instructions being given from a remote location, which made it possible to conduct the test in a safe way during a pandemic. Children were in their classrooms while performing the test, answering the provided questionnaire and tasting samples prepared and sealed in advance.

Results from this study supports previous findings regarding PROP responsiveness. ST were significantly more sensitive than NT and MT towards bitter and umami taste and more sensitive than NT towards sour taste across samples. ST also liked grapefruit juice significantly less than the other taster groups. The results were also in line with literature in the connection between familiarity and stated liking, which were positively correlated. It was shown that familiarity, responsiveness towards sweet taste and PROP are valid predictors of grapefruit juice liking.

The increase in obesity in the world has not been reversed even though extensive research has been done over many years. This means that the solution to the problem has not yet been found, and that there are still gaps in knowledge regarding taste and food preference in children.

Literature list

Aggarwal, B., & Jain, V. (2018). Obesity in Children: Definition, Etiology and Approach. *The Indian Journal of Pediatrics, 85*(6), 463-471. doi:10.1007/s12098-017-2531-x

Aldridge, V., Dovey, T. M., & Halford, J. C. G. (2009). The role of familiarity in dietary development. *Developmental review, 29*(1), 32-44. doi:10.1016/j.dr.2008.11.001

Allematpriser. (n.d.). Suppebuljong. Retrieved from https://allematpriser.no/tilbud/meny:product:7042115003456/ (retrieved 20.04.21).

Anzman-Frasca, S., Savage, J. S., Marini, M. E., Fisher, J. O., & Birch, L. L. (2012). Repeated exposure and associative conditioning promote preschool children's liking of vegetables. *Appetite, 58*(2), 543-553. doi:10.1016/j.appet.2011.11.012

Bajec, M. R., & Pickering, G. J. (2010). Association of thermal taste and PROP responsiveness with food liking, neophobia, body mass index, and waist circumference. *Food quality and preference, 21*(6), 589-601. doi:10.1016/j.foodqual.2010.03.007

Bama. (n.d.). Grapefrukt. Retrieved from https://www.bama.no/cevita/produkter/frisk-presset-juice/frisk-presset-juice/grapefrukt/ (retrieved 20.04.21).

Bartoshuk, L. M., Duffy, V. B., Green, B. G., Hoffman, H. J., Ko, C. W., Lucchina, L. A., . . . Weiffenbach, J. M. (2004). Valid across-group comparisons with labeled scales: the gLMS versus magnitude matching. *Physiol Behav, 82*(1), 109-114. doi:10.1016/j.physbeh.2004.02.033

Bartoshuk, L. M., Duffy, V. B., Hayes, J. E., Moskowitz, H. R., & Snyder, D. J. (2006). Psychophysics of sweet and fat perception in obesity: problems, solutions and new perspectives. *Philos Trans R Soc Lond B Biol Sci, 361*(1471), 1137-1148. doi:10.1098/rstb.2006.1853

Beckerman, J. P., Alike, Q., Lovin, E., Tamez, M., & Mattei, J. (2017). The Development and Public Health Implications of Food Preferences in Children. *Frontiers in nutrition (Lausanne), 4*, 66-66. doi:10.3389/fnut.2017.00066

Birch, L. L., Gunder, L., Grimm-Thomas, K., & Laing, D. G. (1998). Infants' Consumption of a New Food Enhances Acceptance of Similar Foods. *Appetite, 30*(3), 283-295. doi:10.1006/appe.1997.0146

Browne, N. T., Snethen, J. A., Greenberg, C. S., Frenn, M., Kilanowski, J. F., Gance-Cleveland, B., . . . Lewandowski, L. (2021). When Pandemics Collide: The Impact of

COVID-19 on Childhood Obesity. *Journal of Pedriatric Nursing, 56*, 90-98. doi:10.1016/j.pedn.2020.11.004

Cardello, A. V., Meiselman, H. L., Schutz, H. G., Craig, C., Given, Z., Lesher, L. L., & Eicher, S. (2012). Measuring emotional responses to foods and food names using questionnaires. *Food quality and preference, 24*(2), 243-250. doi:10.1016/j.foodqual.2011.12.002

Coulthard, H., Palfreyman, Z., & Morizet, D. (2016). Sensory evaluation of a novel vegetable in school age children. *Appetite, 100*, 64-69. doi:10.1016/j.appet.2016.01.030

Cox, D. N., Hendrie, G. A., & Carty, D. (2016). Sensitivity, hedonics and preferences for basic tastes and fat amongst adults and children of differing weight status: A comprehensive review. *Food quality and preference, 48*, 359-367. doi:10.1016/j.foodqual.2015.01.006

De Cosmi, V., Scaglioni, S., & Agostoni, C. (2017). Early Taste Experiences and Later Food Choices. *Nutrients, 9*(2), 107. doi:https://doi.org/10.3390/nu9020107

De Lauzon-Guillain, B., Jones, L., Charles, M. A., Oliveira, A., Moschonis, G., Betoko, A., . . . Emmett, P. (2013). The influence of early feeding practices on fruit and vegetable intake among preschool children in 4 European birth cohorts. *Am J Clin Nutr, 98*(3), 804-812. doi:10.3945/ajcn.112.057026

Deshaware, S., & Singhal, R. (2017). Genetic variation in bitter taste receptor gene TAS2R38, PROP taster status and their association with body mass index and food preferences in Indian population. *Gene, 627*, 363-368. doi:10.1016/j.gene.2017.06.047

Dinehart, M. E., Hayes, J. E., Bartoshuk, L. M., Lanier, S. L., & Duffy, V. B. (2006). Bitter taste markers explain variability in vegetable sweetness, bitterness, and intake. *Physiology & Behaviour, 87*(2), 304-313. doi:10.1016/j.physbeh.2005.10.018

Dinnella, C., Morizet, D., Masi, C., Cliceri, D., Depezay, L., Appleton, K. M., . . . Monteleone, E. (2016). Sensory determinants of stated liking for vegetable names and actual liking for canned vegetables: A cross-country study among European adolescents. *Appetite, 107*, 339-347. doi:10.1016/j.appet.2016.08.110

Dovey, T. M., Aldridge, V. K., Dignan, W., Staples, P. A., Gibson, E. L., & Halford, J. C. G. (2012). Developmental differences in sensory decision making involved in deciding to try a novel fruit. *Br J Health Psychol, 17*(2), 258-272. doi:10.1111/j.2044-8287.2011.02036.x

Dovey, T. M., Staples, P. A., Gibson, E. L., & Halford, J. C. G. (2008). Food neophobia and 'picky/fussy' eating in children: A review. *Appetite, 50*(2), 181-193. doi:10.1016/j.appet.2007.09.009

Drewnowski, A., Henderson, S. A., & Shore, A. B. (1997). Taste responses to naringin, a flavonoid, and the acceptance of grapefruit juice are related to genetic sensitivity to 6-n-propylthiouracil. *American Journal of Clinical Nutrition, 66*(2), 391-397. doi:10.1093/ajcn/66.2.391

Edulia, n.d. About. Retrieved from https://edulia.eu/about-edulia/ (retrieved 15.03.21).

Ervina, E., Berget, I., Nilsen, A., & Almli, V. L. (2020). The ability of 10–11-year-old children to identify basic tastes and their liking towards unfamiliar foods. *Food quality and preference, 83*, 103929. doi:10.1016/j.foodqual.2020.103929

Goldstein, G. L., Daun, H., & Tepper, B. J. (2007). Influence of PROP taster status and maternal variables on energy intake and body weight of pre-adolescents. *Physiol Behav, 90*(5), 809-817. doi:10.1016/j.physbeh.2007.01.004

Green, B. G., Shaffer, G. S., & Gilmore, M. M. (1993). Derivation and evaluation of a semantic scale of oral sensation magnitude with apparent ratio properties. *Chemical Senses, 18*(6), 683-702. doi:10.1093/chemse/18.6.683

Guinard, J.-X. (2000). Sensory and consumer testing with children. *Trends in Food Science & Technology, 11*(8), 273-283. doi:10.1016/S0924-2244(01)00015-2

Guo, S.-W., & Reed, D. R. (2001). The genetics of phenylthiocarbamide perception. *Annals of human biology, 28*(2), 111-142. doi:10.1080/03014460151056310

Hayes, J. E., Bartoshuk, L. M., Kidd, J. R., & Duffy, V. B. (2008). Supertasting and PROP Bitterness Depends on More Than the TAS2R38 Gene. *Chemical Senses, 33*(3), 255-265. doi:10.1093/chemse/bjm084

Hayes, J. E., Sullivan, B. S., & Duffy, V. B. (2010). Explaining variability in sodium intake through oral sensory phenotype, salt sensation and liking. *Physiol Behav, 100*(4), 369-380. doi:10.1016/j.physbeh.2010.03.017

Heath, P., Houston-Price, C., & Kennedy, O. B. (2011). Increasing food familiarity without the tears. A role for visual exposure? *Appetite, 57*(3), 832-838. doi:10.1016/j.appet.2011.05.315

Helsedirektoratet. (2010). *Nasjonale faglige retningslinjer for primærhelsetjenesten : forebygging og behandling av overvekt og fedme hos barn og unge*.

Holsten, J. E., Deatrick, J. A., Kumanyika, S., Pinto-Martin, J., & Compher, C. W. (2012). Children's food choice process in the home environment. A qualitative descriptive study. *Appetite, 58*(1), 64-73. doi:10.1016/j.appet.2011.09.002

Jilani, H., Ahrens, W., Buchecker, K., Russo, P., & Hebestreit, A. (2017). Association between the number of fungiform papillae on the tip of the tongue and sensory taste perception in children. *Food & Nutrition Research, 61*(1), 1348865-1348865. doi:10.1080/16546628.2017.1348865

Jilani, H., Peplies, J., & Buchecker, K. (2018). Assessment of Sensory Taste Perception in Children. In (pp. 257-275). Cham: Cham: Springer International Publishing.

Kalva, J. J., Sims, C. A., Puentes, L. A., Snyder, D. J., & Bartoshuk, L. M. (2014). Comparison of the Hedonic General Labeled Magnitude Scale with the Hedonic 9-Point Scale. *Journal of Food Science, 79*(2), S238-S245. doi:10.1111/1750-3841.12342

Keller, K. L., Steinmann, L., Nurse, R. J., & Tepper, B. J. (2002). Genetic taste sensitivity to 6-n-propylthiouracil influences food preference and reported intake in preschool children. *Appetite, 38*(1), 3-12. doi:10.1006/appe.2001.0441

Keller, K. L., & Tepper, B. J. (2004). Inherited Taste Sensitivity to 6-n-Propylthiouracil in Diet and Body Weight in Children. *Obes Res, 12*(6), 904-912. doi:10.1038/oby.2004.110

Lanfer, A., Bammann, K., Knof, K., Buchecker, K., Russo, P., Veidebaum, T., . . . Ahrens, W. (2013). Predictors and correlates of taste preferences in European children: The IDEFICS study. *Food quality and preference, 27*(2), 128-136. doi:10.1016/j.foodqual.2012.09.006

Laureati, M., Bergamaschi, V., & Pagliarini, E. (2014). School-based intervention with children. Peer-modeling, reward and repeated exposure reduce food neophobia and increase liking of fruits and vegetables. *Appetite, 83*, 26-32. doi:10.1016/j.appet.2014.07.031

Lawless, H. T., & Heymann, H. (2010). *Sensory Evaluation of Food : Principles and Practices*(2nd ed. 2010. ed.).

Lawless, H. T., Popper, R., & Kroll, B. J. (2010). A comparison of the labeled magnitude (LAM) scale, an 11-point category scale and the traditional 9-point hedonic scale. *Food quality and preference, 21*(1), 4-12. doi:10.1016/j.foodqual.2009.06.009

Maffeis, C., Grezzani, A., Perrone, L., Del Giudice, E. M., Saggese, G., & Tatò, L. (2008). Could the Savory Taste of Snacks Be a Further Risk Factor for Overweight in

Children? *J Pediatr Gastroenterol Nutr, 46*(4), 429-437. doi:10.1097/MPG.0b013e318163b850

Melis, M., & Tomassini Barbarossa, I. (2017). Taste Perception of Sweet, Sour, Salty, Bitter, and Umami and Changes Due to l-Arginine Supplementation, as a Function of Genetic Ability to Taste 6-n-Propylthiouracil. *Nutrients, 9*(6), 541. doi:10.3390/nu9060541

Mennella, J. A., Finkbeiner, S., Lipchock, S. V., Hwang, L.-D., & Reed, D. R. (2014). Preferences for salty and sweet tastes are elevated and related to each other during childhood. *PLoS One, 9*(3), e92201-e92201. doi:10.1371/journal.pone.0092201

Mennella, J. A., Pepino, M. Y., Duke, F. F., & Reed, D. R. (2010). Age modifies the genotype-phenotype relationship for the bitter receptor TAS2R38. *BMC Genetics, 11*(1), 60-60. doi:10.1186/1471-2156-11-60

Mojet, J., Christ Hazelhof, E., & Heidema, J. (2001). Taste perception with age: Generic or specific losses in threshold sensitivity to the five basic tastes? *Chemical Senses, 26*(7), 845-860. doi:10.1093/chemse/26.7.845

Monteleone, E., Spinelli, S., Dinnella, C., Endrizzi, I., Laureati, M., Pagliarini, E., . . . Tesini, F. (2017). Exploring influences on food choice in a large population sample: The Italian Taste project. *Food quality and preference, 59*, 123-140. doi:10.1016/j.foodqual.2017.02.013

Murray, J. M., Delahunty, C. M., & Baxter, I. A. (2001). Descriptive sensory analysis: past, present and future. *Food research international, 34*(6), 461-471. doi:10.1016/S0963-9969(01)00070-9

Mustonen, S., Rantanen, R., & Tuorila, H. (2009). Effect of sensory education on school children's food perception: A 2-year follow-up study. *Food quality and preference, 20*(3), 230-240. doi:10.1016/j.foodqual.2008.10.003

Nakamura, Y., Goto, T. K., Tokumori, K., Yoshiura, T., Kobayashi, K., Nakamura, Y., . . . Yoshiura, K. (2011). Localization of brain activation by umami taste in humans. *Brain Res, 1406*, 18-29. doi:10.1016/j.brainres.2011.06.029

Opplysningskontoret for frukt og grønt. (2019). TOTALOVERSIKTEN 2018. Retrieved from https://www.frukt.no/globalassets/materiell/totaloversikten/totaloversikten-2018.pdf (retrieced 12.05.21).

Pagliarini, E., Proserpio, C., Spinelli, S., Lavelli, V., Laureati, M., Arena, E., . . . Dinnella, C. (2021). The role of sour and bitter perception in liking, familiarity and choice for phenol-rich plant-based foods. *Food quality and preference, 93*, 104250. doi:10.1016/j.foodqual.2021.104250

Russell, C. G., Worsley, A., & Campbell, K. J. (2015). Strategies used by parents to influence their children's food preferences. *Appetite, 90*, 123-130. doi:10.1016/j.appet.2015.02.038

Schonhof, I., Krumbein, A., & Brückner, B. (2004). Genotypic effects on glucosinolates and sensory properties of broccoli and cauliflower. *Die Nahrung, 48*(1), 25-33. doi:10.1002/food.200300329

Schutz, H. G., & Cardello, A. V. (2001). A LABELED AFFECTIVE MAGNITUDE (LAM) SCALE FOR ASSESSING FOOD LIKING/DISLIKING1. *Journal of sensory studies, 16*(2), 117-159. doi:10.1111/j.1745-459X.2001.tb00293.x

Simmonds, M., Llewellyn, A., Owen, C. G., & Woolacott, N. (2016). Predicting adult obesity from childhood obesity: a systematic review and meta-analysis. *Obesity Reviews, 17*(2), 95-107. doi:10.1111/obr.12334

Singh, P. B. (2011). Making Sense of Taste : Psychophysical, molecular biological and neurophysiological studies of umami taste processing in humans. In.

Stein, L. J., Nagai, H., Nakagawa, M., & Beauchamp, G. K. (2003). Effects of repeated exposure and health-related information on hedonic evaluation and acceptance of a bitter beverage. *Appetite, 40*(2), 119-129. doi:10.1016/S0195-6663(02)00173-3

Stone, H., & Sidel, J. L. (2004). *Sensory evaluation practices*(3rd ed. ed.).

Tepper, B. J., Christensen, C. M., & Cao, J. (2001). Development of brief methods to classify individuals by PROP taster status. *Physiology & Behavior, 73*(4), 571-577. doi:10.1016/S0031-9384(01)00500-5

Tepper, B. J., Melis, M., Koelliker, Y., Gasparini, P., Ahijevych, K. L., & Tomassini Barbarossa, I. (2017). Factors Influencing the Phenotypic Characterization of the Oral Marker, PROP. *Nutrients, 9*(12), 1275. doi:10.3390/nu9121275

Tuorila, H., & Mustonen, S. (2010). Reluctant trying of an unfamiliar food induces negative affection for the food. *Appetite, 54*(2), 418-421. doi:10.1016/j.appet.2010.01.010

Ventura, A. K., & Birch, L. L. (2008). Does parenting affect children's eating and weight status? *Int J Behav Nutr Phys Act, 5*(1), 15-15. doi:10.1186/1479-5868-5-15

Wardle, J., Carnell, S., & Cooke, L. (2005). Parental control over feeding and children’s fruit and vegetable intake: How are they related? *Journal of American Diet Association, 105*(2), 227-232. doi:10.1016/j.jada.2004.11.006

West, M., Liem, D. G., Booth, A., Nowson, C., & Grimes, C. (2019). Salt Preference and Ability to Discriminate between Salt Content of Two Commercially Available

Products of Australian Primary Schoolchildren. *Nutrients, 11*(2), 388. doi:10.3390/nu11020388

Zhang, R., Wang, Z., Fei, Y., Zhou, B., Zheng, S., Wang, L., . . . Yu, Y. (2015). The Difference in Nutrient Intakes between Chinese and Mediterranean, Japanese and American Diets. *Nutrients, 7*(6), 4661-4688. doi:10.3390/nu7064661

Zhao, L., Kirkmeyer, S. V., & Tepper, B. J. (2003). A paper screening test to assess genetic taste sensitivity to 6- n-propylthiouracil. *Physiology & Behaviour, 78*(4-5), 625-633. doi:10.1016/S0031-9384(03)00057-X

World Health Organization. (2020). Obesity and overweight. Retrieved from https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight (retrieved 05.05.21).

World Health Organization. (n.d.). Obesity. Retrieved from https://www.who.int/health-topics/obesity#tab=tab_1 (retrieved 05.05.21).

Appendix

Appendix 1: Consent form

Vennligst les sammen med barnet og returner til kontaktlærer med både din og barnets underskrift.

Smaksdetektiv er tilbake!

Hei, er du klar for smaksdetektivspillet Sesong 2?

Vi er tilbake igjen, med flere morsomme aktiviteter for å lære mer om smak. Denne gangen skal juice og grønnsaksbuljong undersøkes! Dere kommer også til å bruke ulike emojier for å vurdere matprøvene.

Velkommen tilbake til smaksdetektivspillet!

Oppgavene

1. **Hvor kraftig er smaken? Liker du den?** Du kommer til å smake på ulike juicer og grønnsaksbuljonger og undersøke hvor kraftig søt, sur, salt, bitter og umami smak det er i hver prøve og hvor mye du liker dem.
2. **Liker du …?** Du vil svare på hvor godt du liker diverse matvarer.
3. **Hvilken foretrekker du?** Du vil velge hvilken matvare du foretrekker fra sett med 2 matvarer.
4. **Kjenner du til denne matvaren?** Vi kommer til å spørre om du kjenner til ulike matvarer og hvor ofte du spiser dem.
5. **Hva føler du om matvaren?** Vi kommer til å teste hva du føler om maten du kommer til å smake.
6. **Teststrimmel:** Du skal smake på en teststrimmel og evaluere i hvilken grad du kjenner bittersmaken.

Hvorfor gjennomfører vi denne aktiviteten?

Vi er smaksforskere fra Nofima som studerer smakssansens rolle i etableringen av matvaner hos barn. Dette er en del av et større internasjonalt prosjekt. For mer informasjon besøk **www.edulia.eu**. Vi er nøye på å følge regelverk (www.fhi) for å forhindre spredning av Covid-19 (bruke masker, hansker, lukket emballasje osv.)

Deltakelsesregler

- I tråd med reglene ved Norsk Senter for Forskningsdata (NSD), **må du returnere skjemaet underskrevet av deg og en foresatt for å kunne delta**. Ikke noe spill uten skjema!
- Hold deg rolig og konsentrert i løpet av aktiviteten. Utfør testene for deg selv; **ikke kopier klassekamerater**, bare **du** vet hvordan ting smaker i din egen munn.
- Deltakelse er frivillig. Det vil si at du fritt kan avbryte eller trekke deg fra spillet til enhver tid uten konsekvenser.

Hvis du har spørsmål om aktivitetene, vennligst kontakt oss:

Valerie Almli, Seniorforsker
Tlf. 64 97 03 05 // 911 66 405
valerie.almli@nofima.no

Ervina, Stipendiat
Tlf. 461 99 171
ervina@nofima.no

Marie Stenvold, Masterstudent
Tlf. 995 919 93
marie.stensvold@nmbu.no

Nofima data protection officer, Anna Maria Bencze Rørå (mia.rora@nofima.no), Tlf +47 649 703 22
NSD – Norsk senter for forskningsdata AS (personverntjenester@nsd.no), Tlf: 55 58 21 17

Informert samtykke til smaksaktiviteter på (navn på skole)

Vennligst kryss av boksene som gjelder, signer og lever skjemaet til kontaktlærer innen **18. September 2020**.

Jeg samtykker til at barnet mitt kan delta i Smaksdetektivsaktiviteter på (navn) Skole.
Alle data behandles konfidensielt. Anonymiserte resultater vil kunne brukes i en prosjektrapport, doktorgradsoppgave, masteroppgave og forskningspublikasjoner. Studien har fått godkjenning fra Norsk Senter for Forskningsdata (NSD), referansekode 715734.

Som takk for ditt barns og din deltakelse vil klassetrinnet motta et støttebidrag til leirskolen.

Barnets navn (BLOKKBOKSTAVER): ____

Klasse: ____

☐	Mitt barn **kan delta** i studiet.
☐	Mitt barn **kan smake på juicen og vegetar-suppebuljong**. Han/hun har ingen allergi mot disse matvarene.
☐	Mitt barn **kan ikke smake på juicen og vegetar-suppebuljong**. Han/hun vil ikke delta i mattestene.

Kommentarer:

____

____

Dine rettigheter

Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke personopplysninger som er registrert om deg og barnet ditt,
- å få rettet personopplysninger om deg og barnet ditt,
- få slettet personopplysninger om deg og barnet ditt,
- få utlevert en kopi av dine og barnets personopplysninger (dataportabilitet), og
- å sende klage til personvernombudet eller Datatilsynet om behandlingen av dine og barnets personopplysninger.

Obs: Alle prøvene blir forberedt på det sensoriske laboratoriet til Nofima, og følger smittevernsregelement for å forhindre spredning av Covid-19.

Sted og dato:

Underskrift foresatt: Barnets underskrift:

Appendix 2: NSD approval

NSD Personvern

27.08.2019 10:03

Det innsendte meldeskjemaet med referansekode **715734** er nå vurdert av NSD.

Følgende vurdering er gitt:

Our assessment is that the processing of personal data in this project will comply with data protection legislation, presupposing that it is carried out in accordance with the information given in the Notification Form and attachments dated 27.08.2019. Everything is in place for the processing to begin. The study also has followed the Helsinki Declaration of using the human responses voluntary.

NOTIFY CHANGES

If you intend to make changes to the processing of personal data in this project it may be necessary to notify NSD. This is done by updating the Notification Form. On our website we explain which changes must be notified. Wait until you receive an answer from us before you carry out the changes.

TYPE OF DATA AND DURATION

The project will be processing special categories of personal data about health (sample 1), and general categories of personal data, until 31.01.2022.

LEGAL BASIS

The project will gain consent from data subjects to process their personal data. We find that consent will meet the necessary requirements under art. 4 (11) and 7, in that it will be a freely given, specific, informed and unambiguous statement or action, which will be documented and can be withdrawn.

The legal basis for processing special categories of personal data is therefore explicit consent given by the data subject, cf. the General Data Protection Regulation art. 6.1 a), cf. art. 9.2 a), cf. the Personal Data Act § 10, cf. § 9 (2). P

RINCIPLES RELATING TO PROCESSING PERSONAL DATA NSD finds that the planned processing of personal data will be in accordance with the principles under the General Data Protection Regulation regarding:

- lawfulness, fairness and transparency (art. 5.1 a), in that data subjects will receive sufficient information about the processing and will give their consent
- purpose limitation (art. 5.1 b), in that personal data will be collected for specified, explicit and legitimate purposes, and will not be processed for new, incompatible purposes
- data minimisation (art. 5.1 c), in that only personal data which are adequate, relevant and necessary for the purpose of the project will be processed
- storage limitation (art. 5.1 e), in that personal data will not be stored for longer than is necessary to fulfil the project's purpose

THE RIGHTS OF DATA SUBJECTS

Data subjects will have the following rights in this project: transparency (art. 12), information (art. 13), access (art. 15), rectification (art. 16), erasure (art. 17), restriction of processing (art. 18), notification (art. 19), data portability (art. 20). These rights apply so long as the data subject can be identified in the collected data.

NSD finds that the information that will be given to data subjects about the processing of their personal data will meet the legal requirements for form and content, cf. art. 12.1 and art. 13.

We remind you that if a data subject contacts you about their rights, the data controller has a duty to reply within a month.

FOLLOW YOUR INSTITUTION'S GUIDELINES

NSD presupposes that the project will meet the requirements of accuracy (art. 5.1 d), integrity and confidentiality (art. 5.1 f) and security (art. 32) when processing personal data and conducting research.

To ensure that these requirements are met you must follow your institution's internal guidelines and/or consult with your institution (i.e. the institution responsible for the project).

FOLLOW-UP OF THE PROJECT

NSD will follow up the progress of the project underway (every other year) and at the planned end date in order to determine whether the processing of personal data has been concluded/is being carried out in accordance with what is documented.

Good luck with the project!

Contact person at NSD: Karin Lillevold

Data Protection Services for Research: +47 55 58 21 17 (press 1)

Appendix 3: Guidelines sent to teachers before instruction meeting

Guidelines for Teacher

Samples:

Each child should have these things ready on their table (provided by Nofima):

1. 1 taste kit labelled with "Detektivsett A"
2. 1 taste kit labelled with "Detektivsett B"
3. 1 paper cup for spiting
4. 1 transparent plastic cup for water (the children can use tap water from the class)

Note:

- The crackers inside the taste kit (Detektivsett A) are gluten and lactose free
- Nofima will provide a trash bag for the disposable cups and packaging that were used for the test
- Children will log in using different username and passwords labelled in their Detektivsett A (one child will get their own username and password)

Equipment (teacher's responsibility):

Prior to the test, each of child should have (from the schools):

1. Signed consent form from their parents (digital or on a paper, note: a photo of it can be sent by email/SMS to the teacher, if the child forgot to deliver it in school)
2. PC/tablet for each child
3. Pencil/pen for each child

Conditions:

- During the test, children should sit with some distance to each other
- If possible, the children should not sit too close with their closest friend (sitting location should be arranged by the teacher, so they will not interfere or be disturbed by their peers)
- Children are allowed go to the toilet at any time – the test can be paused, and can continued afterwards
- The test should be conducted quietly (no talking, no discussion during the test). However, children can ask questions to the instructor via video conference (digitally) during the test or get help from the teacher
- The test will be conducted at the same time for all the children per each section. Children will work independently within each section (3 sections in total – see Table below) if some children have finished one section earlier, they will be provided by a printed riddle (or some activity assigned by the teacher) to keep them occupied until all of children finished the same session.
- The test is voluntary, and children can stop at any time during the test

The test sections

There will be 3 sections.

At the start of each section, instructions will be provided by an instructor of Nofima team

Section 1 (taste kit: "Detektivsett A") Time: 45-55 minutes			**Break (15 minutes)**
Setting samples at the table, connect via Teams (teacher)	Welcoming + intro + instruction section 1	Questionnaires and tasting	Fill in the riddle game
5 min	5 min	40 minutes	15 minutes

Note! During the break children can work with the riddle or do other thing that will not disturb the others

Section 2 (taste kit: "Detektivsett B") Time: 30-35 minutes	
Instruction section 2	Questionnaire and tasting
5 min	30 minutes

Section 3 (the round box inside taste kit "Detektivsett B") Time: ± 8 minutes	
Instruction section 3	Short test of paper disc
5 min	3 min

Norges miljø- og biovitenskapelige universitet
Noregs miljø- og biovitskapelege universitet
Norwegian University of Life Sciences

Postboks 5003
NO-1432 Ås
Norway