Understanding children´s healthiness and hedonic perception of school meals via structured sorting

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Abstract

Trends in the prevalence of childhood overweight and obesity in Europe and especially in Spain have continuously increased in the last three decades. The aim of this work was to study the healthiness understanding (healthy and unhealthy food) in children with different ages and to evaluate liking towards a set of school meals: first courses, second courses and fruit/dessert.

Two hundred and seventy-seven children between the ages of six and twelve from three primary schools in northern Spain, Bizkaia, took part in this study.

All the groups showed a good knowledge of the healthiness of the dishes offered in the school canteen. However, some dishes were difficult to assess for the 6-7- and 8-9-year old groups. Pasta and croquettes with chips were the most preferred dishes. Vegetables and fish dishes were the least preferred. Results suggest that children become increasingly aware of their preferences and critical in their choices with growing age. It was found in this study that there was a strongly inverse relationship between children's perceptions of the healthiness of foods and their preferences for them. The structured sorting task was a good tool for children to classify various dishes (complex food) considering healthiness and hedonic perception at the same time.

In conclusion, these results contribute to a better understanding of children´s nutritional perception (healthy/unhealthy food) and its relation to preferences of school meals, which is important for quality improvement and nutritional planning in school food services.

Keywords: children, school meals, sorting, healthiness perception, hedonic perception

Introduction

Childhood obesity is considered one of the most serious public health challenges of the 21st century (WHO, 2017). Children obesity is one of the most important risk factors in the development of Type 2 diabetes, asthma, sleep difficulties, musculoskeletal problems and future cardiovascular disease, as well as school absence, psychological problems and social isolation (Bibbins-Domingo, Coxson, Pletcher, Lightwood, & Goldman, 2007; Franco, Sanz, Otero, Domínguez-Vila, & Caballero, 2010). Global and European health authorities have warned that by 2030 more than 60% of the European population will be overweight and obese. More specifically, the prevalence of overweight or obesity was found to be higher in countries from Southern or Eastern Europe compared with countries in Central or Northern Europe (20.6% in Greece, 15.2% in Bulgaria, 14.8% in Spain, 12.7% in Poland, 11.4% in Belgium and 10.0% in Germany) (Cadenas-Sanchez et al., 2016; Cattaneo et al., 2010; Manios et al., 2018).

The European Parliament and the World Health Organization (WHO) regional office (Europe, 2006) have emphasized the need to offer children healthier food at school, notably by improving or developing nutritional guidelines for school meals. Most European countries have established specific recommendations for school meals, but only Portugal, the United Kingdom and France have made them mandatory.

Therefore, one of the challenges of the food industry and food service is developing food products that meet children´s sensory expectations and liking.

Childhood obesity is determined by genetic and environmental factors and it is widely accepted to result from interactions between genes and environment (Lanigan, Tee, & Brandreth, 2019). However, social and economic factors such as advertising, the environment, economical status, education and the school environment, transportation and the food environment play an important role in obesity (Franco et al., 2010).Families

and the community in general in a joint effort must become actively involved in the prevention of this health problem. Moreover, the school is the enabling environment for the implementation of prevention programs in which the students learn the importance of nutrition and healthy practices (Sánchez, Viera, & Rodríguez-Mena, 2017). Healthy eating patterns in childhood promote optimal childhood health, growth and intellectual development. Having lunch at school has an important educational function because the diet implies a number of hidden significances, namely a physiological significance to learn to feed properly ,a cultural significance to know different varieties and origins of foods , and a psychological significance to understand why a specific food product may arouse emotions (Pagliarini, Gabbiadini, & Ratti, 2005).

Studies have identified important features of children´s knowledge on nutrition and health from the primary school years onwards (Slaughter & Ting, 2010). Food preferences change with age and are not related to oral sensitivity (Lukasewycz & Mennella, 2012). Other factors such as family food practices, culture and experience have a significant impact on children's food preferences.

In primary schools there is usually a set menu and if the foods provided are not liked, the children may not eat them, and thus, some children may eat very little at lunchtime (Noble, Corney, Eves, Kipps, & Lumbers, 2000). In addition, food waste is generated due to the children´s food rejection. School canteens are big generators of food waste and, at the same time, provide a great opportunity to improve habits regarding nutrition and education on sustainability, thus impacting the future of the food system (Derqui, Fernandez, & Fayos, 2018).

During the last few decades, a great deal of effort has been made to develop sensory methods that are suitable for children (Guinard, 2000). In the last 15 years, a shift has been observed in research orientation as a response to the increased rate of overweight

and obese children worldwide (Laureati, Pagliarini, Toschi, & Monteleone, 2015). Other studies point to the importance of early childhood for learning about health and unhealthy qualities of food and add to the evidence indicating that there is a particular gap in young children´s understanding about unhealthy foods (Tatlow-Golden, Hennessy, Dean, & Hollywood, 2013). Some recent studies have focused on children´s food preferences and new alternative methods to explore the hedonic dimension of young consumers (Varela et al., 2017; Varela & Salvador, 2014; Vennerød, Hersleth, Nicklaus, & Almli, 2017).

The use of sorting techniques and projecting mapping has gained popularity within the field of sensory and consumer science. These methods have been applied mostly with adults (Cadena et al., 2014; Cartier et al., 2006; Jervis et al., 2016; Laureati, Pagliarini, Bassoli, & Borgonovo, 2014). However, few studies with school-age children can be found in the literature. In fact, sorting methods are easy to understand and child-friendly, as many games are based on sorting of shapes and colours, so it is a procedure familiar to children (Varela & Salvador, 2014). Evidence of application of sorting techniques for assessing the nutritional and hedonic perception of healthy and unhealthy food to children aged 5, 7 and 9 years has been provided by Varela and Salvador (2014). Results showed that the application of structured sorting using images proved to be a promising tool for the multi-dimensional assessment in children. Morizet, Depezay, Combris, Picard, and Giboreau (2012) successfully applied sorting techniques with school-aged children as a tool to classify several vegetables according to liking and familiarity.

Further research is needed to assess the potential of sorting and projective techniques for assessing children´s preferences, especially with more complex product sets (Laureati et al., 2015).

Numerous studies have found that eating behaviour and food preferences formed in early childhood can persist into later childhood and even into the start of adult life (Devine,

Connors, Bisogni, & Sobal, 1998; Nicklaus, Boggio, Chabanet, & Issanchou, 2005; Skinner, Carruth, Bounds, Ziegler, & Reidy, 2002) This makes food preferences of children even more important to study. A knowledge of children´s food preferences, the factors influencing them, and their perception of the healthiness of food is needed if school caterers and those involved in nutrition education are to work together to help children choose a nutritionally balanced meal (Noble, Corney, Eves, Kipps, & Lumbers, 2000). Therefore, it appears particularly interesting to investigate the healthiness and hedonic perception of school meals by children. In the present study the reality of some Spanish schools was investigated. The Mediterranean diet is important as a result of its food combinations and its nutritional aspects, and in the case of Spain, main meals are subdivided into three components: first course, second course and fruit/dessert.

To the knowledge of the present authors, this study is the first to combine healthiness and hedonic perception in meals, in children of different ages, in a school context. The purpose of this study was to investigate healthiness perception and hedonic perception of school meals, by children of different ages using a new methodological approach that allow to combine both parameters (structured sorting).

Materials and methods

Participants

A total of 277 children, aged between six and twelve from three primary schools in the North of Spain, Bizkaia, took part in this study. Three groups of children aged 6-7 years (n=94; 55 girls, 39 boys), 8-9 years (n=95; 53 girls, 42 boys) and 10-12 years (n=88; 46 girls, 42 boys) were interviewed. The experimental plan (test methods) adopted in this study is in accordance with the principles contained in the Standard Guide for Sensory

Evaluation of Products by Children and Minors (ASTM, 2013). Parents were informed and approved the participations of their children in the activity. The study protocol was approved by the Ethical Committee of AZTI.

Sorting task

The materials included colour photographs of food and dishes that were commonly served at school lunches to ensure that the foods were representative of the current menu offered to the children provided by the local authority caterers. The children performed a "structured sorting task", where they had to sort 16 colour photographs (stickers) of dishes offered in the school canteen in 4 pre-determined groups (Figure 1). The study was targeted to collect data on 16 dishes consisting of: 5 first courses (3 different vegetables dishes, 1 lentils and 1 pasta), 8 second courses (4 based on fish, 2 on meat and 2 on ham croquettes) and 3 desserts (at the time of presenting the photographs, the name of each dish was also indicated). The methodology was based on the "structured sorting task" previously published by Varela et al. (2014) with some modifications (different symbols and size of sheet). Children received an A3 sheet separated in 4 equal quadrants labelled with 2 symbols. The symbols used were combined representing the concepts of "healthy and I like it" (L/H), "healthy and I don't like it" (DL/H), "not healthy and I like it" (L/NH), "not healthy and I don´t like it" (DL/NH) (Figure 1).

INSERT FIGURE 1 ABOUT HERE

Children were separated into small groups (n=10-15) and were explained the sorting task. The concepts of "it is good for you" or "it is bad for you" were explained by means of two examples of foods not used in the study: apple and candy bar, as follows: "a food/meal you can eat often, every day for example an apple, because it is good for your health" or " a food/meal that you can eat occasionally, as a candy bar, because frequently

eating it could be bad for your health". The test was conducted in the presence of experimenters and canteen monitors. Children could ask questions before the start of the test or individually once the test sheets were handed out.

Overall liking rating

In the second task, the children were told "we are going to play a game so that we can find out what foods you like and what foods you don´t like". The same 16 photographs were rated for the overall liking with the use of 5-point hedonic smiley-scales. Pictures were randomized in the questionnaire following a balanced complete block experimental design (Williams´ design). Children took about 30-45 minutes per group to perform both parts of the study. In general, the tasks took longer with younger children (6-7 years old).

Data analysis

Overall liking data were analysed by means of a 3-way ANOVA considering, age, gender, products and their 2-way interactions as factors and liking data as the dependent variable. Least significant differences (LSD) were calculated by Tukey´s test ($p < 0.05$).

Sorting data were analysed by age group: 6-7 years-old, 8-9 years old and 10-12 years old. Multiple correspondence analysis (MCA) was carried out separately for data obtained from the sorting task in each group of children. MCA allows the individual data from respondents to be considered (Hair, 2009).

The structured sorting task was also analysed by Multiple Factor Analysis (MFA) as described by Varela & Salvador (2014). It was applied on the data matrix formed by food items in the rows, and individual child participants in the columns, and allocating each food item to the chosen group, i.e. A (L/H), B (L/NH), C (DS/H) or D (DL/NH). Rv coefficients were used to compare the perceptual space among age groups.

MFA is a synthesis of PCA (Principal Component Analysis) and MCA (Multiple Correspondence Analysis) that generalises and enables the use of quantitative and qualitative variables. In practise, an MFA performed on K tables that each contain one qualitative variable is equivalent to an MCA performed on the K variables (Escofier & Pagès, 1984). In this work the MFA approach was used as it allowed also comparing and superimposing the different data sets. When reference is made to the individual sets it would be referred as to MCA. The MFA and MCA analyses were performed with XLStat system software (version 2016, Addinsoft, XLSTAT Institute Inc., Paris, France).

Results and discussion

This study aimed, firstly, to determine which of the foods commonly served to primary school children at lunchtime were classified by the school children as healthy and which as unhealthy. Secondary, the study evaluated the acceptability of these foods.

Sorting task

The three age groups were able to easily understand the sorting task and performed this task after the explanations and examples given by the interviewers.

Table 1 shows the percentage of the frequency´s allocation of the 16 foods and dishes that were commonly served at school lunches, to each of the four pre-selected groups for the three age cohorts. Most children in the three age groups categorized the following products as healthy: stewed lentils, sweetened yogurt, pear, food with vegetables and dishes with fish. Regarding "not healthy food", the three groups categorized the following dishes: croquettes with chips (57% of the children with 6-7 years, 71% ,8-9 years and 77% 10-12 years) and chocolate cupcakes (for example 95% of the children with 8-9 years). In both cases, all three groups showed a higher percentage of the identification of

"not healthy food" as age increased. Results for the first course, spaghetti with tomato, showed that 34% of the youngest children (6-7 years) considered this food as "not healthy". However, lower percentages of children between 8-9 and 10-12 years categorized this dish as "unhealthy" (27% and 28% respectively)". On the other hand, a greater percentage of children between 8-9 years (41%) and 10-12 years (46%) associated Gardener's style meatballs as "not healthy" dishes versus 28% of children between 6-7 years.

INSERT TABLE 1 ABOUT HERE

Previous studies regarding the perceptions of healthiness found that children perceived takeaway food as unhealthy compared with proper meal and homemade foods (Ross, 1995). Some aspects of the global food culture such as fast food and hamburgers and pizzas have clearly gained a hold and have become universal in the way we now eat (Hardyment, 1995, pp. 186-8).

The Multiple Correspondence Analysis (MCA) for 8-9 years group and 10-12 years group revealed the separation of the products depending mainly on their healthiness in the first factor of the MCA, while the liking was more associated to the second factor. As an example, Figure 2 displays the sample plot for the 8-9 years old group. In this case, "chocolate cupcake''(a less healthy product) was grouped towards the positive side of factor 1 and other options such as vegetables and fish (the healthy foods) were associated to the negative side of factor 1. The ''healthiness'' of the dishes seemed to have had the most weight in the classification, correlated mainly with the first factor of the MCA, which explained most of the variability. However, the MFA for youngest children, 6-7 years olds revealed the separation of the products depending mainly on the liking (Figure 3).

Studies by Ross (1995), Turner, Mayall, and Mauthner (1995) and Varela and Salvador (2014) have shown that children had a clear concept of "healthy" and "unhealthy" food. However, in this study for the youngest children (6-7 years), the separation of the products depended mainly on the liking and not the perception of healthiness (Figure 3). These results are in accordance with previous research with 4-6 year old children documenting that the taste is a more powerful determinant of food selection than its healthfulness in children (Nguyen, Girgis, & Robinson, 2015). On the other hand, reduced liking has been reported as one of the key factors involved in the rejection of healthy foods as fish, vegetables, fruits and fibre-enriched products (Dovey et al., 2012; Laureati, Cattaneo, Bergamaschi, Proserpio, & Pagliarini, 2016; Zeinstra, Koelen, Kok, & de Graaf, 2010).

INSERT FIGURE 2 AND FIGURE 3 ABOUT HERE

The Multi Factor Analysis (MFA) was run on the three data sets derived from the sorting in order to study the correlation between the three groups of children (Figure 4). The MFA showed that the coordinates of each product in each configuration were very close, highlighting the high correlation between the perceptions in the three groups. This is also supported by the obtained RV coefficients, which were very close to one (0.945 between 6-7y and 8-9y; 0.941 between 6-7y and 10-12years and 0.975 between 8-9y and 10-12y). An RV coefficient greater than 0.7 is generally considered as a good level of agreement (Cartier et al., 2006).

"The croquettes with chips" and "chocolate cupcake" appeared well-separated from the rest of the dishes in the first factor, because these dishes of the menu are considered as unhealthy options.

The perception of the three groups of children showed a good knowledge of the healthiness of the 16 dishes of food that were representative of the current menu offered to the children by the schools' caterers.

INSERT FIGURE 4 ABOUT HERE

Overall liking rating

The ANOVA analyses (Table 2) revealed significant differences between the meals, the age of children and gender (F=45.232, p<0.0001; F=12.009, p<0.0001 and F=18.357, p<0.0001 respectively). The interactions Gender*Product and Age*Product were also significant. Figure 5 and 6 display the overall liking scores interaction for each meal and age and gender, respectively. Croquettes with chips had the highest liking rating for the 6-7 year and 8-9 years groups. However, for 10-12 years-old children, sweetened yogurt was the most-liked dish. The dishes that were least-liked for all ages were those made with vegetables, such as green beans with potatoes followed by green vegetable purée.

In relation with fish products, it was found that hedonic perceptions were also very low, especially for tuna with peppers and mackerel burgers. In the present study the acceptability of a fish product, mackerel burger, by the youngest children was significantly higher than ratings from the other age groups (p <0.05,"data not shown). In the same direction, Pagliarini et al. (2005) reported that children aged 7-10 years become increasingly aware of their preferences and critical in their choices with growing age. The same behaviour was observed in the study of Latorres, Mitterer-Daltoé, and Queiroz (2016), where the authors analysed the acceptance of breaded fish meatballs with children, aged 6-14 years and realized that age was significantly and inversely correlated with acceptance. The main fish consumption barriers are fishbones and smell, for that reason fish can become more attractive to children through fish presentation products without bones and with smooth flavours such as hamburgers, nuggets and meatballs (Latorres et al., 2016; Mitterer-Daltoé, Latorres, Queiroz, Fiszman, & Varela, 2013).

The opinion of the children about fish products was different depending on the cooking methods (breaded or baked). In general, a higher percentage of children like breaded hake

more than baked hake. Similar results on fish dishes in school canteen have been obtained in children of the comparable age by Laureati et al. (2016). The way of preparing a food influenced its hedonic rating as well as the amount uneaten food (Caporale, Policastro, Tuorila, & Monteleone, 2009).

INSERT TABLE 2 ABOUT HERE

In general, the 6-7 year old group gave significantly higher overall liking scores to all the dishes offered in the school canteen. This result is in line with the results reported by Caton et al. (2014), which indicated that the younger children (preschool children from three different EU countries) enjoyed more with food. On the other hand, other studies relating to hedonic rating of meals at schools pointed out that there are stereotypical perceptions of the food served in the canteens tasting bad and being low quality (Tuorila, Palmujoki, Kytö, Törnwall, & Vehkalahti, 2015) (Persson Osowski, Göranzon, & Fjellström, 2013). Throughout the school year children have probably adopted these stereotypical perceptions.

INSERT FIGURE 5 ABOUT HERE

The ANOVA analyses that were conducted revealed that significant differences between the meals, the gender of children and their interaction (Figure 6). In general, boys scored higher on the liking rating of all products than girls. The main fish dishes (baked hake with lettuce, mackerel burger) were rated higher by boys than girls. The same results were found regarding vegetables plates, green vegetable purée and green beans with potatoes which were rated higher by boys than girls (interaction gender*product, $F=3.349$, $p< 0.0001$). On the other hand, boys became more critical regarding croquettes with lettuce. Regarding the desserts, no significant differences were found between boys and girls.

Children dislike vegetables (Cooke & Wardle, 2005) and when given the option they avoid them when allowed to choose their lunch (Nicklaus et al., 2005). One explanation

for low vegetable intake is that vegetables are disliked due to their strong or bitter taste, unfamiliar texture, low energy density and lack of availability/accessibility (Bell & Tepper, 2006; Di Noia & Byrd-Bredbenner, 2014; Rasmussen et al., 2006).Thus, decreasing intake of fruit and vegetables with increasing age of children and adolescents seems to be related in European countries (Rasmussen et al., 2006).

In a recent investigation examining children´s eating behaviour, Caton et al. (2014) conducted a preschool-based intervention to investigate how individual characteristics influence initial acceptance and effectiveness of repeated exposure to a novel vegetable. In this study, they identified four categories of children: "plate clearers", who consistently consumed what was served, "no-eaters", who ate very little, "learners", who responded positively to the intervention and "others", who expressed no distinct consumption pattern.

In the present study it was found that products with high acceptability were classified as not healthy. For example, the liking rating of croquettes with chips was very high, but was classified as not healthy from 77% of the children. Similar results demonstrate that the foods chosen for the 'healthy' meal by primary schoolchildren were chosen least frequently as the 'preferred' meal (Noble et al., 2000; Tilston, Gregson, Neale, & Douglas, 1991).

A further important consideration is that this study included pictures of real foods in the sorting task. However, further research with school children is needed to better understand the mechanisms underlying food association and categorization food items in healthy or unhealthy. These finding have important implications from an educational point of view, to teach children about healthy and unhealthy foods at very early stages in life.

The main limitation of this study comes from the nature of the structured sorting test, as children are instructed to use two fixed variables as drivers of the groups, the results do not allow to determine which aspect is more relevant in their choice, health or hedonics. In this sense, it would be interesting to apply a free sorting or projective mapping to a set of similar stimuli, to see if health and hedonics are important drivers of the classification, and in what degree.

INSERT FIGURE 6 ABOUT HERE

Conclusions

The results of the present study show that children have distinctive healthiness and hedonic perception about the different dishes that are provided at school canteen.

It was found in this study that there that products with high acceptability (as croquettes with chips and chocolate cake) were classified as not healthy.

The aim of this study was to generate a comprehensive description of how children of different ages spontaneously react about food and nutrition. A major contribution of the present investigation is adding to the scarce literature that bridges the gap in the understanding of children´s hedonic perception and their own health assessments.

In order to maximize the effectiveness of nutrition programs, we need a detailed understanding of what and how children of different ages think about food and nutrition. Throughout their lives, children are exposed to information about food, eating, nutrition and health via their parents, their peers, the media and school, and they actively construct theories to organize their understandings of these topics. In the future, it would be interesting not only to improve the nutritional education at schools, but also for the avoidance of waste of foods.

Further research would be needed to develop an easy tool (for example a game, via a Web application, app) to assess the potential of the structured sorting task with more food

products and include in such a tool a test of the taste of real food items as related to their hedonic and health perception.

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	6-7 years (n=94)				8-9 years (n=95)				10-12 year (n=88)			
Products	**L/H**	**L/NH**	**DS/H**	**DS/NH**	**L/H**	**L/NH**	**DS/H**	**DS/NH**	**L/H**	**L/NH**	**DS/H**	**DS/NH**
First courses												
Stewed lentils	68.09	6.38	22.34	3.19	78.95	1.05	20.00	0.00	67.05	2.27	28.41	2.27
Green vegetables purée	50.00	2.13	39.36	8.51	43.16	1.05	53.68	2.11	36.36	0.00	59.09	4.55
Carrot purée	62.77	3.19	30.85	3.19	67.37	3.16	29.47	0.00	63.64	1.14	32.95	2.27
Green beans with potatoes	37.23	3.19	51.06	8.51	32.63	1.05	64.21	2.11	26.14	0.00	68.18	5.68
Spaghetti with tomato	64.89	31.91	1.06	2.13	66.32	23.16	6.32	4.21	68.18	21.59	4.55	5.68
Second courses												
Croquettes with lettuce	59.57	26.60	8.51	5.32	65.26	24.21	9.47	1.05	67.05	22.73	5.68	4.55
Croquettes with chips	41.49	56.38	1.06	1.06	26.32	68.42	2.11	3.16	22.73	70.45	0.00	6.82
Baked hake with lettuce	50.00	7.45	37.23	5.32	51.58	2.11	43.16	3.16	48.86	0.00	47.73	3.41
Breaded hake with lettuce	57.45	7.45	26.60	8.51	53.68	6.32	38.95	1.05	52.27	4.55	40.91	2.27
Tuna with peppers	46.81	12.77	34.04	6.38	49.47	2.11	46.32	2.11	43.18	3.41	47.73	5.68
Mackerel burger	39.36	14.89	36.17	9.57	31.58	8.42	49.47	10.53	30.68	5.68	48.86	14.77
Breaded chicken breast with lettuce	62.77	12.77	18.09	6.38	72.63	10.53	13.68	3.16	80.68	12.50	6.82	0.00
Gardener`s style meatballs	60.64	22.34	10.64	6.38	51.58	35.79	7.37	5.26	48.86	40.91	5.68	4.55
Fruit/Dessert												
Sweetened yogurt	91.49	7.45	1.06	0.00	87.37	6.32	5.26	1.05	86.36	7.95	4.55	1.14
Pear	76.60	3.19	18.09	2.13	69.47	2.11	28.42	0.00	60.23	0.00	39.77	0.00
Chocolate cupcake	18.09	76.60	1.06	4.26	3.16	86.32	1.05	9.47	4.55	79.55	1.14	14.77

Table 1. Percentage of frequency`s allocation of food products (%) to each of the four pre-selected groups for the three age cohorts.

Source	DF[1]	Sum of squares	Mean squares	F	Pr > F
Gender	1	31.478	31.478	18.357	**< 0.0001**
Age	2	41.185	20.593	12.009	**< 0.0001**
Product	28	2171.667	77.560	45.232	**< 0.0001**
Gender*Age	2	6.004	3.002	1.751	0.174
Gender*Product	28	160.797	5.743	3.349	**< 0.0001**
Age*Product	56	141.102	2.520	1.469	**0.013**

Table 2. Effects of different factors on overall liking for dishes (ANOVA, $p < 0.05$).

[1]DF, degree of freedom.

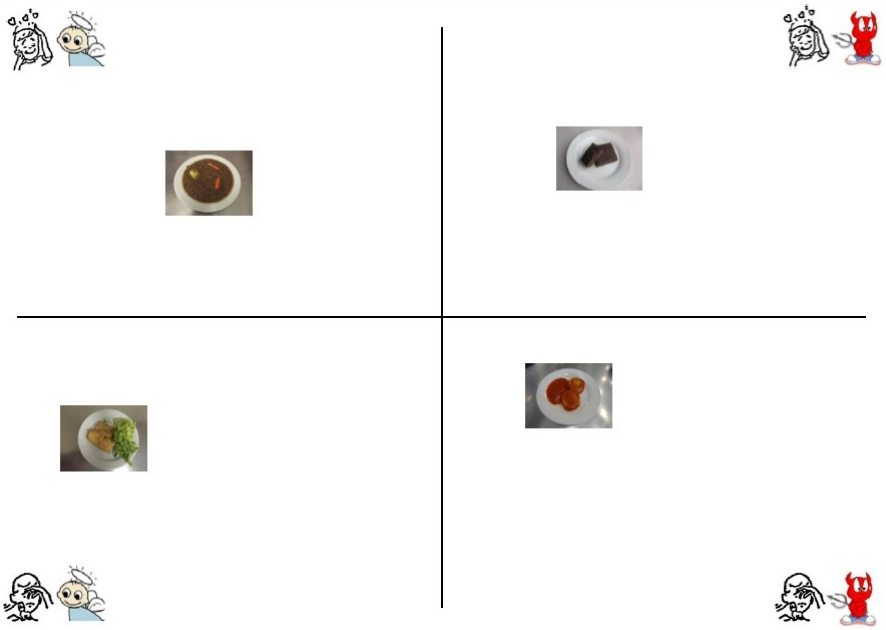


Figure 1. An example of 4 meals included in the structured sorting ballot.

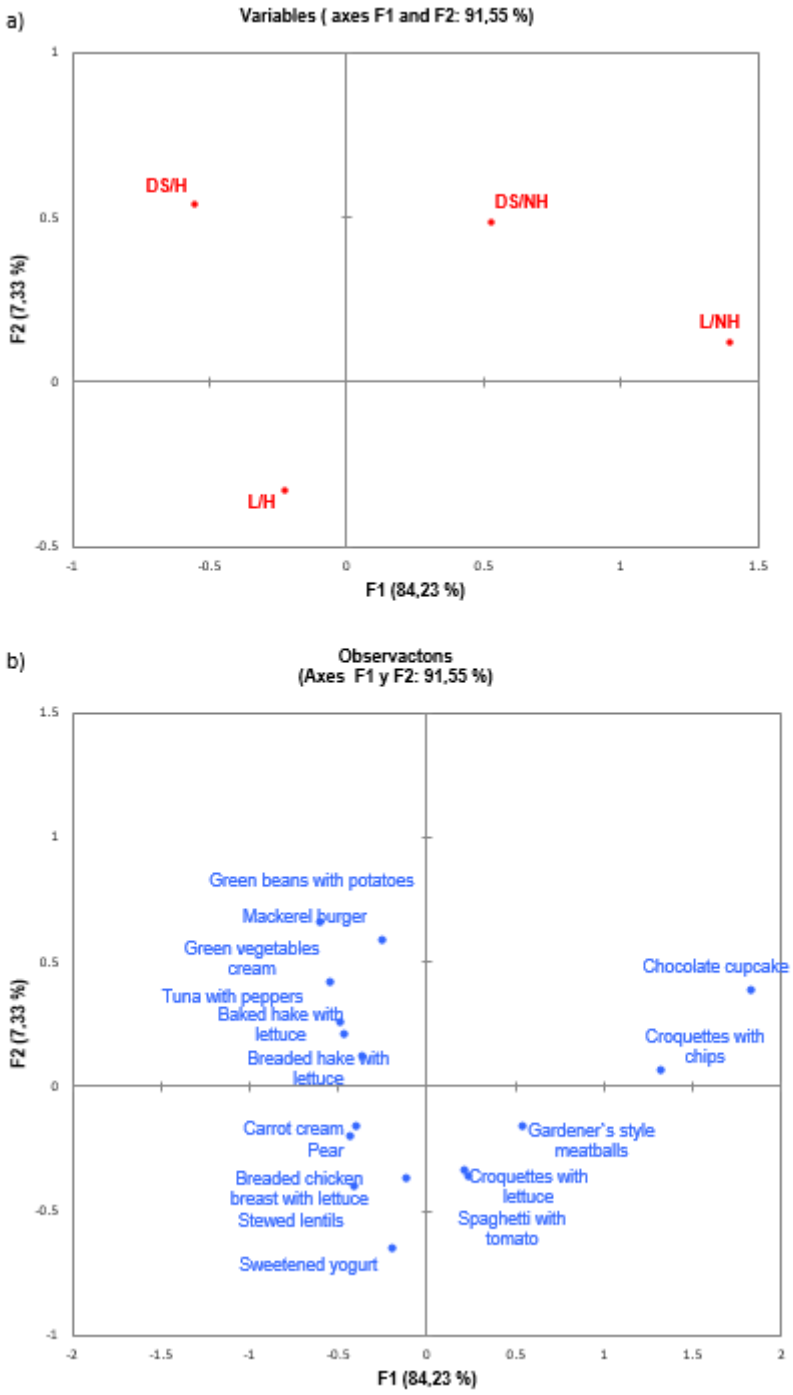


Figure 2. (a) Variables plot of the two first factors of the Multiple Correspondence Analysis of the sorting task data for the 8-9 years group (b) Product map of the two first factors of the Multiple Correspondence Analysis of the sorting task data for the 8-9-year group.

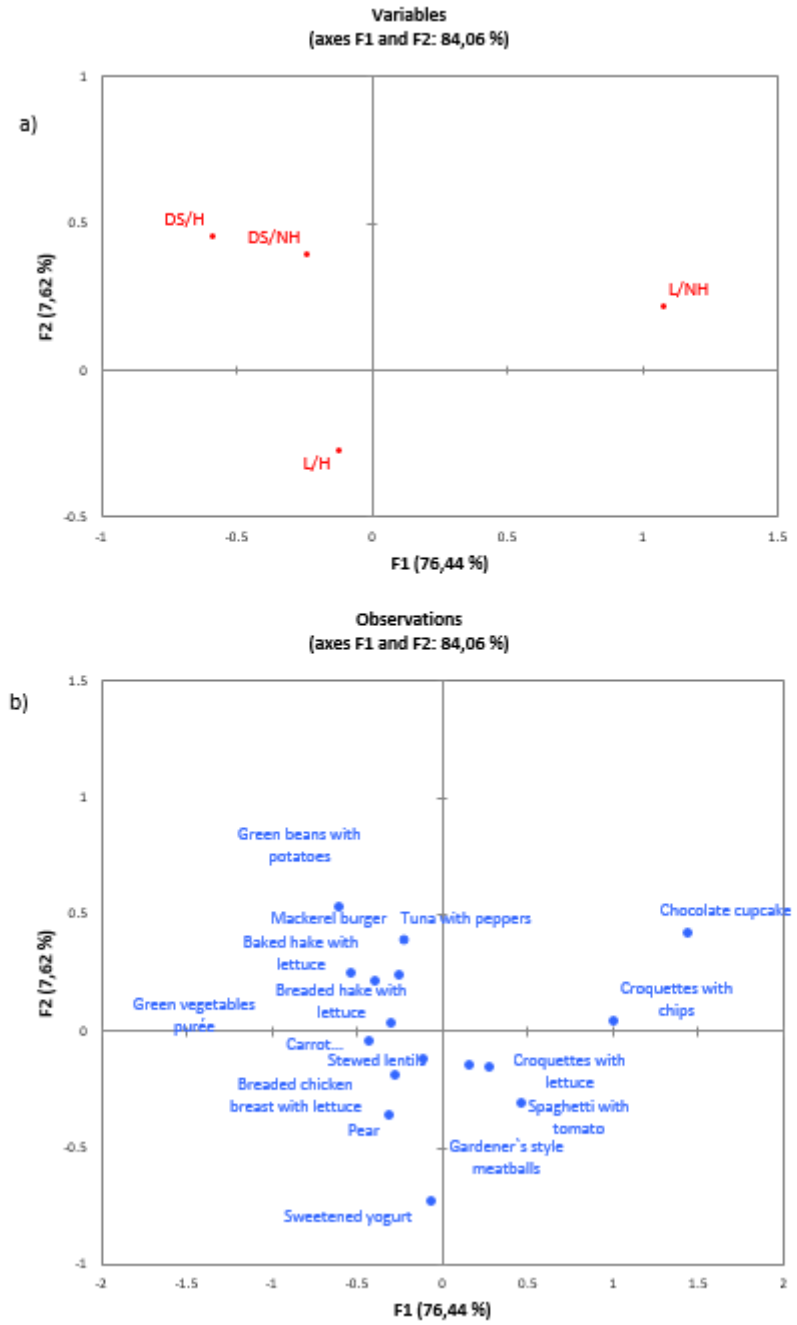


Figure 3. (a) Variables plot of the two first factors of the Multiple Correspondence Analysis of the sorting task data for the 6-7 years group (b) Product map of the two first factors of the Multiple Correspondence Analysis of the sorting task data for the 6-7-year group.

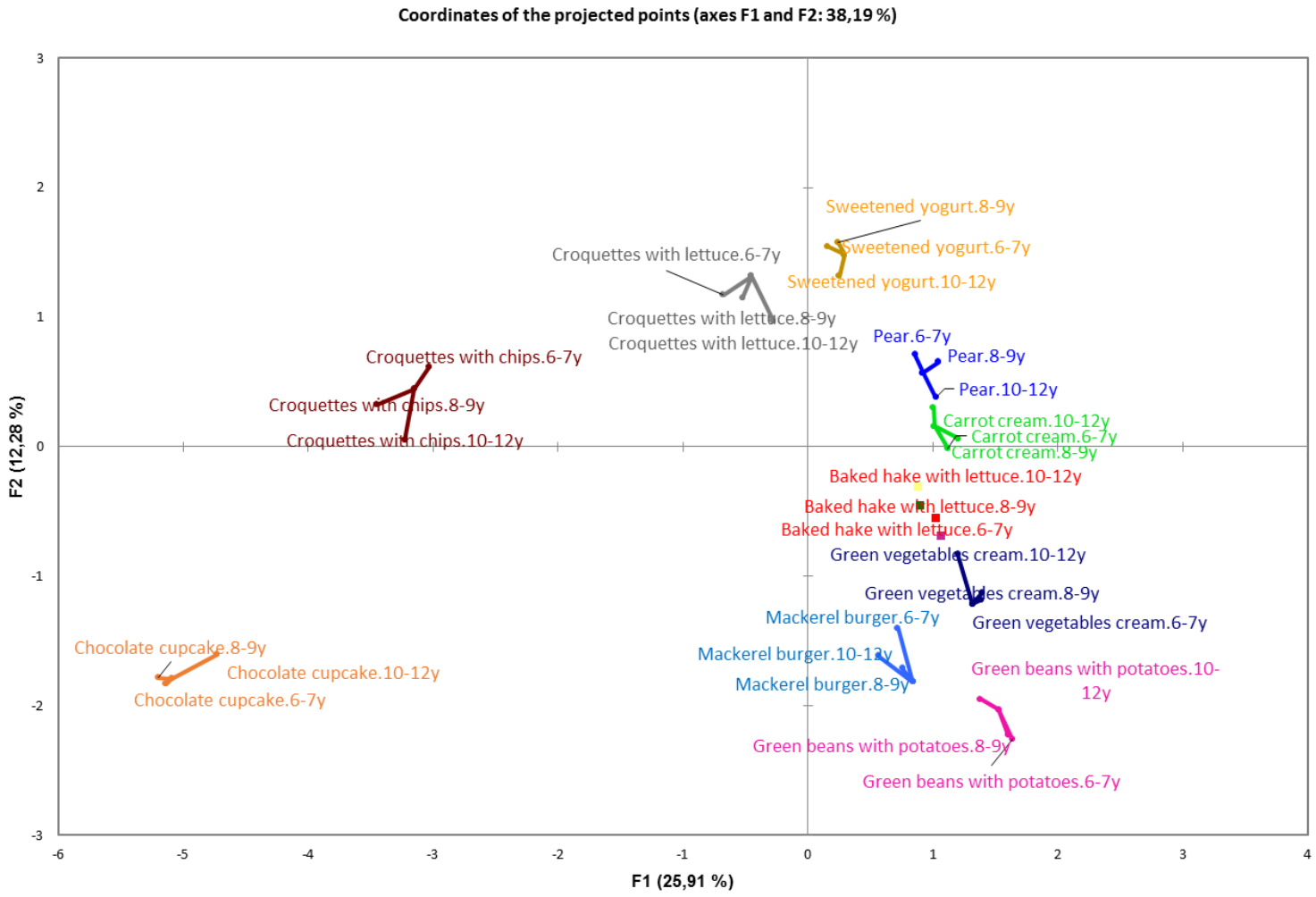


Figure 4. Superimposed representation of the most representative products (10 dishes) in the Multi Factor Analysis (MFA). Each sample is represented using three points corresponding to each age group (6-7, 8-9, 10-12 years old), the consensus representation is depicted by the middle point.

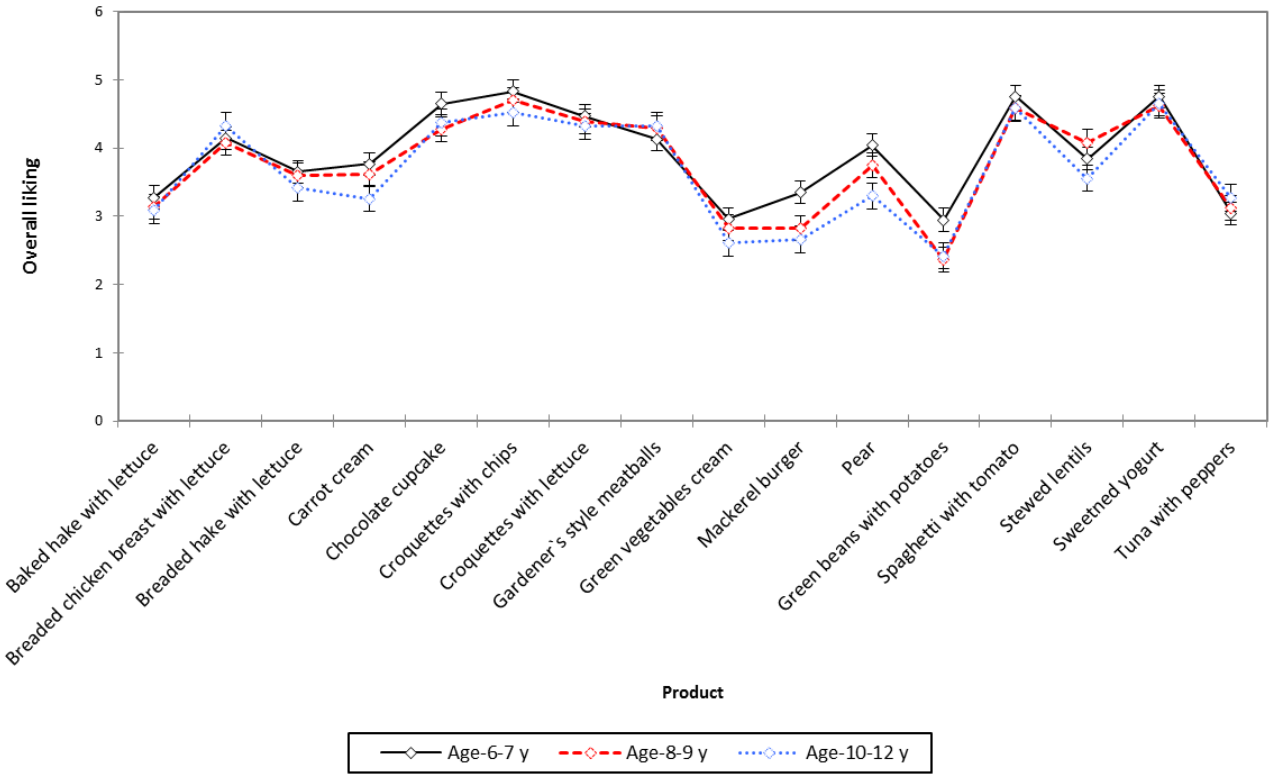


Figure 5. Interaction plot from ANOVA applied to the overall liking score for each meal and age. Error bars shown are standard error of mean.

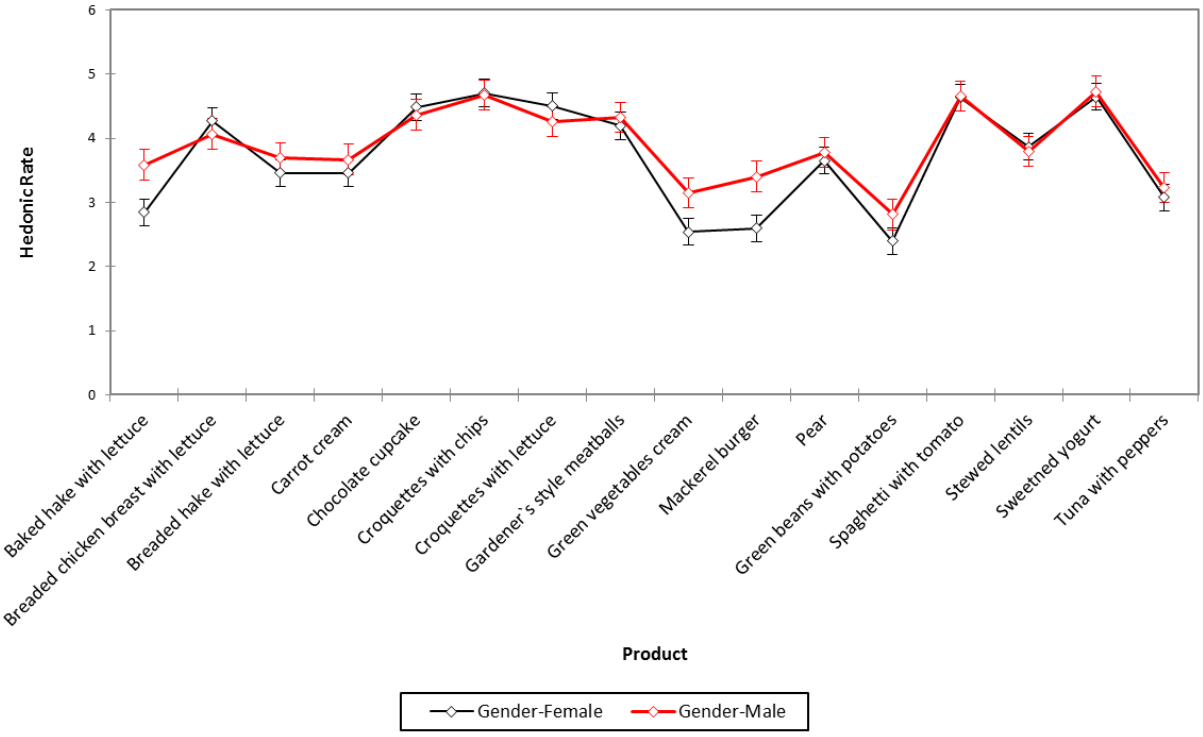
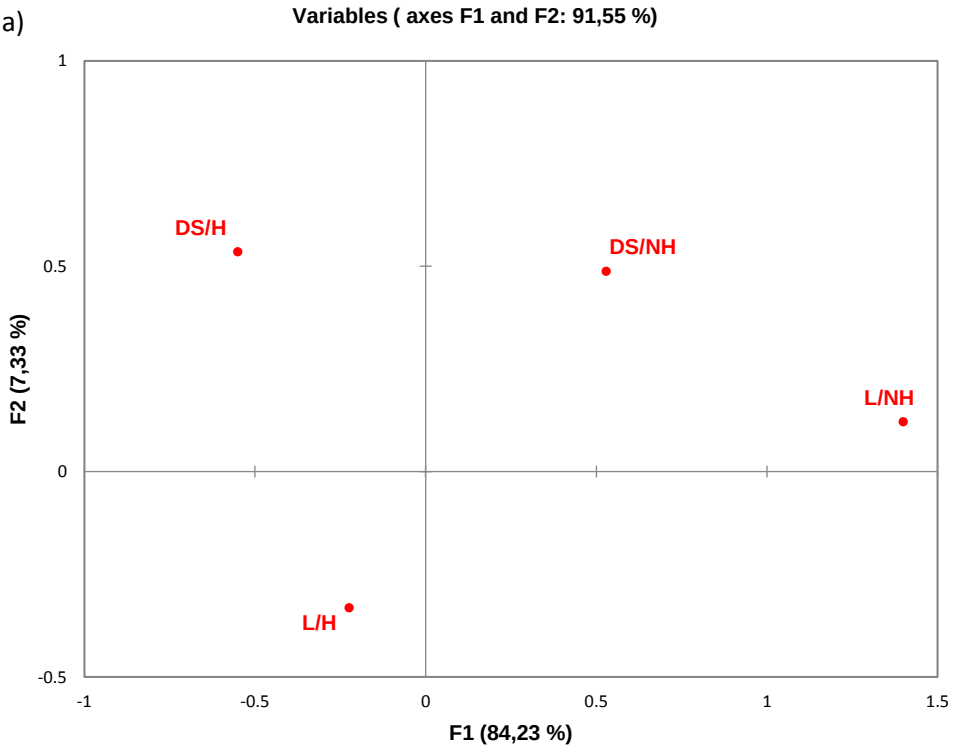
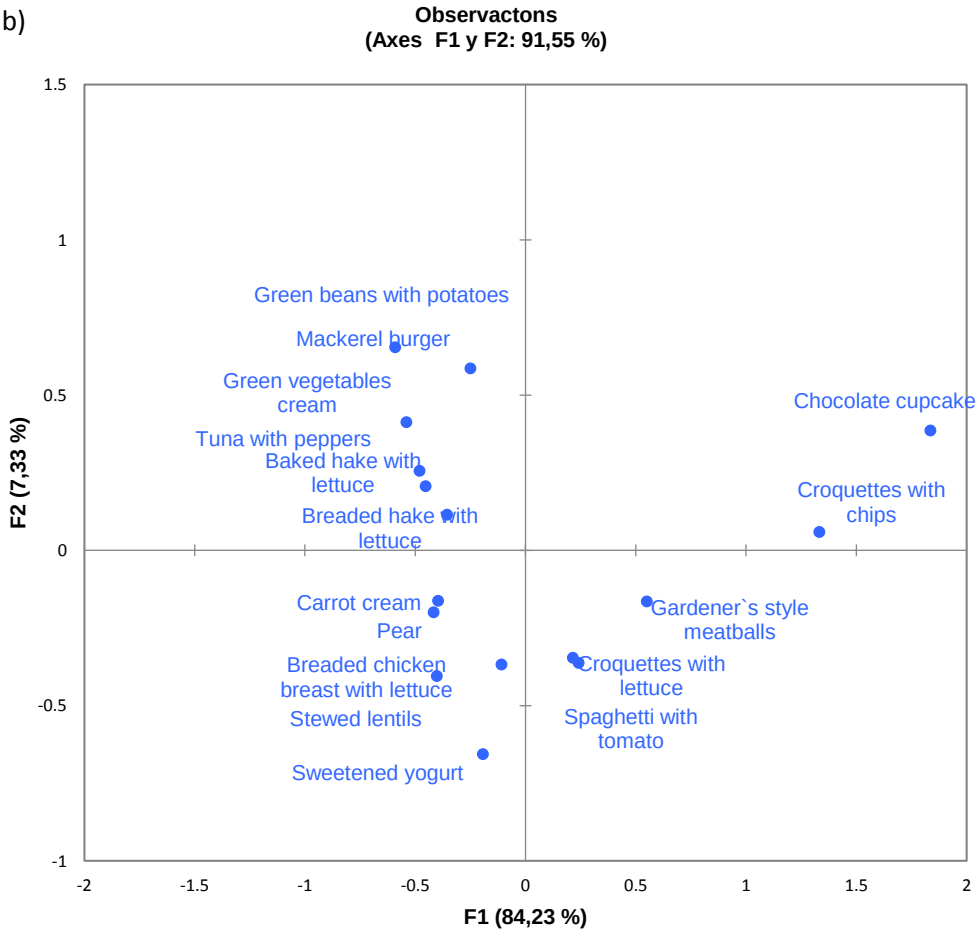


Figure 6. Interaction plot from ANOVA applied to the overall liking score for each meal and gender. Error bars shown are standard error of mean.

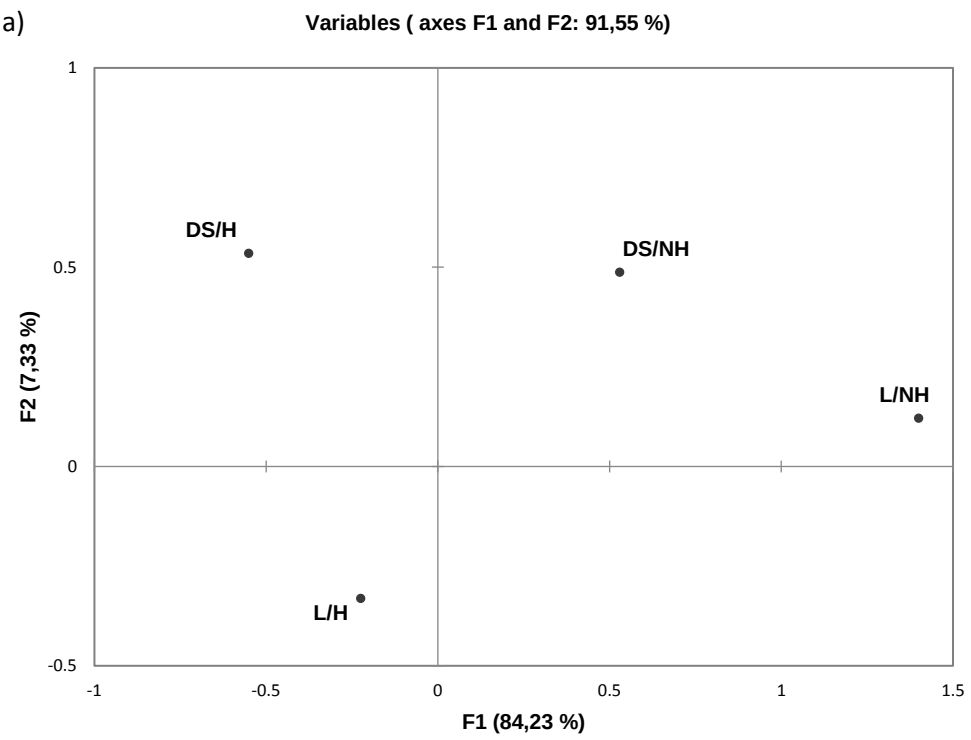
a)


Variables (axes F1 and F2: 91,55 %)
DS/H
DS/NH
L/NH
L/H
F2 (7,33 %)
F1 (84,23 %)
1
0.5
0
-0.5
-1
-0.5
0
0.5
1
1.5

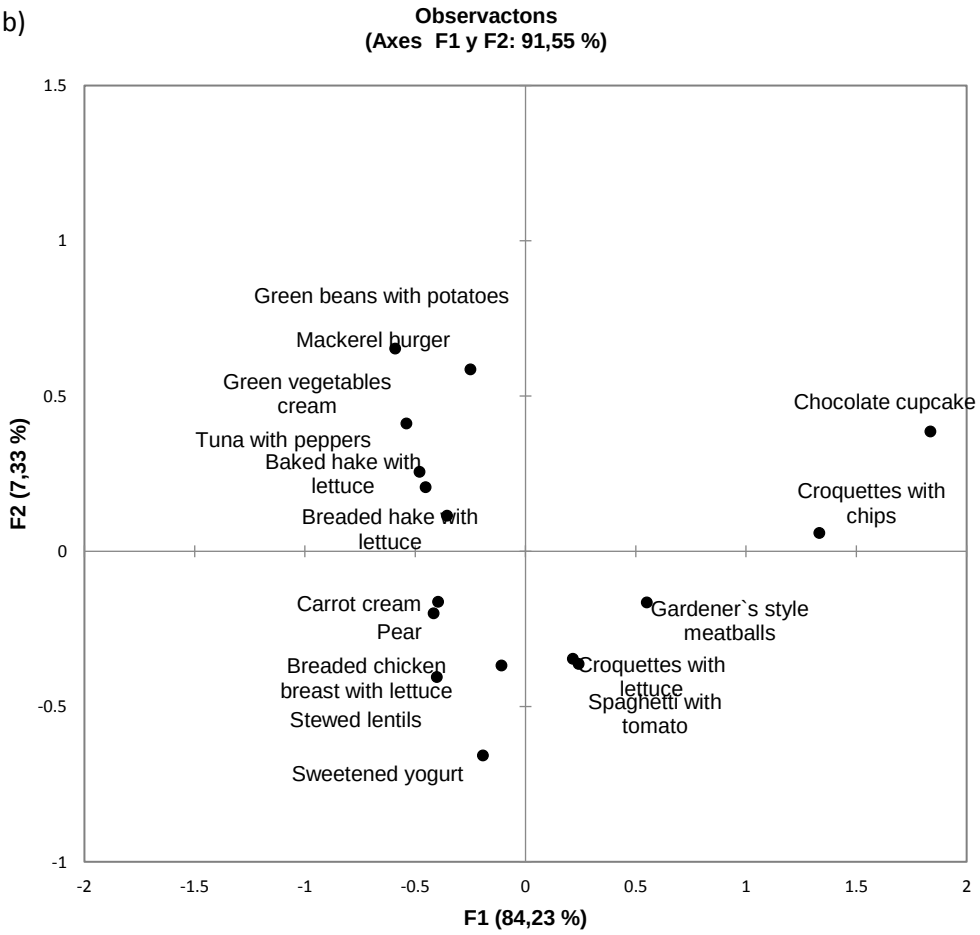
b)


Observactons
(Axes F1 y F2: 91,55 %)
Green beans with potatoes
Mackerel burger
Green vegetables cream
Tuna with peppers
Baked hake with lettuce
Breaded hake with lettuce
Chocolate cupcake
Croquettes with chips
Carrot cream
Pear
Breaded chicken breast with lettuce
Stewed lentils
Sweetened yogurt
Gardener`s style meatballs
Croquettes with lettuce
Spaghetti with tomato
F2 (7,33 %)
F1 (84,23 %)
1.5
1
0.5
0
-0.5
-1
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2

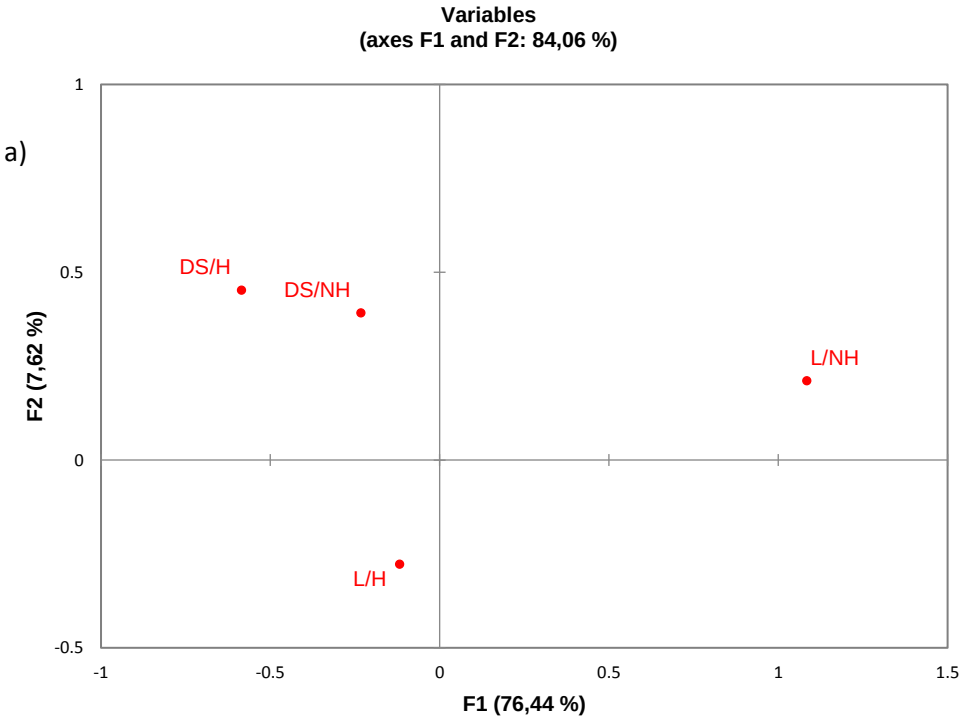
a)


Variables (axes F1 and F2: 91,55 %)
DS/H
DS/NH
L/NH
L/H
F2 (7,33 %)
F1 (84,23 %)
1
0.5
0
-0.5
-1
-0.5
0
0.5
1
1.5

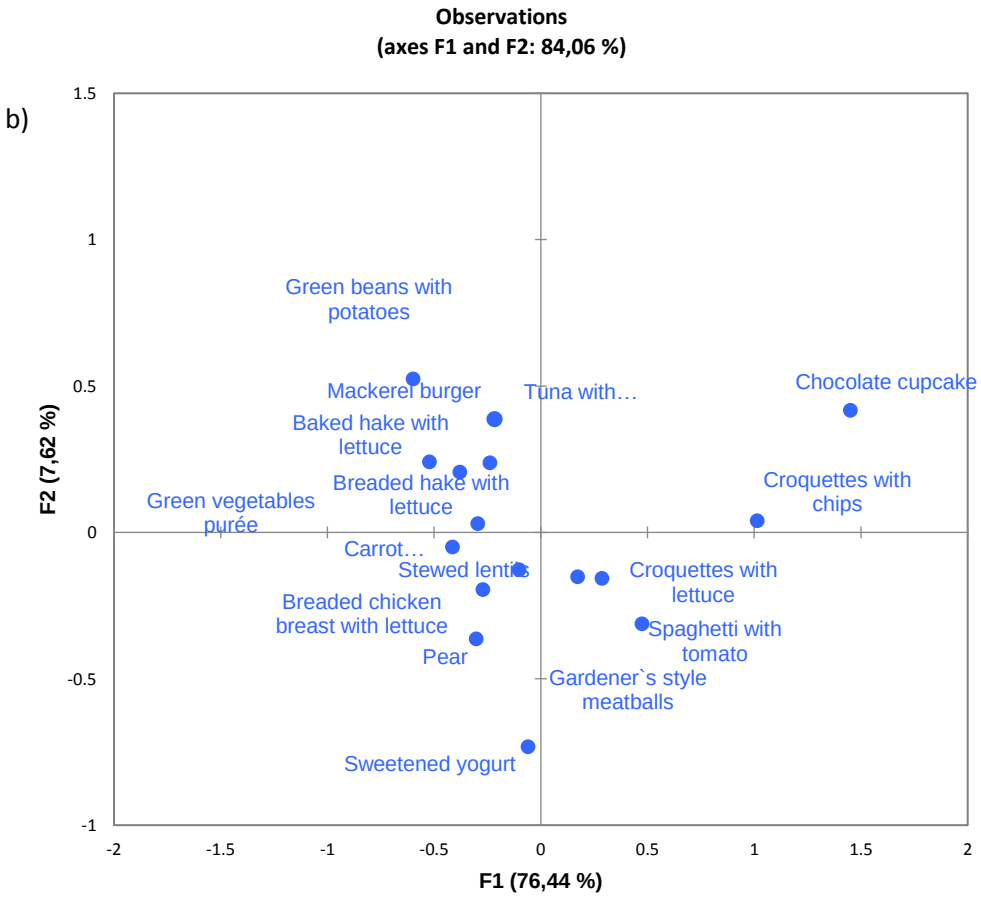
b)


Observactons
(Axes F1 y F2: 91,55 %)
Green beans with potatoes
Mackerel burger
Green vegetables cream
Tuna with peppers
Baked hake with lettuce
Breaded hake with lettuce
Chocolate cupcake
Croquettes with chips
Carrot cream
Pear
Breaded chicken breast with lettuce
Stewed lentils
Sweetened yogurt
Gardener`s style meatballs
Croquettes with lettuce
Spaghetti with tomato
F2 (7,33 %)
F1 (84,23 %)
1.5
1
0.5
0
-0.5
-1
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2

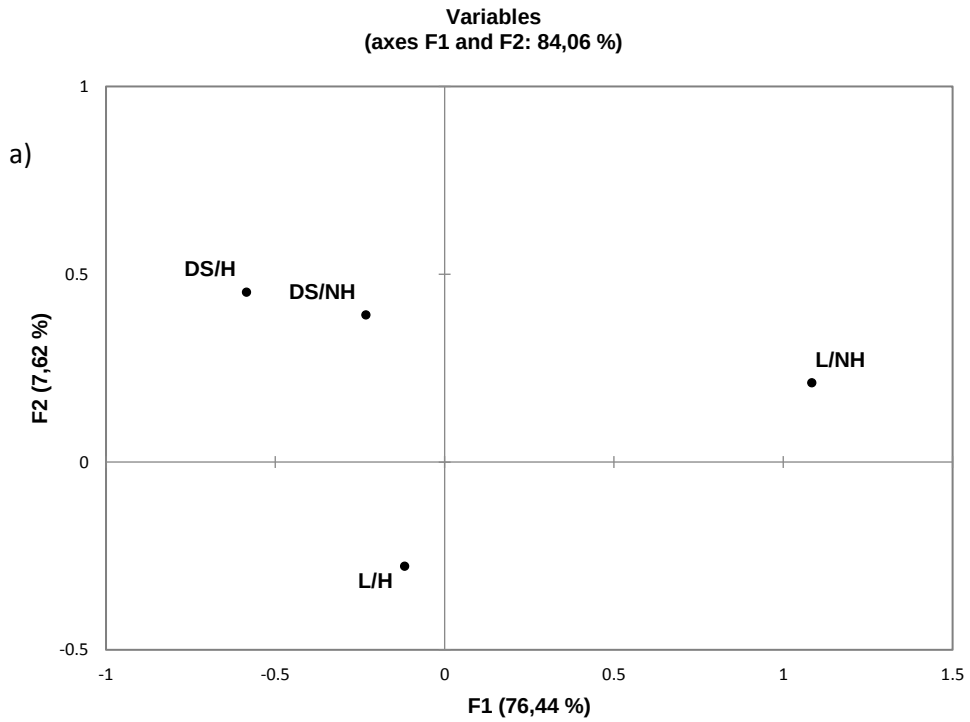
a)


Variables
(axes F1 and F2: 84,06 %)
DS/H
DS/NH
L/NH
L/H
F2 (7,62 %)
F1 (76,44 %)
1
0.5
0
-0.5
-1
-0.5
0
0.5
1
1.5

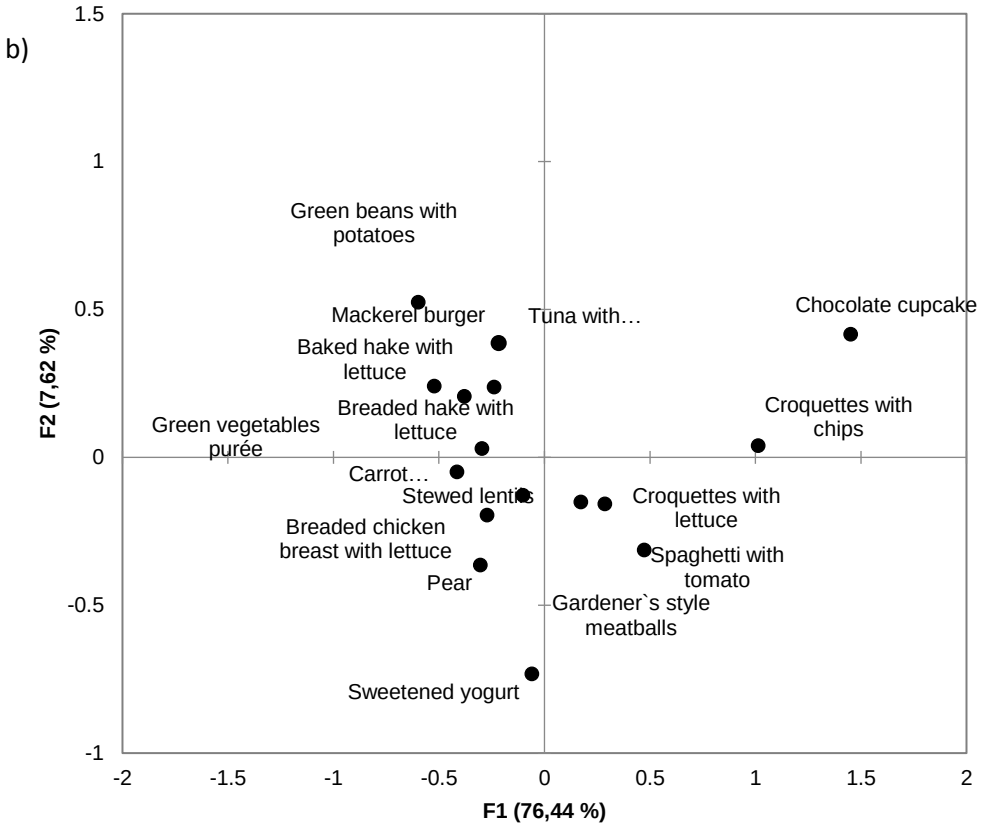
b)

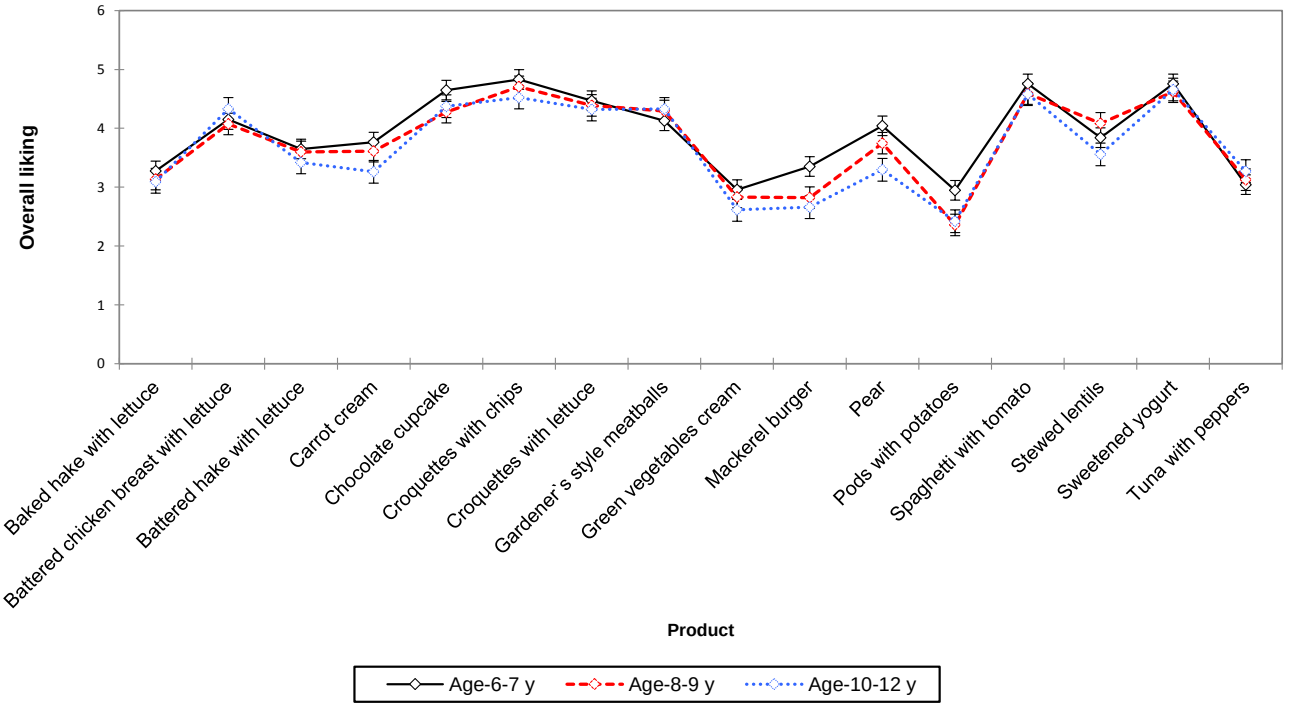

Observations
(axes F1 and F2: 84,06 %)
Green beans with potatoes
Mackerel burger
Tuna with…
Chocolate cupcake
Baked hake with lettuce
Breaded hake with lettuce
Croquettes with chips
Green vegetables purée
Carrot…
Stewed lentils
Croquettes with lettuce
Breaded chicken breast with lettuce
Spaghetti with tomato
Pear
Gardener`s style meatballs
Sweetened yogurt
F2 (7,62 %)
F1 (76,44 %)
1.5
1
0.5
0
-0.5
-1
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2

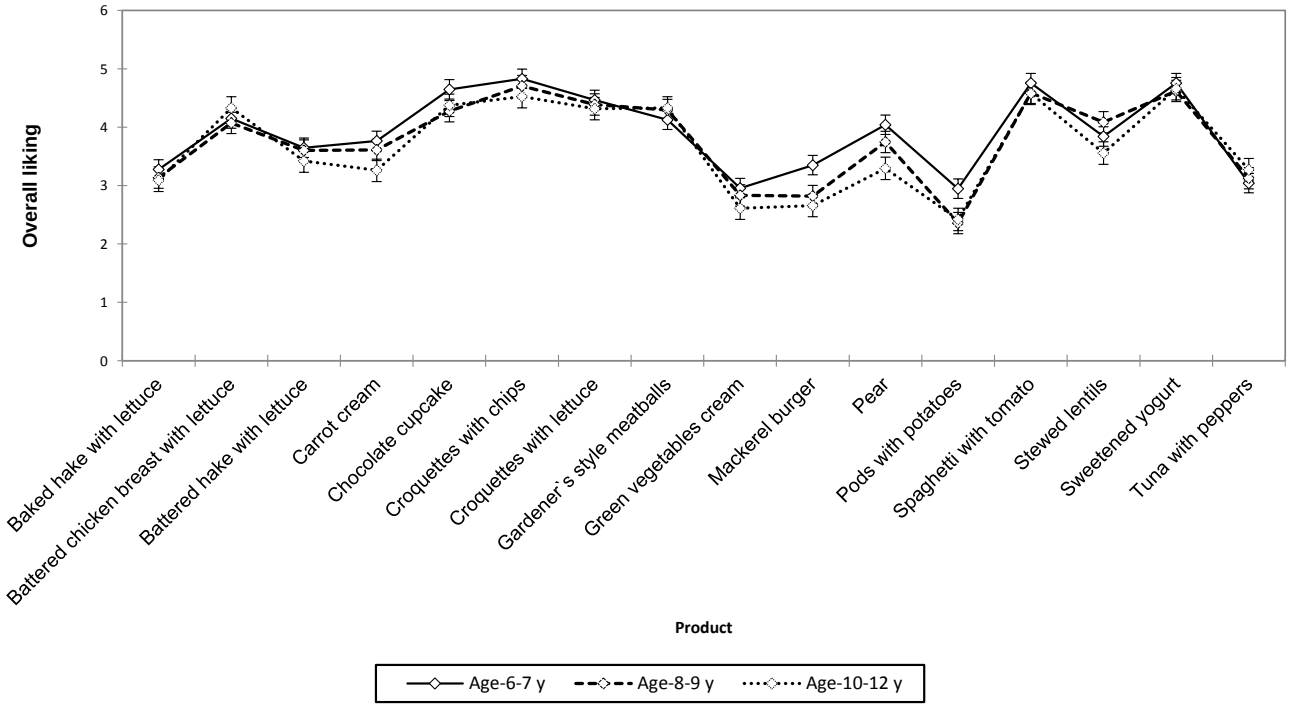
a)

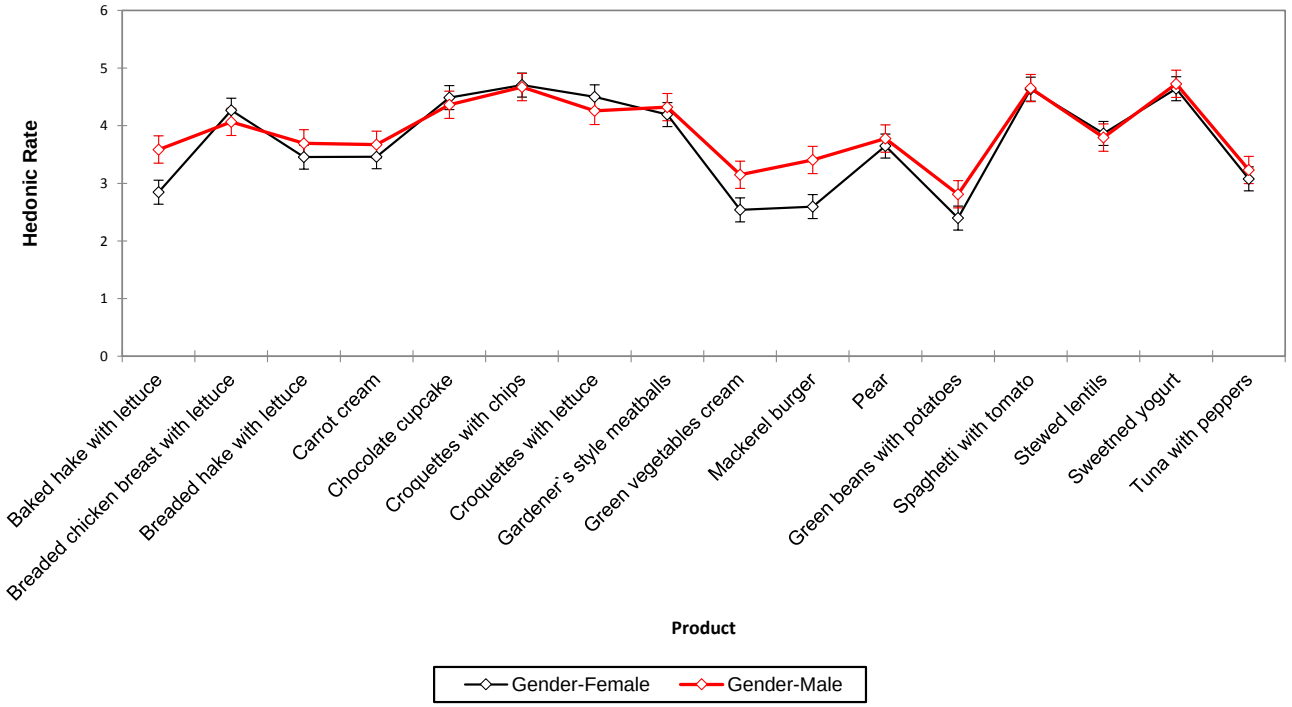

Variables
(axes F1 and F2: 84,06 %)
DS/H
DS/NH
L/NH
L/H
F2 (7,62 %)
F1 (76,44 %)
1
0.5
0
-0.5
-1
-0.5
0
0.5
1
1.5

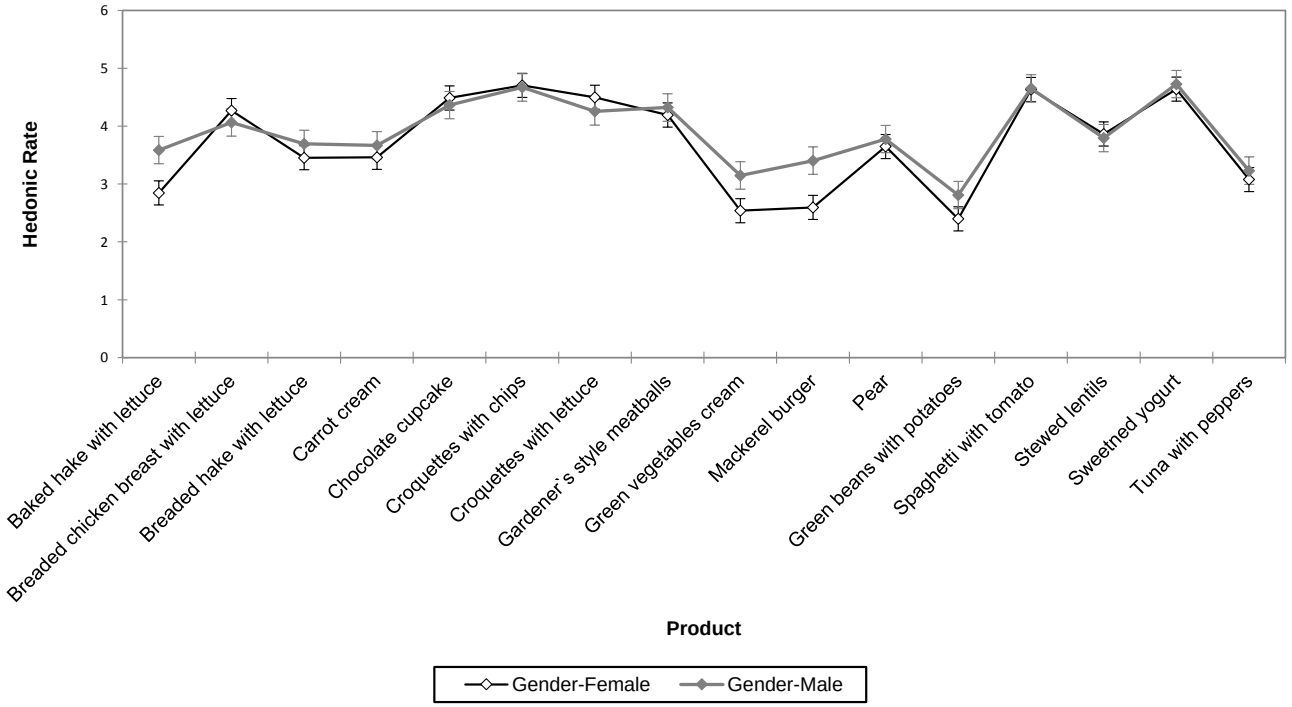
b)

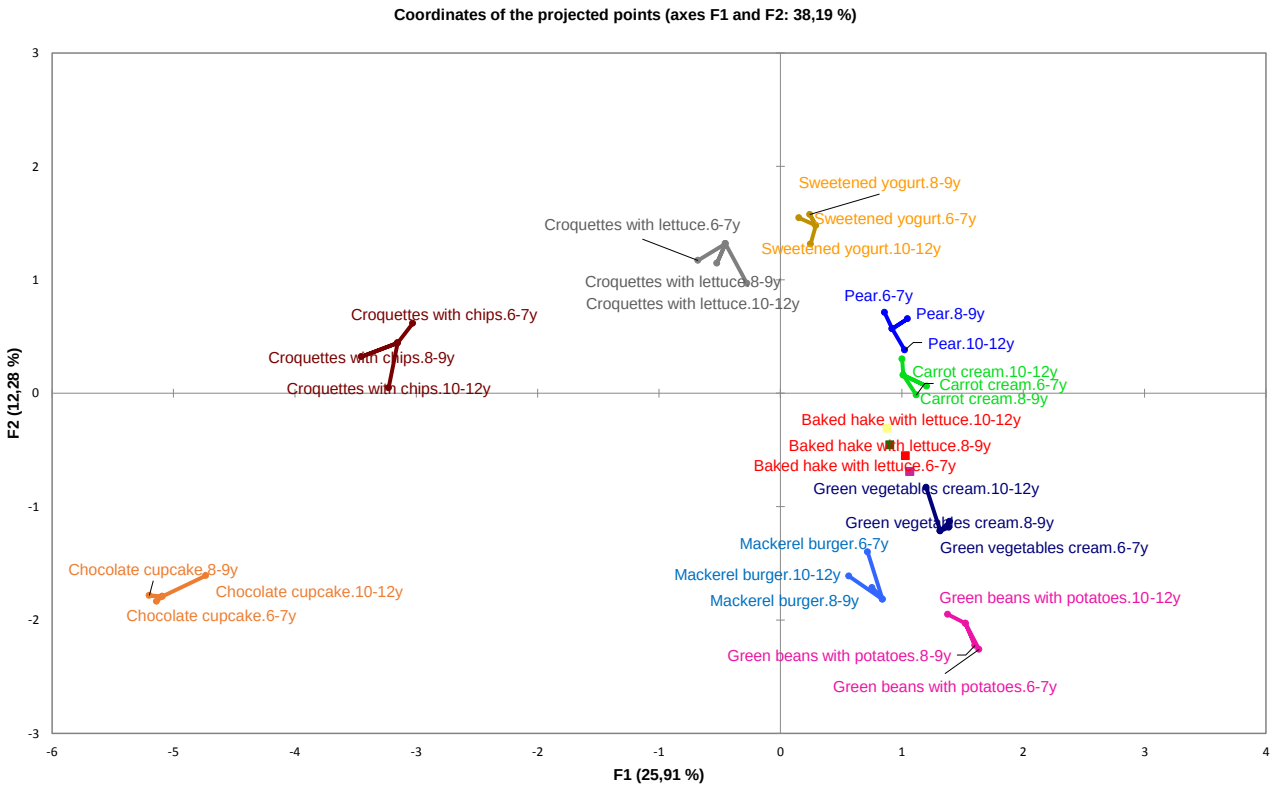

Observations
(axes F1 and F2: 84,06 %)
Green beans with potatoes
Mackerel burger
Tuna with…
Chocolate cupcake
Baked hake with lettuce
Breaded hake with lettuce
Croquettes with chips
Green vegetables purée
Carrot…
Stewed lentils
Croquettes with lettuce
Breaded chicken breast with lettuce
Spaghetti with tomato
Pear
Gardener`s style meatballs
Sweetened yogurt
F2 (7,62 %)
F1 (76,44 %)
1.5
1
0.5
0
-0.5
-1
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2

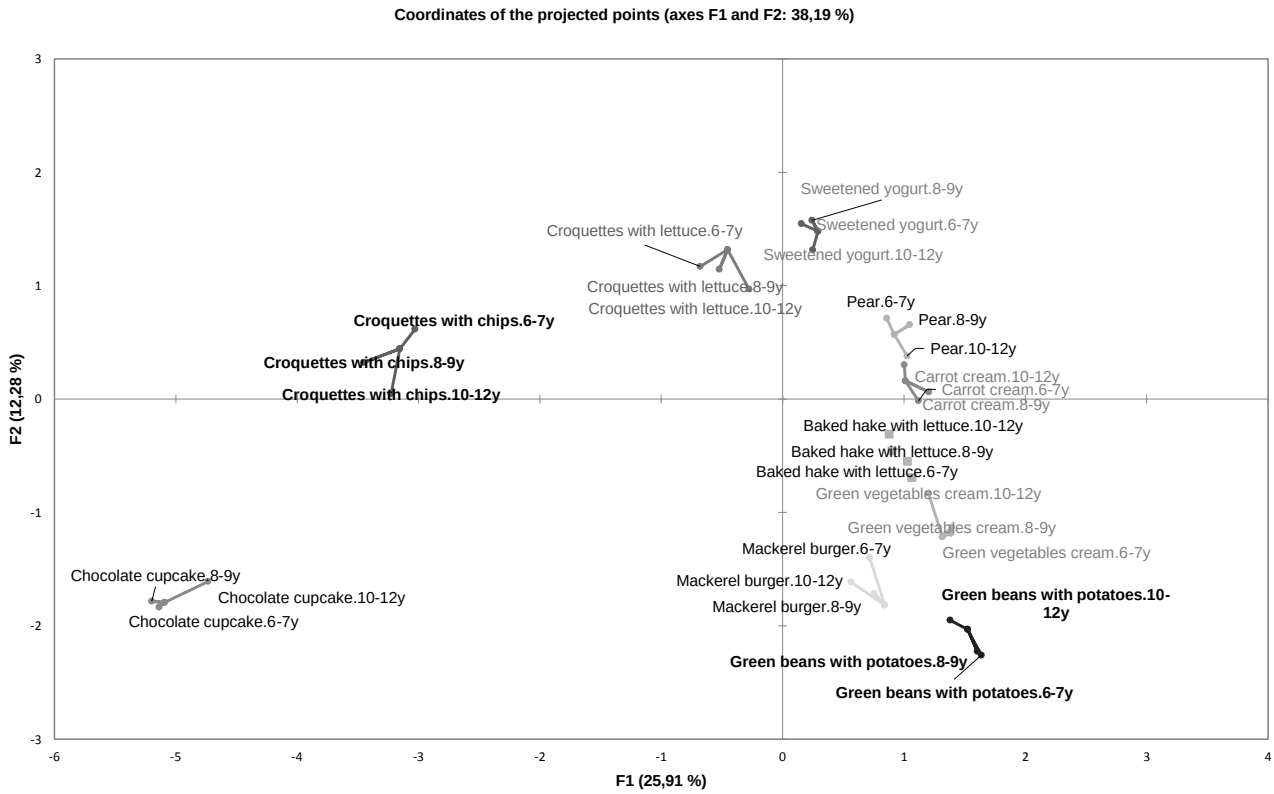

Overall liking
6
5
4
3
2
1
0
Baked hake with lettuce
Battered chicken breast with lettuce
Battered hake with lettuce
Carrot cream
Chocolate cupcake
Croquettes with chips
Croquettes with lettuce
Gardener´s style meatballs
Green vegetables cream
Mackerel burger
Pear
Pods with potatoes
Spaghetti with tomato
Stewed lentils
Sweetened yogurt
Tuna with peppers
Product
Age-6-7 y
Age-8-9 y
Age-10-12 y


Overall liking
6
5
4
3
2
1
0
Baked hake with lettuce
Battered chicken breast with lettuce
Battered hake with lettuce
Carrot cream
Chocolate cupcake
Croquettes with chips
Croquettes with lettuce
Gardener´s style meatballs
Green vegetables cream
Mackerel burger
Pear
Pods with potatoes
Spaghetti with tomato
Stewed lentils
Sweetened yogurt
Tuna with peppers
Product
Age-6-7 y
Age-8-9 y
Age-10-12 y


Hedonic Rate
6
5
4
3
2
1
0
Baked hake with lettuce
Breaded chicken breast with lettuce
Breaded hake with lettuce
Carrot cream
Chocolate cupcake
Croquettes with chips
Croquettes with lettuce
Gardener´s style meatballs
Green vegetables cream
Mackerel burger
Pear
Green beans with potatoes
Spaghetti with tomato
Stewed lentils
Sweetned yogurt
Tuna with peppers
Product
Gender-Female
Gender-Male


Hedonic Rate
6
5
4
3
2
1
0
Baked hake with lettuce
Breaded chicken breast with lettuce
Breaded hake with lettuce
Carrot cream
Chocolate cupcake
Croquettes with chips
Croquettes with lettuce
Gardener´s style meatballs
Green vegetables cream
Mackerel burger
Pear
Green beans with potatoes
Spaghetti with tomato
Stewed lentils
Sweetned yogurt
Tuna with peppers
Product
Gender-Female
Gender-Male


Coordinates of the projected points (axes F1 and F2: 38,19 %)
F2 (12,28 %)
F1 (25,91 %)
3
2
1
0
-1
-2
-3
-6
-5
-4
-3
-2
-1
0
1
2
3
4
Sweetened yogurt.8-9y
Sweetened yogurt.6-7y
Sweetened yogurt.10-12y
Croquettes with lettuce.6-7y
Croquettes with lettuce.8-9y
Croquettes with lettuce.10-12y
Pear.6-7y
Pear.8-9y
Pear.10-12y
Croquettes with chips.6-7y
Croquettes with chips.8-9y
Croquettes with chips.10-12y
Carrot cream.10-12y
Carrot cream.6-7y
Carrot cream.8-9y
Baked hake with lettuce.10-12y
Baked hake with lettuce.8-9y
Baked hake with lettuce.6-7y
Green vegetables cream.10-12y
Green vegetables cream.8-9y
Green vegetables cream.6-7y
Mackerel burger.6-7y
Mackerel burger.10-12y
Mackerel burger.8-9y
Chocolate cupcake.8-9y
Chocolate cupcake.10-12y
Chocolate cupcake.6-7y
Green beans with potatoes.10-12y
Green beans with potatoes.8-9y
Green beans with potatoes.6-7y


Coordinates of the projected points (axes F1 and F2: 38,19 %)
F2 (12,28 %)
F1 (25,91 %)
3
2
1
0
-1
-2
-3
-6
-5
-4
-3
-2
-1
0
1
2
3
4
Sweetened yogurt.8-9y
Sweetened yogurt.6-7y
Sweetened yogurt.10-12y
Croquettes with lettuce.6-7y
Croquettes with lettuce.8-9y
Croquettes with lettuce.10-12y
Croquettes with chips.6-7y
Croquettes with chips.8-9y
Croquettes with chips.10-12y
Pear.6-7y
Pear.8-9y
Pear.10-12y
Carrot cream.10-12y
Carrot cream.6-7y
Carrot cream.8-9y
Baked hake with lettuce.10-12y
Baked hake with lettuce.8-9y
Baked hake with lettuce.6-7y
Green vegetables cream.10-12y
Green vegetables cream.8-9y
Green vegetables cream.6-7y
Mackerel burger.6-7y
Mackerel burger.10-12y
Mackerel burger.8-9y
Green beans with potatoes.10-12y
Green beans with potatoes.8-9y
Green beans with potatoes.6-7y
Chocolate cupcake.8-9y
Chocolate cupcake.10-12y
Chocolate cupcake.6-7y

	6-7 years (n=94)				8-9 years (n=95)				10-12 year (n=88)			
Products	**L/H**	**L/NH**	**DS/H**	**DS/NH**	**L/H**	**L/NH**	**DS/H**	**DS/NH**	**L/H**	**L/NH**	**DS/H**	**DS/NH**
First courses												
Stewed lentils	68.09	6.38	22.34	3.19	78.95	1.05	20.00	0.00	67.05	2.27	28.41	2.27
Green vegetables purée	50.00	2.13	39.36	8.51	43.16	1.05	53.68	2.11	36.36	0.00	59.09	4.55
Carrot purée	62.77	3.19	30.85	3.19	67.37	3.16	29.47	0.00	63.64	1.14	32.95	2.27
Green beans with potatoes	37.23	3.19	51.06	8.51	32.63	1.05	64.21	2.11	26.14	0.00	68.18	5.68
Spaghetti with tomato	64.89	31.91	1.06	2.13	66.32	23.16	6.32	4.21	68.18	21.59	4.55	5.68
Second courses												
Croquettes with lettuce	59.57	26.60	8.51	5.32	65.26	24.21	9.47	1.05	67.05	22.73	5.68	4.55
Croquettes with chips	41.49	56.38	1.06	1.06	26.32	68.42	2.11	3.16	22.73	70.45	0.00	6.82
Baked hake with lettuce	50.00	7.45	37.23	5.32	51.58	2.11	43.16	3.16	48.86	0.00	47.73	3.41
Breaded hake with lettuce	57.45	7.45	26.60	8.51	53.68	6.32	38.95	1.05	52.27	4.55	40.91	2.27
Tuna with peppers	46.81	12.77	34.04	6.38	49.47	2.11	46.32	2.11	43.18	3.41	47.73	5.68
Mackerel burger	39.36	14.89	36.17	9.57	31.58	8.42	49.47	10.53	30.68	5.68	48.86	14.77
Breaded chicken breast with lettuce	62.77	12.77	18.09	6.38	72.63	10.53	13.68	3.16	80.68	12.50	6.82	0.00
Gardener`s style meatballs	60.64	22.34	10.64	6.38	51.58	35.79	7.37	5.26	48.86	40.91	5.68	4.55
Fruit/Dessert												
Sweetened yogurt	91.49	7.45	1.06	0.00	87.37	6.32	5.26	1.05	86.36	7.95	4.55	1.14
Pear	76.60	3.19	18.09	2.13	69.47	2.11	28.42	0.00	60.23	0.00	39.77	0.00
Chocolate cupcake	18.09	76.60	1.06	4.26	3.16	86.32	1.05	9.47	4.55	79.55	1.14	14.77

Table 1. Percentage of frequency`s allocation of food products (%) to each of the four pre-selected groups for the three age cohorts.

Source	DF[1]	Sum of squares	Mean squares	F	Pr > F
Gender	1	31.478	31.478	18.357	**< 0.0001**
Age	2	41.185	20.593	12.009	**< 0.0001**
Product	28	2171.667	77.560	45.232	**< 0.0001**
Gender*Age	2	6.004	3.002	1.751	0.174
Gender*Product	28	160.797	5.743	3.349	**< 0.0001**
Age*Product	56	141.102	2.520	1.469	**0.013**

Table 2. Effects of different factors on overall liking for dishes (ANOVA, $p < 0.05$).

[1]DF, degree of freedom.