

1           **Research challenges and methods to study food preferences in school-aged children:**

2                                   **A review of the last 15 years**

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11  
12   **Abstract**

13   Until only a few decades ago, there was little interest in research about children as consumers. Today,  
14   the food market for “the small consumers” is continuously growing and many foods and beverages  
15   are developed specifically for this target group. Furthermore, a better understanding of children's food  
16   preferences could also help design strategies to reduce obesity and malnutrition. The present review  
17   examines the main research domains in which measurement of children’s food preferences are applied  
18   and gives an overview of the progress made during the last 15 years in the field of consumer testing  
19   with children, highlighting the need of investigating and using new methods in addition to existing  
20   ones. Attention is also devoted to the choice of specific methods according to the child’s age.

21   An intense interest in consumer and sensory research with children is demonstrated by the systematic  
22   increase of scientific publications on this topic. A shift in research methodology has been observed  
23   in the last 15 years, being research more focused on feeding behavior and healthy eating. Recent  
24   investigations confirm that children in the age range of 4–11 years are able to perform most traditional  
25   consumer tests in addition to more sophisticated methods (e.g. projective mapping, memory and  
26   emotion evaluation) if age-appropriate procedures are adopted.

27

28 **Keywords:** consumer testing, food acceptability, male and female children, healthy eating, memory,

29 emotion, wanting, observational studies

30

## 31 1. Introduction

32 Traditionally, there has been relatively little interest in children's food preferences. However,  
33 considering that food market for children is continuously growing, a wide variety of foods and  
34 beverages has been developed for this younger target group. In fact, children greatly influence  
35 purchases or even buy food themselves, and accordingly, the interest of food companies towards  
36 children in product development programs seems justified (Laureati, Pagliarini, Mojet, & Köster,  
37 2011). Developing products for children requires their input since their wants and needs differ from  
38 those of adults. Differences in preferences or sensory acuity between children and adults, or both, are  
39 well established (de Graaf & Zandstra, 1999; Drewnowski, 1997; Liem, Mars, de Graaf, 2004;  
40 Zandstra & De Graaf, 1998). Literature data have reported marked age-related differences in sweet  
41 taste discrimination and preference (Liem et al., 2004) as well as in sour taste preference (Liem &  
42 Mennella, 2003). Likewise, texture preference has been found to vary from childhood to adulthood  
43 (Lukasewycz & Mennella, 2012; Zeindstra, Koele, Kok & de Graaf, 2010). Therefore, it is impossible  
44 to predict the nature of these differences without actual information from the intended target group.  
45 Furthermore, a better understanding of children's food preferences could also help design strategies  
46 to reduce obesity and malnutrition. Recently, international guidelines have been established on  
47 prevention and control of the so-called non-communicable diseases, with specific emphasis on  
48 childhood obesity (WHO, 2012). Several actions are proposed, one of which is aimed at shaping taste  
49 preferences from an early age through information and awareness campaigns addressed towards  
50 schools, families, and childhood aggregation centers. Food preferences, particularly in children  
51 (Birch, 1999; Laureati et al., 2015b), are indeed believed to play a central role in the prediction of  
52 human food choices (Drewnowski, 1997; Köster, 2009). In this context, sensory preferences and thus  
53 the methods used to explore them, play a key role for understanding the food behavior of children  
54 and directing them towards healthier food choices.

55 The sensory methods used with children have been reviewed by Guinard (2001) and Popper & Kroll  
56 (2005). In these two review articles, the authors stressed the importance of using methods that are  
57 appropriate for different age groups, considering the sensory, cognitive and social factors that may  
58 impact testing with children. These issues are also included in the recently revised international  
59 standard guideline on sensory evaluation by children and minors (ASTM, 2013).

60 Starting from these two articles, the present review firstly reconstructs the framework regarding the  
61 study of children's preferences from 1980 to 2000. Next, the progress made from 2000 to 2015 in the  
62 field of consumer testing (i.e. study of liking and preference) with children is examined with the aim  
63 of identifying the main research domains and to show trends in application of consumer research with  
64 children also in terms of new methods used, either together or in addition to existing ones. Specific  
65 attention is also devoted to the appropriateness of methods according to children's age.

## 66

## 67 **2. Research domains for conducting sensory testing with children**

68 A search for relevant papers and categorization of the research challenges of food sensory studies on  
69 children is not an easy task since it is a highly multidisciplinary and heterogeneous area. Some  
70 considerations may come from the number of cited papers in two relevant databases: Scopus (science,  
71 technology, health, medicine, social sciences, arts and humanities) and Pubmed (more related with  
72 health and medicine).

73 Considering the keywords "children food preferences" or "children food sensory" from 2000 to 2014,  
74 without applying any filter, Scopus (<http://www.scopus.com/>) returned 3172 documents and Pubmed  
75 (<http://www.ncbi.nlm.nih.gov/pubmed>) 1812; the increase over time is almost linear for both  
76 databases with similar peaks in 2008 and 2012. The number of published papers increased  
77 approximately 4.1-fold (Scopus) and 4.6-fold (Pubmed) from 2000 to 2014 (**Figure 1**). In 2013, there  
78 was a decrease in the number of publications (ratio of publication 2013/2012=0.8), confirmed by the  
79 same trend in 2014.

80 Looking at the subject areas present in databases, around one-third or one-fourth of the cited papers  
81 concern “Health and Medicine”, and it would appear that the sensory research on children has  
82 “Medicine” and “Nursing” as main subject areas (Scopus), followed by “Agricultural and Biological  
83 Sciences” even if many other areas have contributed to the increase in the number of publications  
84 during the period analyzed.

85 Articles were further categorized to identify specific research topics. To do so, after the initial search  
86 with the main keywords “children food preferences” or “children food sensory”, an additional search  
87 was made sorting papers by subject areas and keywords retrieved by databases. Following this  
88 approach, publications were grouped according to 7 main research areas as seen below:

- 89 1. Feeding behaviour (medicine, nutrition, psychology, education, sociology, food science)
- 90 2. Eating disorders (medicine, nutrition, psychology)
- 91 3. Healthy eating and nutrition education (medicine, nutrition, psychology and education)
- 92 4. Sensory perception (medicine, psychology, food science)
- 93 5. Consumer science (food science, economy)
- 94 6. Food quality (food science)
- 95 7. Food safety/prevention (food science, medicine)

96 A schematic overview of the 7 research areas and the links between them is depicted in Figure 2. In  
97 this conceptual map, the areas are represented as oval spots and their surface is reported roughly  
98 proportional to the number (of the total of about 3000 papers reported by Scopus) of manuscripts  
99 categorized by each; it should be considered that, due to the highly multidisciplinary topic, many  
100 articles are linked to or belong to more than one research area. The core and multidisciplinary  
101 challenge, in terms of the highest number of publications and cross relation with the other research  
102 areas, is the study of “feeding behaviour” (more than one-third of publications), which is radially  
103 connected by specific and characterizing groups of keywords with the other four main research areas,  
104 respectively, in a clockwise direction, from the top left of Figure 2: “eating disorders”, “healthy  
105 eating, nutrition education”, “consumer science” and “sensory perception”. On a second level, in

106 terms of the amount of related research, the challenge of the “food quality” is mainly, but not  
107 exclusively, linked with “sensory perception” and “consumer science”; “food quality” is related to a  
108 small and recent area in which sensory and preferences studies on children are associated with “food  
109 safety and prevention”, e.g. risk perception of school food consumption (Kim, Kim, Park, Kang,  
110 Hwang, & Rhee, 2015). Starting from this framework, the present review focuses on the studies  
111 dealing with consumer science involving children. The following chapters examine the “healthier  
112 shift” taken from 1980 to 2015 in terms of research drivers and analyse the main methods used in  
113 consumer testing with children over the last 15 years.

114

### 115 **3. Trends in consumer testing with children from 1980 to 2015: towards a healthier direction**

116 The trend in the application of sensory and consumer testing with children from 1980 to 2015 is  
117 shown in Figure 3. Information about research challenges and methodologies from 1980 to 1999 is  
118 based on the analysis of the last two review articles by Guinard (2001) and Popper and Kroll (2005),  
119 whereas information about research conducted from 2000 till present is the result of a thorough  
120 analysis of the articles selected in the present paper.

121 In the last decades, a great deal of effort has been made to develop sensory methods that are suitable  
122 for children. More specifically, from 1980 to 1999 attention was essentially devoted to the discovery  
123 of methods that were appropriate for specific age groups and to apply such methods to find food  
124 formulations that met children’s expectations. These techniques were mainly hedonic methods,  
125 although simple discriminant methods were also adopted.

126 Reviewing the literature on consumer testing with children during the last 15 years, a shift in research  
127 orientations can be clearly observed. In the 21st century, studies have mainly focused on healthy  
128 eating habits among young consumers. Sensory and hedonic methods are applied with the main  
129 purpose of food optimization to develop healthier options that are liked by children. To address this  
130 issue traditional methods are often found in the literature, although new approaches have been  
131 suggested and successfully applied with children. These new methods, which will be discussed in

132 section 4, consist mainly in projective mapping, sorting techniques and indirect approaches to explore  
133 implicitly food preferences.

134 According to this shift in research orientation, and in agreement with research areas shown in the  
135 conceptual map (Figure 2), most of the publications related to consumer testing with children in the  
136 21<sup>th</sup> century have dealt with the topic of increasing acceptance and consumption of fruits and  
137 vegetables (F&V) through food educational programs (Healthy eating, Nutrition and Education)  
138 (Laureati, Bergamaschi & Pagliarini, 2014; Olsen, Ritz, Kraaij & Møller, 2012b; Reverdy, Schlich,  
139 Köster, Ginon & Lange, 2010) or by using specific preparation methods (Poelman & Delahunty, 2011;  
140 Poelman, Delahunty & de Graaf, 2013; Rohlf's Dominguez et al., 2013; Zeinstra et al., 2010). Other  
141 studies have attempted to find the most age-appropriate procedure to investigate aspects (e.g. food  
142 neophobia) related to low consumption of F&V (Laureati, Bergamaschi & Pagliarini, 2015a) or  
143 investigate the relationship between children's food preferences, sensory sensitivity, and nutritional  
144 status (e.g. BMI) (Feeney, O'Brien, Scannell, Markey & Gibney, 2014; Hartvig, Hausner, Wendin,  
145 & Bredie, 2014; Hill, Wardle & Cooke, 2009; Laureati et al., 2015b; Suomela et al., 2012).

146 Several studies have also focused on product development or optimization of food formulations  
147 destined for children (Food Quality, Consumer Science). These studies are linked with healthy choice  
148 as well since they are mainly focused on finding new strategies for changing children's preferences  
149 towards a more healthy direction. This is achieved by manipulating the fat content in food  
150 formulations (Kildegaard, Løkke & Thybo, 2011a; Olsen, van Belle, Meyermann & Keller, 2011) or  
151 by studying the sensory aspects that best correlate with children's acceptance of fruits (Kühn & Thybo,  
152 2001; Thybo, Kühn & Martens, 2003; Torrieri, Di Monaco, Cavella & Masi, 2008), vegetables  
153 (Brueckner, Schonhof, Schroedter & Kornelson, 2007), and whole-grain bakery products (Delk &  
154 Vickers, 2007). In the context of food product development, several studies have focused on  
155 optimization of school meals (Caporale, Policastro, Tuorila & Monteleone, 2009; Donadini, Fumi,  
156 Vanoni & Porretta, 2012; Donadini, Fumi & Porretta, 2013; Hausner, Hartvig, Reinbach, Wendin &  
157 Bredie, 2012; Lakkakula, Geaghan, Zanovec, Pierce & Tuuri, 2010; Pagliarini, Ratti, Balzaretto &

158 Dragoni, 2003; Pagliarini, Gabbiadini & Ratti, 2005), indicating a certain interest in consumer testing  
159 with children in a real eating context. Other investigations have assessed specific sensory aspects (e.g.  
160 taste and flavor) related to food perception (Sensory perception, Consumer Science, Food Quality)  
161 (Lanfer et al., 2013; Liem & Mennella, 2003; Liem, Westerbeek, Wolterink, Kok, & de Graaf, 2004b;  
162 Liem, Zandstra, & Thomas, 2010). Finally, a great deal of interest has been observed for gender-  
163 related differences in food preferences during childhood in terms of comparison according to BMI  
164 (Kimura, Endo, Minamimae, Kanzaki, & Hanaki, 2014) or efficacy of school-based interventions to  
165 increase F&V preference (Cunningham-Sabo & Lohse, 2014).

166 The shift observed in the last 15 years in research orientation is a response to the increased rate of  
167 overweight and obese children worldwide. This phenomenon may in part explain the increased  
168 attention toward children's food preferences and the need of finding new alternative methods to  
169 explore the hedonic dimension of young consumers. Traditional and new approaches used in  
170 consumer testing with children during the last 15 years are reviewed in the following chapter.

171

#### 172 **4. What's new in consumer testing with children? Overview of studies from 2000 to 2015**

173 A selection of studies published between 2000 and 2015 is reported in **Table 1**. We restricted the  
174 search to the journals that typically publish articles presenting methodological advances in sensory  
175 and consumer science or critically discuss sensory methodologies. These journals are Food Quality  
176 and Preference (<http://www.journals.elsevier.com/food-quality-and-preference/>), Appetite, and  
177 Journal of Sensory Studies. We used the keyword "children" within these journals in the period 2000-  
178 2015, we checked the references list within the papers that were returned and then we manually  
179 selected the articles based on the following criteria:

180 1) articles published in English language;

181 2) articles dealing with self-reported consumer testing (either a direct or an indirect measure of  
182 liking/preference) with children (no parental report of the child's acceptability/preference);



183 3) articles involving at least 60 children, except if a smaller number was justified by the methodology  
184 (e.g. observational studies);

185 4) articles involving healthy children (e.g. no diabetes, autism, anorexia or bulimia);

186 5) articles which included children within the age range of 4 to 11 year. This specific age range has  
187 been chosen on the basis of the following criteria: 1) this is a critical period in children's life with  
188 respect to food preference development, since experience with food increases with age as does  
189 autonomy in food selection; 2) it is well established that starting from the age of 4 years, children can  
190 reliably perform most of the sensory tests such as discriminant and hedonic methods; 3) after the age  
191 of 11 years, a series of complex metabolic factors associated with puberty arise and influence body  
192 composition development (Loomba-Albretch and Styne, 2009).

193 Although the present review is mainly addressed on children aged between 4-11 years, a certain  
194 flexibility has been kept in the selection of papers, including, when necessary, articles that  
195 investigated a slightly broader age range (e.g. 9-14 or 3-5). This choice was made for those articles  
196 in which a deeper analysis according to children's age was performed, thus enabling investigation on  
197 the intended target group.

198 The literature search following these criteria returned 57 research articles (Table 1). We classified the  
199 articles in two categories according to the approach used to study food preferences: 1) direct methods  
200 corresponding to explicit approaches to measure preferences; these methods include traditional, well-  
201 known techniques (i.e. hedonic rating scales, ranking test, paired comparison test) as well as new  
202 approaches (i.e. projective mapping and sorting techniques); 2) indirect methods to implicitly  
203 evaluate food preferences; these methods correspond to new, alternative procedures devoted to the  
204 assessment of variables that are strongly related to food acceptance and that may provide important  
205 information for predicting or explaining liking (i.e. implicit paradigms to study the type of memory  
206 that children use for specific foods and ingredients; wanting evaluation; study of emotions in relation  
207 to choice of food).

208

209 4.1. *Direct methods to study food preferences in children*

210 4.1.1. *Traditional approaches: paired comparison, ranking and rating scales*

211 **Table 1** provides an overview of the traditional and new methods applied from 2000 to 2015. Among  
212 the traditional methods, the most widely used were 5- and 7-point rating scales, accounting for more  
213 than 50% of all studies. The ranking test was frequently used as well, whereas other methods such as  
214 the paired-comparison test, 3-, 9-point and linear scales were used rarely. All these methods were  
215 applied independently of age, suggesting that children can reliably perform consumer testing if age-  
216 appropriate protocols are adopted. An in-depth description of the appropriateness of such traditional  
217 approaches according to children's age is reported in **Table 2**.

218 A comparison of different hedonic methods can be found in the studies by Kildegaard et al. (2011a)  
219 and Kildegaard, Tønning & Thybo (2011c). They investigated liking of different beverages in  
220 children aged 9–14 years using a 5-point hedonic facial scale and multiple ranking. Even if this age  
221 range exceeds that under investigation in the present review, the authors provided evidence that  
222 children in each age-group (including children aged 9-11 years) were able to discriminate products  
223 varying in sourness, fattiness, and fruit content according to liking. In addition, agreement between  
224 ranked and rated liking was observed, thus indicating the appropriateness of the two sensory methods.  
225 Similar findings were observed by Liem & Zandstra (2010) who found a high consistency between  
226 ranked and rated liking for different samples of margarine in 6–9 year-old children. Liem et al. (2004a)  
227 compared the ability of even younger children (4–5 years) with that of adults in discriminating the  
228 liking of an orange beverage varying in sweetness using ranking and paired-comparison tests. A high  
229 consistency between the two procedures was seen for 5-year-old children and adults. Four-year-old  
230 children performed poorly but were able to identify differences in preference across stimuli.  
231 Accordingly, Donadini et al. (2012) reported that children around 4–5 years were able to discriminate  
232 in terms of liking different types of cheese using a 5-point hedonic facial scale. This indicates that  
233 even young children can reliably perform hedonic tests. Cordelle, Piper & Schlich (2005) used both  
234 a linear unstructured scale and a paired-comparison test to investigate the consistency of liking

235 measurements in children aged between 9 and 12 years for beverages differing in taste or flavor. The  
236 use of unstructured scales with children is not common. However, in their study, Cordelle and  
237 colleagues added faces under the extreme anchors to help children to better understand the scale. A  
238 high coherence between the two liking measurements for all age groups was seen with no age-related  
239 differences in the use of the linear scale (same mean values and same dispersion across age groups).  
240 Poelman & Delahunty (2011) and Rollins, Loken, Birch (2010) used an approach in which the 3-  
241 point hedonic scale was combined with the ranking method. Both studies found good agreement  
242 between the two measurements. However, it should be underlined that this scale might not sensitive  
243 enough to represent the degree of liking by children (Lakkakula et al., 2010), especially older ones.  
244 Evidence of the appropriateness of the 7-point hedonic facial scale use with children is reported by  
245 Laureati et al. (2011) and Laureati & Pagliarini (2013) who showed, respectively, that children are  
246 able to discriminate in terms of liking among different types of food and among different levels of  
247 sweetness of the same food. Similarly, the results of Pagliarini et al. (2005) revealed that 7-10-year-  
248 old children provide repeatable results when asked to assess liking for the same dish in two separate  
249 sessions. In their study, Pagliarini et al. (2005) found age-related differences in liking scores, with  
250 younger children providing systematically higher liking ratings than older ones. Similar age-related  
251 differences were reported by Moskowitz (2002) who showed that children aged 8 and 9 years had a  
252 slight bias to use the top of the 9-point liking scale compared to older peers. Pagliarini et al. (2005)  
253 speculated that the difference was not related to misunderstanding of the scale but rather to the  
254 development of preference due to the acquisition of a more critical attitude towards food as a  
255 consequence of exposure to a more varied diet rather than to different use of the scale. Interestingly,  
256 Caporale et al. (2009) reported that the 7-point hedonic facial scale may also be successfully  
257 administered to very young children (i.e. 4-5 years old) as they showed that hedonic ratings predicted  
258 subsequent food intake, thus demonstrating the predictive validity of the measurement.

259 In summary, recent studies on consumer testing with children confirm that they are able to perform  
260 all hedonic protocols, including the use of sophisticated hedonic scales. Given the reliability of

261 children, it seems advisable to opt for more discriminating tools such as a 5- or 7-point scale instead  
262 of a 3-point scale. Overall, care should be taken when establishing age-appropriate protocols,  
263 including child-friendly environments, simplified questionnaires (e.g. limited number of questions  
264 and pages), which should be read to younger children, tests in an individual setting or a small group,  
265 and use of warm-up samples to instruct children about the procedure should be carefully chosen and  
266 provided.

267

#### 268 *4.1.2. Traditional approaches: Computerized interactive visual preference*

269 Improved skills in computers and increased use of the Internet have opened new possibilities to  
270 investigate visual consumer preferences. One example is the use of highly quality pictures to assess  
271 preference. This focuses on visual appearance, which is often the first sensation that arouses interest  
272 in a given food, especially for children (Moskowitz, 1994).

273 The use of non-tasting methods such as photographs of foods has previously been applied to younger  
274 children (Guthrie, Rapoport & Wardle, 2000), but interactive computerized measurement of  
275 children's preferences has received little attention. This procedure has been applied by Vereecken,  
276 Vandervorst, Nicklas, Covents and Maes (2010) to investigate F&V preferences among a sample of  
277 4–6-year-old children showing a high reliability of the measurement, even if the relationship between  
278 the responses of children and parents was moderate. Olsen et al. (2012a) reported that the evaluation  
279 of images of foods in a computerized conjoint analysis provided reproducible information about  
280 visual food preferences in children 9–14 years, and the results were in concordance with both actual  
281 hedonic measures and product choices. No age-related differences in reproducibility were found, even  
282 though a tendency towards higher reproducibility with increased age was observed. Good correlation  
283 between visual preferences as expressed in the picture-based conjoint analysis and actual choice was  
284 also found by an earlier study of the same authors (Kildegaard, Olsen, Gabrielsen, Møller and Thybo,  
285 2011).

286 Although the assessment of food preferences using real products is recommended, this approach can  
287 be of interest for interpreting purchase situations, where taste information is not available and  
288 consumers make decisions based on appearance Kildegaard et al. (2011b). In addition, it can be of  
289 help when rapid measurement of many products is needed or when a preliminary selection based on  
290 visual food properties is necessary for successive, more detailed evaluation. Another advantage that  
291 should be mentioned concerns simultaneous administration to multiple children, higher response rates,  
292 and fast and easy data processing, as well as suitability for online testing. It is thus an interesting  
293 approach in school-based educational programs. Some recommendations are reported for researchers  
294 who intend to apply such methodology: 1) the number of visual stimuli should be carefully considered,  
295 and take into account potential confusion and fatigue effects ; 2) it is a prerequisite that children are  
296 familiar with the foods they are looking at, so that their evaluations will indeed be based on liking  
297 rather than lack of familiarity; 3) it is possible to obtain information only for specific products  
298 attributes that are visually apparent.

299

#### 300 *4.1.3. New approaches: projective mapping and sorting techniques*

301 The appropriateness of new approaches in consumer testing with children is reported in Table 3.  
302 Projective mapping and derived techniques are simple user-friendly procedures that have gained  
303 popularity within the field of sensory and consumer science. These methods have been applied with  
304 adults for several purposes, such as cross-cultural studies (Laureati, Pagliarini, Bassoli, & Borgonovo,  
305 2014) or in comparison with descriptive methods (Holler Mielby, Hopfer, Jensen, Thybo, & Heymann,  
306 2014). The technique allows consumers to express perceptual similarities/dissimilarities and grouping  
307 sets of products by placing them on a bidimensional surface. In its simplest form, it is a non-verbal  
308 method based on perceptual distances among products. Despite its simplicity, it has only recently  
309 been successfully tested on the young consumer. Varela & Salvador (2014) provided children aged  
310 5, 7, and 9 years with pictures representing various healthy and unhealthy foods and asked them to  
311 allocate each picture on an A4 sheet separated in 4 equal quadrants labeled with 2 symbols each to

312 convey the 4 groups. The symbols used were a “yummy face” (a smiley figure with the tongue out),  
313 a “yuck face” (smiley with a “do not like face”), a devil (meaning “bad for you”) and an angel  
314 (meaning “good for you”) to represent their liking and perception of healthiness. Next, children were  
315 provided with the pictures and were asked to rate the liking of each item on a 7-point hedonic facial  
316 scale. The results for the three age cohorts were very similar, and children were able to group products  
317 taking into account both healthiness and hedonic perception as instructed.

318 Evidence of application of sorting techniques with school-aged children has been provided by Morizet,  
319 Depezay, Combris, Picard, & Giboreau (2012) who reported that children are able to correctly classify  
320 several vegetables according to liking and familiarity.

321 Although further research is needed to assess the potential of projective and sorting techniques for  
322 assessing children’s preference - especially with more complex product sets and tasting real products  
323 - it seems that the procedures can be easily understood. Moreover, the procedures are suitable to be  
324 presented as a game in that can also be used with younger children. Therefore, projective mapping  
325 and sorting tasks can be considered a promising tool in consumer research with children, but care  
326 should be taken in explaining how to position the products so that children use the total space on the  
327 map and use symbols to represent a few sensory concepts (hedonic valence or simple sensory  
328 properties such as sweet, sour, bitter etc.).

329

#### 330 4.2. *Indirect methods to study food preference in children*

331 To date, several measurements to assess children’s food liking and preference have been proposed.  
332 One of the limit of “traditional” hedonic methods is that they reflect conscious cognitive processes,  
333 whereas consumer acceptance is also based on unconscious processes, which may be measured by  
334 implicit physiological and behavioural measures (Köster, 2003). In this section, the new approaches  
335 proposed in addition to traditional hedonic measurements to interpret children’s food liking and  
336 preference are reviewed, with particular reference to implicit paradigms used to investigate children’s  
337 food memory, and methods to assess children’s wanting and emotions.

338

339 *4.2.1. Implicit paradigms to study food memory in children*

340 Over the last decade, a notable number of studies has been performed in an attempt to delineate the  
341 mechanisms involved in incidental learning and memory of food. If we consider the way we learn,  
342 store, and retrieve sensory food input, it is fairly evident that we rarely pay attention to what we eat  
343 or drink, unless something differs from our expectations (Laureati & Pagliarini, 2013). Nevertheless,  
344 sensory information is unconsciously retained by the brain and remains “hidden” until the time when  
345 a new food is experienced (Köster, Prescott, & Köster, 2004). This aspect is particularly relevant for  
346 food preference since at the critical moment of choice consumers seldom have the opportunity to taste  
347 the product and base their choice on the expectation they have toward a particular product.  
348 Consumer’s expectations, in turn, rely mainly on the information provided by memory. Although the  
349 implicit nature of food memory is evident, most of the available studies on memory of sensory stimuli  
350 deal with conscious and intentional mechanisms of learning. As regarding children, studies are  
351 focused on explicit paradigms to investigate the relationship between flavor labeling and recognition  
352 of flavor in children (Frank, Brearton, Rybalsky, Cessna & Howe, 2011; Lumeng, Zuckerman,  
353 Cardinal & Kaciroti, 2005). However, this approach is reductive as it does not take into consideration  
354 the incidental component of memory processes and the understanding of food memory under normal  
355 conditions. This limitation has been underlined by Jos Mojet and Ep Köster who tried to overcome  
356 the lack of ecological validity in food memory research by validating an incidental learning paradigm  
357 to study food memory in a natural setting (Mojet & Köster, 2002). Through the application of this  
358 paradigm with adults, some food memory features have been delineated (see Morin-Audebrand et al.,  
359 2012 for review).

360 Very recently, this paradigm has been also tested successfully with children. For instance, Laureati,  
361 Morin-Audebrand, Pagliarini, Sulmont-Rossé, Köster, & Mojet (2008) compared incidental learning  
362 and memory for a custard dessert in three sensory modalities (i.e. taste, flavor, and texture) involving  
363 children (9–11 years old) and adults (18–45 years old). They found that children had good recall of

364 the custard dessert eaten the day before (i.e. target) in terms of liking, whereas the distractors with  
365 increased concentration of sugar and cherry aroma were remembered as less pleasant than the target.  
366 Moreover, no age-related differences in the way food is remembered were found, underlining that  
367 children understood the task and were able to precisely store and retrieve information about the food  
368 they eat. Accordingly, Laureati, Pagliarini, Mojet, & Köster (2011) investigated incidental learning  
369 and memory for three different food stimuli that varied in sweet taste in children between 7–10 years.  
370 They reported that children clearly recognized the distractors at different levels of sweetness as being  
371 different from the memory of the target product eaten the previous day, but memory was product-  
372 dependent, a result already observed in adults (Köster et al., 2004; Morin-Audebrand, Laureati,  
373 Sulmont-Rossé, Issanchou, Köster, & Mojet, 2009). In general, these studies showed better memory  
374 performance in a relative memory task (i.e. remembering a specific characteristic, such as liking, of  
375 the target and distractors) compared with an absolute memory task (i.e. recognizing the target among  
376 a series of distractors). The prominence of memory for liking, over absolute memory, has interesting  
377 practical implications. In fact, when making a choice, consumers usually choose on the basis of their  
378 previous experience with a product, i.e. their memory for the liking or disliking of a product. If these  
379 memories deviate from the actual experiences, the representation in memory may be the most  
380 important predictor in food choice.

381 Clear evidence of children's reliability in performing memory tasks was also provided by Laureati &  
382 Pagliarini (2013) who showed that children were able to recognize distractors varying in different  
383 levels of sweetness from memory, hedonic (7-point facial hedonic scale), and perceptive (paired  
384 comparison) points of view. Interestingly, they also found that children's memory was better under  
385 incidental rather than intentional conditions. This outcome has the important methodological  
386 implication, that explicit paradigms should be cautiously considered when applied for studying food  
387 learning and memory. This is because they are probably not appropriate, and are less ecologically  
388 valid than implicit experimental procedures.



389 In summary, even if no general conclusions can be drawn from food memory studies due to the small  
390 numbers of papers and the limited number of children assessed, it seems recommendable to include  
391 memory tests among the criteria for industrial market launch decisions, since food expectations and  
392 food liking depend to a large extent on incidentally learned memory. In this context, the evaluation  
393 of relative memory in children for liking seems to be especially appropriate since it can provide new  
394 information that is not normally captured by measuring liking. First, it can highlight memory shifts,  
395 which as an indicator of unmatched expectations plays a crucial role in food choice; second, it can be  
396 more discriminative than the traditional measurement of liking (Laureati et al., 2008, 2011). Moreover,  
397 food developers should keep in mind that young consumers can perceive even the smallest sensory  
398 differences of a given food product and, more importantly, are able to learn and involuntarily  
399 memorize such variations.

400

#### 401 4.2.2. *Wanting evaluation*

402 Research indicates that not only liking but also wanting plays an interdependent role in food choice  
403 and consumption in adults, which highlights the importance of the distinction between liking and  
404 wanting. Wanting is the intrinsic motivation to engage in eating a food, now or in the near future  
405 (Mela, 2006). Liking is a contributor to wanting, which presumably carries a component of  
406 anticipated pleasure, while liking is not sufficient to predict wanting (Mela, 2001). Studies focusing  
407 on children's liking and wanting as separate pathways for food choice are limited but interesting, as  
408 there is evidence that the decrease in wanting, rather than liking, may explain boredom effects due to  
409 repeated exposure to food stimuli (Liem & Zandstra, 2009). Since repeated exposure is often used in  
410 sensory research with children to increase acceptance of healthy food, studying wanting in children  
411 might provide further information to better explain their food behavior. In this context, Liem &  
412 Zandstra (2009) investigated the influence of repeated consumption of snack foods on children's  
413 liking and wanting. Interestingly, the results revealed that wanting rather than liking was most  
414 affected by repeated daily consumption over a period of 3 weeks, but the effect of liking on the

415 prediction of food choice was consistently larger than the effect of wanting. Kildegaard et al. (2011a,c)  
416 also investigated liking and wanting in children as separate pathways. In these studies, no difference  
417 between liking and wanting was observed, but rather the two measures were highly correlated and  
418 children segmentation according to appreciation for sour food was very similar to that obtained  
419 through wanting data (Kildegaard et al., 2011c). Other studies carried out with children measured  
420 their desire to eat a variety of healthy and unhealthy foods but without taking in consideration the  
421 relationship with liking (Jansen, Mulkens, & Jansen, 2007; Jansen, Mulkens, Emond & Jansen, 2008).  
422 Although these studies indicate that children seem to be able to answer questions related to the desire  
423 to eat, some limitations should be highlighted. First, the hedonic scales used for rating liking and  
424 wanting were very similar. Both measurements consisted of a 5-point facial scale in which the  
425 extremes were represented by the same icons, i.e. the same sad face was used to represent the  
426 minimum degree of both liking and wanting scale, and the same smiley face was used to anchor the  
427 maximum degree of both liking and wanting. Second, wanting and liking evaluations were conducted  
428 in the same session or with only a short time interval between the assessment of liking and wanting.  
429 This could bias the results and lead to underestimation of the difference between liking and wanting.  
430 Research with adults suggests that introspective ratings are vulnerable to cross-contamination,  
431 meaning that distinct sets of underlying processes (liking vs. wanting) may be interpreted as a single  
432 variable (Berridge, 1996). This can be of particular relevance when children are involved, since they  
433 can have even more difficulties than adults in discriminating the concept of desire to eat from that of  
434 liking. One way to overcome this limitation is by using clearly distinct scales for liking and wanting  
435 evaluation (e.g. wanting might be represented through images of the size of product the child wants  
436 to eat) and, if possible, conduct the two measurements in separate sessions or with an appropriate  
437 time interval between them. Another option could be to consider the adoption of an implicit approach  
438 (e.g. behavioral tasks, physiological correlates, etc.) to measure food wanting, which has been shown  
439 to work well with adults (Finlayson, King, & Blundell, 2008). The approach has the advantage of  
440 using simple behavioral tasks (e.g. choosing the food a person mostly wants to eat in a forced choice

441 methodology) to obtain an indirect measure of wanting such as reaction time, which can be easily  
442 adapted to methodologies used with children.

443

#### 444 *4.2.3. Emotion evaluation*

##### 445 *4.2.3.1. Use of questionnaires*

446 Research on adults has found that the measurement of emotions can be used to explore differences  
447 between food products when the acceptability or preferences for the products are similar (King &  
448 Meiselman, 2010; Jaeger, Cardello, & Schutz, 2013). Certain foods are more attractive and successful  
449 on the market than others simply because they make us feel good; in other words, they trigger positive  
450 emotions. The study of emotions in relation to food choice has recently been investigated by King &  
451 Meiselman (2010) and De Smet & Schiffertein (2008). In these studies, feelings during food  
452 consumption were measured using verbal standardised questionnaires, which could be too difficult  
453 and not suitable to use as they are with children. Gutjar et al. (2014) noted that implementing emotion  
454 measurement with a consumer defined and product and language specific emotional lexicon improves  
455 discriminative sensitivity, such as in the Check All That Apply (CATA) approach of Ng, Chaya &  
456 Hort (2013) and in the EmoSemio approach of Spinelli, Masi, Dinnella, Zoboli, & Monteleone (2014).  
457 Consequently, it could be suggested that this approach, which is more language sensitive can be  
458 suitable for use with children.

459 De Pelsmaecker, Schouteten, & Gellynck (2013) recently investigated whether 8–13-year-old children  
460 associate different emotions with different brands of flavoured milk. In this study, the children  
461 themselves generated a list of 20 emotions taken from previous research by Desmet & Schifferstein  
462 (2008) and King & Meiselman (2010) that subsequently classified as positive, negative, or neutral.  
463 Children were helped in understanding the meaning of the emotions and were free to add their own  
464 terms, e.g. childish. The CATA method was then used to link these 20 emotions to six brands of  
465 flavoured milk. It was seen that all emotions except one discriminated the six brands of milk. More  
466 specifically, children associated more positive emotions with the leader brands and more negative

467 emotions with less known products such as rice and soy milk, thus suggesting they understood the  
468 task. Unfortunately, emotions were not compared with any liking measurement of the products, and  
469 thus it is not possible to conclude whether the emotion profile is more discriminating than liking for  
470 acceptability evaluation of flavoured milk. However, this first study on children's emotion related to  
471 food has the merit of having conducted the experiment in a real and trusted environment (i.e. at  
472 school), without the presence of parents which can be seen as a barrier for children to express their  
473 own opinions. Moreover, the report did not provide evidence of differences in performance according  
474 to age, and thus further research is needed to address this issue.

475

#### 476 *4.2.3.2. Observational studies*

477 Emotions and cognitive associations with foods may also be measured with the help of advanced non-  
478 verbal and/or non-invasive physiological measures. As these measures do not rely on cognitive  
479 development, they may be more suitable for children. Non-verbal measures include facial expressions,  
480 which signal emotion of the face. In this context, facial expression evaluation can be seen as a useful  
481 tool to investigate aspects related to the hedonism of food consumption that cannot be investigated  
482 by applying traditional methods. Observational techniques provide objective measures, with orofacial  
483 actions (e.g. lip licking, tongue protrusion) to food cues used as markers of implicit affective  
484 processing in animals and humans (Schaal, Marlier, & Soussignan, 2000; Steiner, Glaser, Hawilo, &  
485 Berridge, 2001). In addition, this approach is independent of the cognitive skills of children, thus  
486 overcoming some difficulties that might be encountered in sensory testing with children due to their  
487 short attention span and reduced cognitive or language ability. Well-known examples in the food  
488 domain include the findings of Steiner's and colleagues (Steiner, 1973; Steiner et al., 2001) which  
489 revealed that infants can recognize and discriminate between various basic tastes and odors. More  
490 specifically, newborn infants show differentiated facial responses to various basic solutions: a sweet  
491 taste elicits facial relaxation, sucking, tongue protrusions, and may lead to a smile; a sour taste elicits

492 lip pursing; a bitter taste gives rise to head turns, mouth gaping, nose wrinkling and lowered mouth  
493 corners; and a salty taste has a less distinctive pattern.

494 Observational studies have gained increasing attention in the last decade in response to the availability  
495 of specific software (e.g. Face Reader) that can translate facial muscle movements into basic  
496 expressions (e.g. happy, sad, angry, surprised, scared, disgusted, and neutral) based on the Facial  
497 Action Coding System developed by Ekman (Ekman, 1992).

498 Examples of its application in observational studies in school-age children are less frequent in the  
499 literature than those in infants, but they have produced promising results that help to better understand  
500 and interpret the development of food preferences in children. In a recent study by Soussignan, Schaal,  
501 Boulanger, Gaillet, & Jiang (2012), distinct measures of liking (oro-facial reactivity, liking, wanting,  
502 and preference) for visual and odor cues related to food and non-food items were compared in 6–11-  
503 year-old children. It was found that orofacial reactivity to food cues is a valid measure of positive  
504 appetitive responses, and in particular lip sucking was clearly associated with higher liking for both  
505 visual and olfactory food cues. In addition, orofacial reactivity discriminated overweight children  
506 from normal-weight children, with the former displaying a higher frequency of lip sucking when  
507 exposed to high-energy dense food pictures and food odorants. This differentiation was not obtained  
508 through self-rated liking, wanting, or preference, thus suggesting that facial expressions might be  
509 more sensitive than self-reports for predicting a potential risk for the development of  
510 overweight/obesity.

511 In contrast, Zeinstra, Koelen, Colindres, Kok, & de Graaf (2009) found that facial expressions are  
512 suitable to measure dislike, but not to measure various gradients of food acceptance in children aged  
513 5–13 years. Negative facial expressions for disliked food stimuli were easily recognized, whereas the  
514 distinction between a positive or neutral expression was less clear. This outcome is understandable,  
515 since the foods that humans consume and accept may result in mild positive reactions, thus making  
516 it more difficult to distinguish gradations of food acceptance based on facial expressions. Similar  
517 findings were reported by de Wijk, Kooijman, Verhoeven, Holthuysen, & de Graaf (2012) who

518 compared facial expressions in response to the sight, smell, or taste of liked and disliked food in  
519 children (8–10 years old) and adults and concluded that facial expressions successfully reflect  
520 negative but not positive food preferences. Of course, these results should be interpreted with caution  
521 as the number of children involved was rather low (from 6 to 40).

522 Observational studies have undoubted strengths that must be highlighted, such as the previously  
523 mentioned ability to capture implicit reactions that cannot be extrapolated using traditional methods  
524 and the reduction of burden and fatigue seen in some traditional hedonic tests requiring multiple  
525 sample tasting (e.g. complete rank order) as only one tasting is sufficient to register a reaction.  
526 However, when the approach is applied to school-aged children, the environment in which the  
527 observation is conducted should be considered with caution as a laboratory context may influence  
528 expressiveness. In this context, control of facial expressions and the ability to intentionally make  
529 faces develops gradually in the growing child. Although 5- and 12-year-old children appear equally  
530 capable in masking their facial expressions in response to unpleasant odors (Soussignan & Schaal,  
531 1996), it is unclear how much masking and control occurs in response to food stimuli. Finally, facial  
532 recognition systems for emotions depend on small lists of emotions, thus missing potentially valuable  
533 information. Longer and more tailored lists of emotions are indeed recommended when working with  
534 a new product category in order to fully present the emotional response of consumers (King &  
535 Meiselman, 2010). All these issues should be considered as challenges in future observational  
536 research with children.

537

## 538 **5. Conclusions**

539 Review of the scientific literature on consumer testing with children in the last 15 years brings about  
540 the following main considerations. First of all, the intense interest in this research area is demonstrated  
541 by the systematic increase of scientific publications on sensory research in children. However, a shift  
542 in research methodology has been observed. While from 1980 to 2000 most studies were aimed at  
543 devising appropriate procedures to use in food product development with children, the major focus

544 of the most recent studies is to use sensory research to study feeding behavior and to promote healthy  
545 eating among children.

546 Recent investigations confirm that children in the age range of 4–11 years are able to perform most  
547 traditional consumer tests in addition to more sophisticated methods (e.g. memory and emotion  
548 evaluation) if age-appropriate procedures are adopted. Using indirect methods to study variables that  
549 are closely related to liking seems promising to better understand food behavior in children, and we  
550 encourage their application when traditional methods cannot provide much information. Some of the  
551 recent procedures still require optimization and validation. This is especially true in observational  
552 studies, which are undoubtedly effective in very young children, but which have limitations in school-  
553 age children and pre-teens. Additionally, questionnaires on emotions should be validated in terms of  
554 reliability and predictive validity (e.g. measurement of liking paired to emotion evaluation is  
555 encouraged). Finally, when applying consumer testing with children, care should be taken in  
556 establishing age-appropriate protocols, including child-friendly environments, to perform the test. In  
557 particular, simplified questionnaires (e.g. limited number of questions and pages), which should be  
558 read to younger children, tests in an individual setting or a small group, taking into consideration the  
559 sex/gender variable, and use of warm-up samples to instruct children about the procedure, should be  
560 carefully chosen and provided.

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791 Table 1. Summary of the most relevant studies published between 2000 and 2015.

Article	Age range (y)	New hedonic methods	Traditional hedonic methods							
			paired-test	ranking	3-point	5-point	7-point	9-point	Linear scale	Other
1. Brueckner et al. 2007	7-11								x	
2. Caporale et al. (2009)	4-5							x		
3. Cordelle et al. (2005)	7-12; 18-60		x							x
4. De Pelsmaeker et al. (2013)	8-13	Emotion								
5. de Wijk et al. (2012)	8-10; 22	Facial expression								
6. Delk & Vickers (2007)	8-12							x		
7. Donadini et al. (2012)	4.5-5.5							x		
8. Donadini et al. (2013)	5							x		
9. Feenay et al. (2014)	7-13							x		
10. Hartvig et al. (2014)	9-11								x	
11. Frank et al. (2011)	4-11	Food memory								
12. Hartvig et al. (2015)	9-11								x	
13. Hausner et al. (2012)	9-11								x	
14. Hill et al. (2009)	7-9							x		
15. Jansen et al. (2007)	5-6	Wanting								
16. Jansen et al. (2008)	5-7	Wanting								
17. Jiang et al. (2013)	6-11	Wanting							x	
18. Kildegaard et al. (2011a)	9-14	Wanting		x				x		
19. Kildegaard et al. (2011b)	9-13			x						
20. Kildegaard et al. (2011c)	9-14	Wanting		x				x		
21. Kühn & Thybo (2001)	9-13							x		
22. Lakkakula et al. (2010)	9-11								x	
23. Lanfer et al. (2013)	6-9		x							
24. Laureati et al. (2008)	8-10	Food memory							x	
25. Laureati et al. (2011)	8-10	Food memory							x	
26. Laureati et al. (2013)	8-10	Food memory							x	
27. Laureati et al. (2014)	6-10								x	
28. Laureati et al. (2015a)	6-10								x	



793 *Table 2. Appropriateness of traditional hedonic methods used with children aged 4 to 11 years.*  
 794 *Summary of the most relevant findings of studies carried out in 2000-2015.*  
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Traditional methods	Age range (years)			
	4–5	6–7	8–9	10–11
Paired comparison	Yes <sup>(1)</sup>	–	Yes <sup>(2)</sup>	Yes <sup>(2)</sup>
Ranking	Yes <sup>(1, 3-5)</sup>	Yes <sup>(3-6)</sup>	Yes <sup>(3-4, 6-8)</sup>	Yes <sup>(4, 7-8)</sup>
Hedonic scales:				
3-point	Yes <sup>(4-5)</sup>	Yes <sup>(4-5)</sup>	Yes <sup>(4)</sup>	Yes <sup>(4)</sup>
5-point	Yes <sup>(6, 9)</sup>	Yes <sup>(6)</sup>	Yes <sup>(6-8)</sup>	Yes <sup>(7-8)</sup>
7-point	Yes <sup>(10)</sup>	Yes <sup>(11-13)</sup>	Yes <sup>(11-13)</sup>	Yes <sup>(11-13)</sup>
9-point	–	–	Yes <sup>(14)</sup>	Yes <sup>(14)</sup>
Unstructured linear	–	–	Yes <sup>(2)</sup>	Yes <sup>(2)</sup>

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 797 (1) Liem et al. (2004a); (2) Cordelle et al. (2005); (3) Liem & Mennella (2003); (4) Rollins et al.  
 798 (2010); (5) Poelman & Delahunty (2011); (6) Liem & Zandstra (2010); (7) Kildegaard et al. (2011a);  
 799 (8) Kildegaard et al. (2011c); (9) Donadini et al. (2012); (10) Caporale et al. (2009); (11) Pagliarini  
 800 et al. (2005); (12) Laureati et al. (2011); (13) Laureati & Pagliarini; (14) Moskowitz (2002)  
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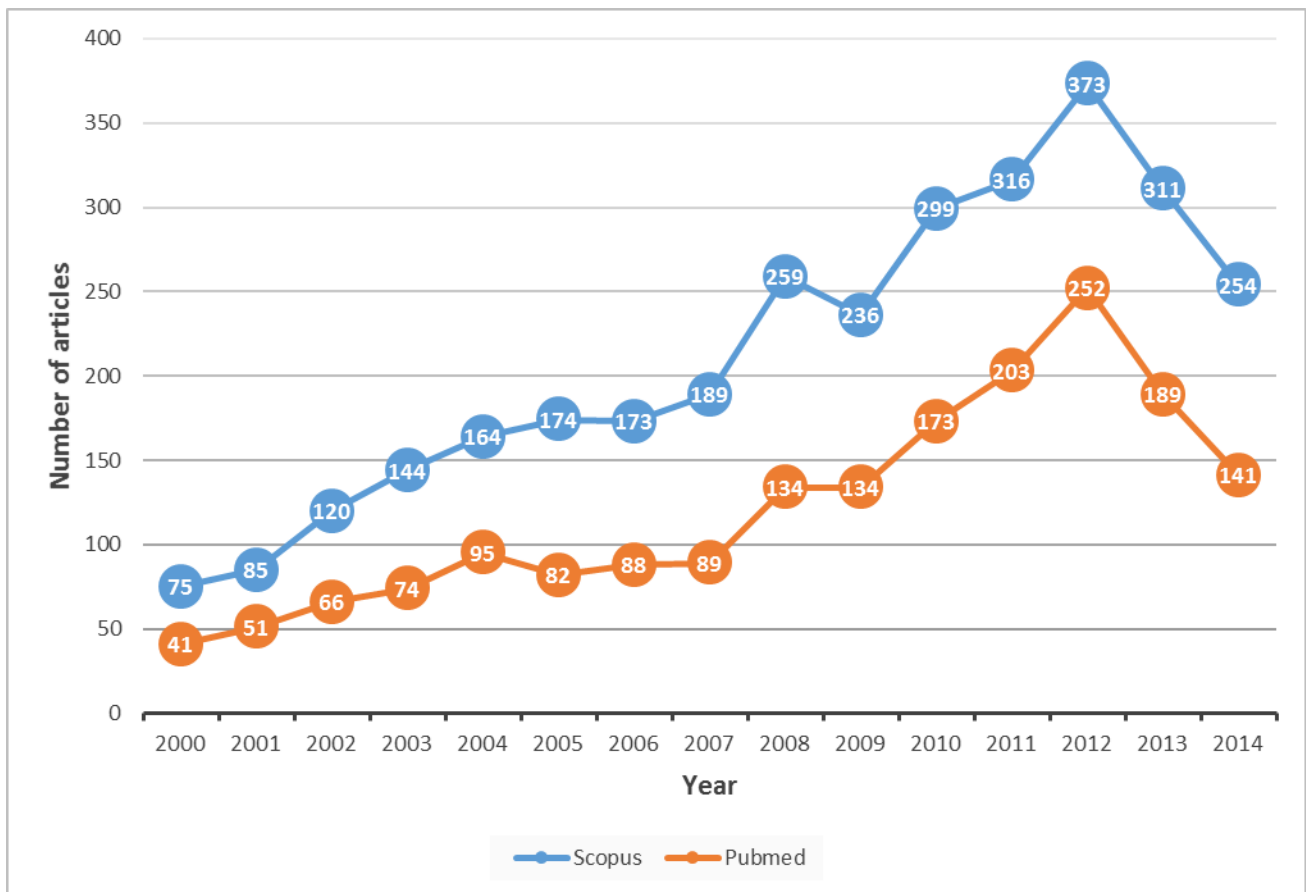
*Table 3. Appropriateness of new hedonic methods used with children aged 4 to 11 years. Summary of the most relevant findings of studies carried out in 2000-2015.*

New methods	Age range (years)			
	4–5	6–7	8–9	10–11
Projective mapping and sorting	Yes <sup>(1)</sup>	Yes <sup>(1)</sup>	Yes <sup>(1,17)</sup>	Yes <sup>(1,17)</sup>
Implicit/Explicit memory	Yes <sup>(2,3,6)</sup>	Yes <sup>(2,3,5)</sup>	Yes <sup>(2,4-6)</sup>	Yes <sup>(2,4-6)</sup>
Wanting	Yes <sup>(7-8)</sup>	Yes <sup>(7-11)</sup>	Yes <sup>(9-13)</sup>	Yes <sup>(9-13)</sup>
Emotion (questionnaires)	–	–	Yes <sup>(14)</sup>	Yes <sup>(14)</sup>
Emotion (observational studies)	No <sup>(15)</sup>	No <sup>(15)</sup> , Yes <sup>(10)</sup>	No <sup>(15-16)</sup> , Yes <sup>(10)</sup>	No <sup>(15-16)</sup> , Yes <sup>(10)</sup>

808 (1) Varela & Salvador, 2014; (2) Frank et al., 2011; (3) Lumeng et al., 2005; (4) Laureati et al., 2008;  
809 (5) Laureati et al., 2011; (6) Laureati et al., 2013; (7) Jansen et al., 2007; (8) Jansen et al., 2008; (9)  
810 Jiang et al., 2013; (10) Soussignan et al., 2012; (11) Liem & Zandstra (2009); (12) Kildegaard et al.,  
811 2011a; (13) Kildegaard et al., 2011c; (14) De Pelsmaecker et al., 2013; (15) Zeinstra et al., 2009; (16)  
812 de Wijk et al., 2012; (17) Morizet et al. (2012).

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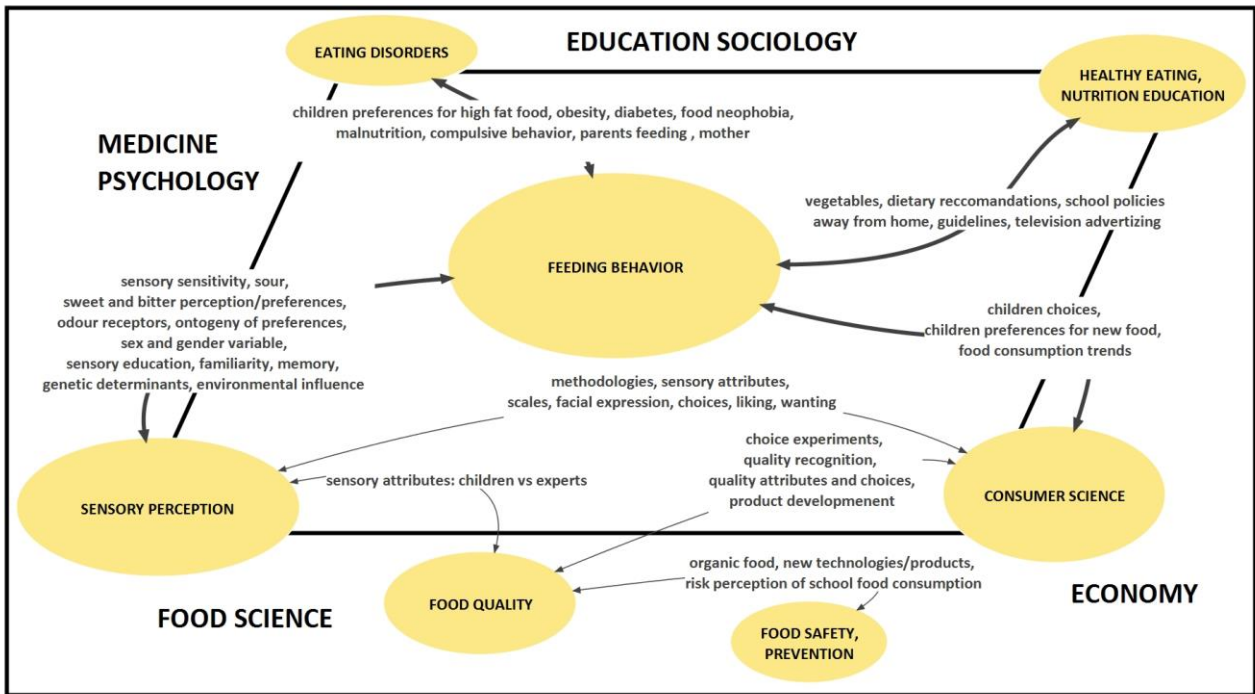
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817 **Fig. 1.** Number of paper cited by Scopus and PubMed in 2000–2014, sorted by the keywords  
818 “children food preferences” or “children food sensory”.

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**Fig. 2.** Conceptual map of the main areas for measuring the sensory aspects and the food preferences of children. Groups of keywords were used to “tag” the interconnections.

1980 - 2000
<p><b>Research challenges</b></p> <ol style="list-style-type: none"> <li>1. Devising new sensory and hedonic methods for children</li> <li>2. Applying sensory and hedonic methods for: <ul style="list-style-type: none"> <li>• Quality control management</li> <li>• Meeting children's food expectation</li> </ul> </li> </ol>
<p><b>Traditional methodologies</b></p> <p><i>Discriminant methods</i></p> <ul style="list-style-type: none"> <li>• Paired comparison</li> <li>• Duo-trio</li> <li>• Ranking</li> </ul> <p><i>Consumer methods</i></p> <ul style="list-style-type: none"> <li>• Paired comparison</li> <li>• Ranking</li> <li>• Hedonic scales</li> <li>• Focus group</li> <li>• Repertory grid method</li> <li>• Observational studies (child &lt; 3 years)</li> </ul>

2000 - 2015	
<p><b>Research challenges</b></p> <ol style="list-style-type: none"> <li>1. Finding new sensory and hedonic methods for children</li> <li>2. Applying sensory and hedonic methods for: <ul style="list-style-type: none"> <li>• Product reformulation (less caloric options)</li> <li>• Food educational programs</li> </ul> </li> </ol>	
<p><b>Traditional methodologies</b></p> <p><i>Discriminant methods</i></p> <ul style="list-style-type: none"> <li>• Paired comparison</li> <li>• Duo-trio</li> <li>• Ranking</li> </ul> <p><i>Consumer methods</i></p> <ul style="list-style-type: none"> <li>• Paired comparison</li> <li>• Ranking</li> <li>• Hedonic scales</li> <li>• Focus group</li> <li>• Repertory grid method</li> <li>• Observational studies (child &lt; 3 years)</li> </ul>	<p><b>New methodologies</b></p> <p><i>Projective mapping and sorting techniques</i></p> <p><i>Indirect approaches</i></p> <ul style="list-style-type: none"> <li>• Implicit memory paradigms</li> <li>• Wanting evaluation</li> <li>• Emotion evaluation: <ul style="list-style-type: none"> <li>Questionnaires (Check All That Apply)</li> <li>Observational studies (child &gt; 3 years)</li> </ul> </li> </ul>

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824 Figure 3. Overview of the trend in the application of sensory and consumer testing with children from 1980 to 2015