Structured sorting using pictures as a way to study nutritional and hedonic perception in children

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Abstract

A good insight about the development of food choice patterns and the reasons behind eating healthy or unhealthy food is of particular importance as nutritional influences on health can be established early in childhood. Sensory and consumer testing with children can be very valuable for that aim but it requires appropriate protocols due to their cognitive abilities and attention spans. In this work, structured sorting was proposed as a tool to study children's nutritional understanding and hedonic perception of various healthy and less heathy, «junky» foods. The task was well understood and easily performed by the three studied age cohorts (5yo, 7yo, 9yo). The structured sorting with the use of images appeared as a promising tool to study children holistic perception of products considering multidimensional concepts, in this particular case demonstrated by the fact that they were able to classify products taking into account healthiness and hedonic perception at the same time.

Keywords: *children; sorting; nutritional knowledge; hedonic perception*

1. Introduction

A good understanding of the early development of food choice patterns and the reasons behind eating healthy or unhealthy food is of particular importance as nutritional influences on health can be established in childhood, a time of potential influence via educational programs. The growing awareness of the importance of a healthy diet in early childhood has driven the attention to the study of children's understanding of food nutritional properties (Tatlow-Golden, Hennessy, Dean, et al., 2013). In particular, the fact that that children's diet could be linked to their food knowledge (Kandiah & Jones, 2002), and the recent evidence of their sensitivity to marketing of unhealthy food (Ferguson, Muñoz & Medrano, 2012) makes it very important to better understand children's nutritional perception and its relation to food preferences. Interestingly enough, the foods that children usually reject are those ones which may have greatest importance for later health, as fruit or vegetables (Blisset & Fogel, 2013). Children are born with some innate predisposition to like and dislike certain flavours (Beauchamp & Menella, 2011), however, preferences are malleable and could be modified responding to a number of social and environmental factors. For instance, it is well known now that children who are pressured to eat certain foods may show decreased preference for them in the future; conversely, social facilitation by peers could reinforce the preference for a previously disliked item (Ventura & Worobey, 2013). Various intervention studies have been pursued in different countries trying to shape children's preference through educational programs (Casson, 2001; Kandiah & Jones, 2002; Powers, Struempler, Guarino, et al., 2005; Baskale & Bahar, 2011), but very little is known about pre-schoolers (under 6yo), a period where the development of food knowledge is fast, and when food experiences would be central to later behaviour towards food (Holub& Musher-Eizenman, 2010; Tatlow-Golden, et al., 2013).

Nguyen (2007) found that 3-year-olds, 4-year-olds, 7-year-olds, were able to evaluatively categorize pictures of foods accurately as "junky" or "healthy", concluding that their classifications corresponded to expert classifications to some degree by age

3y.o., and that children would start understanding the reasoning behind these classifications by the age of 4y.o.Nevertheless, children's perception of nutritional aspects cannot be isolated from their hedonic appreciation, being their actual food choice influenced by multiple parameters. In this sense, Tatlow-Golden et al. (2013) found that young children had very high levels of ability to identify healthy foods as important for growth and health, but considerably less ability to reject unhealthy items, showing that not only nutritional knowledge would be determinant of their behaviour but hedonics would play a major role.

Understanding children's perception of complex concepts could be challenging, particularly with younger ones. Literature suggests that children from 2-7yo only can focus in one aspect of a product at a time, as they are limited in their centration and also have a short attention span, what results in that children could be strongly affected by irrelevant dimensions of complex stimuli (Bernard & Friedman, 1995; Resurreccion, 1998; Guinard, 2001; Popper & Kroll, 2004). Between the ages of 7 and 11 (the "concrete operational stage") children start mastering logical and systematic thinking, gain the ability to analyse products according to more than one dimension and learn about classifications (Atik & Ozdamar Ertekin, 2013). Consequently, successful testing with children must have into account their sensory and cognitive abilities, with the careful selection of adequate tasks, the use of child-friendly wording of questions, adapted scales and according duration of the test. Nguyen and Murphy (2003) stated that children are precocious in dealing with food categories, because of the role food plays in their lives and that they are quite flexible in the types of categories they form and use, having the competence to appropriately form taxonomic, script, and evaluative categories. Sorting methods are easy to understand and children friendly, as many games are based on sorting of shapes, colours, etc. so it is a procedure familiar for children. Children as young as 3-5yo could realise simple sorting tasks without difficulty if well explained (Guinard, 2001). However, care must be taken, as even when they understand it, their attention span may limit their ability to perform the task, as

Popper & Kroll explained (2004), a 3-year-old can understand a sorting task, but he/she may have problems to remember the assignment because of lack of attention to successfully complete the task. Otherwise, Kimmel et al. (1994) recommended that pictures could be a good way of helping children to understand sensory tests. Other authors have suggested that a good alternative for gathering liking information from children could be through the rating of pictures instead of real products (Baxter, Schroder & Bower, 1999; Olsen, Kildegaard, Gabrielsen et al., 2012).

The aim of this work was to explore structured sorting with the use of images as a potential tool to study complex stimulus, in this case nutritional understanding and hedonic perception of various healthy and less healthy, «junky» foods in children of 5, 7 and 9yo.

2. Materials and methods

2.1 Participants

Three groups of children of 5yo (n=45), 7yo (n=52) and 9yo (n=51) were interviewed in a primary school, in their own classrooms. Three interviewers and one teacher managed the tests. The task was self-administered, following the instructions and examples given by the interviewers, who were then available for consultation.

2.2 Tasks

Structured sorting

The children preformed what we would call a “structured sorting task”, where they had to sort 12 food items in 4 pre-determined groups. They received altogether 12 stickers with pictures of food products in random order: *fresh fruit, orange juice, fresh vegetables, chocolate covered biscuits, nuts, crisps, coke, milk products, donuts, chocolate candy bar, candy (gumdrops), and bread*. All the products could be consumed as snacks and half of them were associated to a healthy diet, while the rest were less healthy, «junky» options. They also received an A4 sheet separated in 4 equal quadrants labelled with 2 symbols each to convey the 4 groups. The symbols

used were a “yummy face” (a smiley figure with the tongue out), a “yuck face” (smiley with a “do not like face”), a devil (meaning “bad for you”and an angel (meaning “good for you”). The signs 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).

Children in the three groups were explained the sorting task by means of two examples of foods different than the ones used in the test: *chocolate cake* and *cherry tomatoes.* The explanation of the tasks was given to the whole group; children could raise their hands and ask questions at that time, or individually once being handed out the test sheets. The concepts of “it is good for you” and “it is bad for you” were explained as “a food you can eat often, whenever you want, because it is good for your health” or “a food you can only eat in certain occasions because frequently eating it could be harmful for your health”. The interviewers explained the task using a big board representing the A4 sheet and two pictures of the *chocolate cake* and *cherry tomatoes,* and in discussion with the children and the teacher realised the exemplifying exercise.

Overall liking rating

After the sorting task, they were given a new ballot, where the 12 same pictures were rated for overall liking with the use of 7-point hedonic smiley-scales (Chen et al., 1996) without worded labels. Pictures were randomized in the questionnaire following a balanced complete block experimental design (Williams’ design).

2.3. Data analysis

Multiple Factor Analysis (MFA) was used to analyse the data from the sorting task, on the matrix of the individual consumers’ grouping (the products in the rows, the consumers (children) in the columns, and allocating each product to the particular chosen group, *i.e.* A, B, C or D).

MFA was used to study the relation between the three sorting tests realised by the different age-groups. RV coefficients were also calculated for that purpose. The RV coefficient is a multivariate statistic ranging from 0 (uncorrelated, orthogonal

configurations) to 1 (perfect agreement, homothetic configurations) (Robert & Escoufier, 1976). MFA is a synthesis of PCA (Principal Component Analysis) and MCA (Multiple Correspondence Analysis) that generalizes to enable the use of quantitative and qualitative variables. In practise an MFA performed on K tables that contain each one qualitative variable is equivalent to an MCA performed on the K variables (Escofier and 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.

Two-way ANOVA (age, product and their interaction as factors) was used to analyse the overall liking data. Least significant differences were calculated by Tukey's test ($p<0.05$).

Internal preference maps were built by applying principal component analysis (PCA) on the correlation matrix of consumer individual liking data for each of the children group.

All data analyses were performed using XL-Stat 2009 (Insightful, New York, NY).

3. Results and discussion

The test was well understood by the 3 age cohorts. It took about 40-50 min per group to accomplish both parts of the study (sorting and acceptability testing). The time was not registered individually, but timings varied to a large extent among students even within the same group. In general it can be said that the exercise took longer with the younger children. **3.1. Sorting task**

The three age groups were capable of performing the sorting task after the explanations and examples given by the interviewers. This is in accordance to what Guinard (2001) suggested in his review of sensory and consumer testing with children, that sorting was a task that could be understood by pre-schoolers (3-5 years old). Although previous research has suggested that children from 5-7 would require one-to-one, personal interviews for being able to understand the task (Kroll, 1990), the present

study showed that sorting would be simple enough for being understood by 5yo and up, after being given an example.

The results for the three age cohorts were very similar. They were able to group the products taking into account both healthiness and hedonic perception as instructed. According to Piaget's theory of cognitive and affective development (Wadsworth, 1984; Guinard, 2001) children below 7 would be limited in their logical thinking abilities (defined as "pre-operational") meaning they could concentrate in one aspect of a situation at a time. However, in the present study, children of the three groups (from 5 to 9 yo) were able to sort the food items taking into account two independent factors at the same time, liking and healthfulness, suggesting that sorting is an easy task that could allow the evaluation of complex concepts even for the pre-school children. Nguyen and Murphy (2003) suggested that children do form abstract concepts and they may be able to use simultaneously both categorical and other kinds of relations. In their research they tested if children used multiple kinds of concepts by measuring them independently and showed that children had the potential for conceptual flexibility, as they were not restricted to a single form of categorization. The present work goes a step further showing that children as young as 5yo can categorize using more than one concept at the same time, being able to draw complex conclusions.

The fact of having used pictures for the sorting task, rather than real foods could have simplified the understanding and categorization. Kimmel, Grant & Guinard (1994) suggested that the use of pictures as examples in sensory tests with children might simplify their understanding.

Table 1 shows the frequency of allocation of the 12 food items to each of the four pre-selected groups for the three age cohorts. Almost all the products were categorized as expected regarding their healthiness by the majority of the participants: *fresh vegetables, orange juice, fresh fruit, bread* and *milk products* under the "healthy" symbol and *crisps, candy, chocolate candy bar, donuts, chocolate biscuits* and *coke* under the "not healthy" one. However, the opinions were divided regarding the product

198 *nuts*, a healthy snack that many of the children in the three cohorts had the perception
199 of being “not healthy”. Taking into account all the interviewed children, 81 of them
200 classified nuts as not healthy and 64 as healthy. In particular, in the 7yo group a big
201 majority of the children (40 vs 10) categorized them within the not healthy groups. This
202 perception might arise from the fact that they could be linking this food to other less
203 healthful snacks like crisps. Also, nuts are many times subjected to preconceptions of
204 being not very healthful because of their high caloric content, or being perceived as
205 less nutritious when associated to their fried/salted counterparts (Oakes, 2004), some
206 of these perceptions could be held by their parents and transmitted to the children for
207 example through being a restrained food item at home. Gracey, Stanley, Burke, et al.
208 (1996) observed that school children of lower socioeconomic levels consumed
209 significantly less nuts than those teenage children of higher levels, which might be
210 related to a probable lower nutritional knowledge in the household.
211 The Multiple Correspondence Analysis (MCA) for each of the age groups revealed the
212 separation of the products depending mainly on their healthinessin the first factor of the
213 MCA, while the liking was more associated to the second factor (Figure 2a). Figure 2b,
214 displays the sample plot for the 9yo group; in the example, “junky”, less healthy
215 products were grouped towards the positive side of the first factor (right) and the
216 healthy foods were associated to the negative part of it (left). *Nuts* were plotted middle-
217 way on the graph. *Fresh vegetables* were associated to the positive (upper) part of the
218 second factor, due to their more negative hedonic perception as compared to the rest
219 of the food items (Figure 2a). The “healthiness” of the sorted items seemed to have
220 had the most weight in the classification, correlated mainly to the first factor of the
221 MCA, which explained most of the variability.
222 To study the correlation between the three cohorts, an MFA was run on the three data
223 sets derived from the sorting (Figure 3). The superimposed representation of the
224 products in the Multi Factor Analysis (MFA) showed that the coordinates of each
225 product in each configuration were very close, highlighting the high correlation between

the perceptions in the three groups. This was also demonstrated by the obtained RV coefficients (also displayed on figure 3) which were all close to one. RV depends on the relative position of the points in the configuration and it is independent of rotation and translation (Robert & Escoufier, 1976). An RV coefficient greater than 0.7 is generally considered as a good level of agreement (Cartier et al., 2006).

The exception were the *fresh vegetables* that were not that well correlated between groups, probably due to their differences in hedonic perception between the three (further details in the next section). The *fresh vegetables* appeared well separated from the rest of the healthy options in the second factor because of their low hedonic perception in comparison to the rest of the tested food items.

It also can be observed how the consensus point for the *nuts* appeared middle way in the map between the “healthy” and “not healthy” food items, because of the split of the responses between those two categories The correlation between the 3 groups was also less good for *nuts*, the balance between “healthy” and “not healthy” responses was different in the 3 populations, what can be seen by the separation of the points on the x axis. As discussed, a big percentage of the 7yo classified them as “not healthy” (40 vs 10) more than half of the 5yo did the same (23 vs 21) and in the 9yo group the categorization was more towards the “healthy” option (33 vs 18) (Table 1).

In general, the three groups of children showed a good knowledge of the nutritional value of the tested foods, in agreement with Nguyen (2007) who found that even 3-year-olds could categorize many foods into “healthy” or “junky”. In that research however, there appeared to be some foods that were particularly difficult for most of the children to categorize accurately, this seemed to be the case also with the *nuts* in the present study.

3.2. Overall liking and preference mapping

The ANOVA showed significant differences in liking between the products, the age groups and their interaction. Figure 4 displays the overall liking scores interaction chart

together with some of the ANOVA statistics. Although the hedonic reaction in the three groups was rather similar, there were some particularities. In general, 5yo kids gave significantly higher overall liking scores to all items. *Crisps* were the top liked product for all ages, *fresh vegetables* were the less liked for the 7yo and 9yo, *coke* was the less liked in the 5yo group. The *candy (gumdrops)* was less liked in the 9yo group.

The liking patters within each group were quite homogeneous, as revealed by the internal preference maps (IPM) in the three cases. The consumer vectors covered only one of the quadrants of the map, showing good accordance in the hedonic perception towards the evaluated items within each group. Figure 5 shows as an example the IPM for the 7yo age group. The fact that the hedonic response was similar in the tree groups, and that the products were well discriminated, suggests that there was a good understanding of the 7-point smiley hedonic scale in all of them, in agreement with the literature, stating that the understanding of liking scales starts around 5yo (Kroll, 1990; Kimmel et al., 1994; Chen, Resurreccion & Paguio, 1996; Guinard, 2001).

The obtained product configurations were very different to the ones obtained in the sorting task, proving different perception was reflected by both results: liking was not the only driver of the sorting, healthiness perception was also taken into account. In this sense, the fact that children classified the foods attending primarily to the healthiness of the foods rather than their liking is an interesting point. This could be arising from an educational issue, as they are taught about nutrition and the fact of realising the task in class could predispose them to pay more attention to that. Also, they might have been involuntarily primed by the instructions given, as the interviewers explained the concept of “healthy” and “unhealthy”, and they performed an example. It would be interesting to repeat this experiment outside school, to being able to draw more generalising conclusions regarding the weight of nutritional and hedonic aspects in their categorization.

The potential application of structured sorting as a means to study complex concepts around nutrition with pre-schoolers is anyway promising, as very little was previously

known in this topic regarding children under the age of 6 years (Tatlow-Golden et al., 2013). It would be interesting to continue this line of research to examine the capabilities of sorting regarding different aspects of children's perceptions about foods. The use of simple images of very well-known foods in the present work was a first step. It is still to be proved how well sorting would work on more complex stimulus (e.g. meals/dishes) or when using less known food items. Also, it would be interesting to find out the applicability of this approach with real foods, with tasting involved, as the interaction between the healthiness and the actual hedonic response could be more complex than the one highlighted by this work by the imagined or expected liking.

The use of pictures in the categorization exercise made it simple to fulfil and at the same time "fun" for small children as it resembled a game. In terms of practicalities, in this work the number of pictures utilised was not particularly large (12 pictures), but the friendliness of the task and the understanding shown by the interviewees would suggest it would be possible to use it with more items. In a previuos work, Nguyen (2007) utilised 70 pictures to be categorized by children 3-7yo with success, in that case the pictures were also simple and the foods well known, but they just sorted them in two goups (junky/healthy). The fact of categorizing using more than one criteria could make the task more tiresome and complex, so it is expectable than such a large number of items could be too many. More research would be needed to being able to recommend a maximum amount of pictures to be included in a test like this.

4. Conclusions

The structured sorting task was well understood and easily performed by the three studied age cohorts (5yo, 7yo, 9yo).

The structured sorting with the use of images appeared as a promising tool to study children perception of multidimensional concepts, in this particular case demonstrated by the fact that they were able to classify products taking into account healthiness and hedonic perception at the same time.

In general, the three groups of children showed a good knowledge of the nutritional value of the tested foods; the three cohorts presented some particularities regarding liking, but the preference patterns were comparable.

Further research would be needed to assess the potential of this tool to assess nutritional knowledge with more complex product sets, and in particular with tasting of real products. Being that structured sorting was well understood, free sorting with a description step would be another interesting tool to test with young children, probably needing more support at the time of realising the task. Also, other more complicated categorization tasks would be worthy of testing with children, as it can be napping, for nutritionally related concepts or other sensory or non-sensory parameters.

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Tables

Table 1- Frequency of allocation of the food products to each of the four pre-selected groups for the three age cohorts

	5yo				7yo				9yo			
	L/H	DL/H	L/NH	DL/NH	L/H	DL/H	L/NH	DL/NH	L/H	DL/H	L/NH	DL/NH
FRESH FRUIT	45	0	0	0	41	10	0	0	48	3	0	0
ORANGE JUICE	34	10	1	0	36	13	1	1	48	3	1	0
FRESH VEGETABLES	34	11	0	0	15	33	0	1	25	24	1	0
BREAD	39	3	1	1	36	11	1	2	44	6	2	0
NUTS	19	2	21	2	8	2	31	9	28	5	15	3
MILK PRODUCTS	38	2	2	3	41	10	0	0	48	3	0	0
CHOCOLATE BISCUITS	8	6	17	13	3	4	24	17	5	4	33	9
CRISPS	12	0	30	3	3	0	40	5	7	3	38	3
COKE	0	1	19	24	0	2	26	22	1	0	32	17
DONUTS	2	3	22	15	6	4	23	15	0	1	36	13
CHOCOLATE BAR	0	4	31	8	0	1	37	11	0	2	44	5
CANDY	0	1	30	13	1	0	42	7	0	1	35	14

Figure captions

Figure 1. Structured sorting ballot

Figure 2a – Variables plot of the two first factors of the Multiple Correspondence Analysis of the sorting task data for the 9yo group.

Figure 2b – Product map of the two first factors of the Multiple Correspondence Analysis of the sorting task data for the 9yo group. With triangles are shown the food items expected to be sorted as “not healthy” and with circles the “healthy” options.

Figure 3 – Superimposed representation of the products in the Multi Factor Analysis (MFA) and Rv coefficients. Each sample is represented using three points corresponding to each age group (5yo, 7yo, 9yo), the consensus representation is depicted by the middle point. For the chocolate bar, candy and coke only the consensus label was kept for clarity (the groups labels were very close to the consensus). RV coefficients are included in the embedded table.

Figure 4 – Interaction plot from the ANOVA applied to the overall liking scores. ANOVA statistics are also included in the embedded table

Figure 5 – Internal preference map based on the individual overall liking scores, example for the 5yo group. Products’ map (left) and consumers’ map (right)