KEER2014, LINKÖPING | JUNE 11-13 2014
INTERNATIONAL CONFERENCE ON KANSEI ENGINEERING AND EMOTION RESEARCH

Development of an Affective Sensorial Analysis Method for the Food Industry

Lluís Marco-Almagro[1], Simon Schütte[2]

[1] *Universitat Politècnica de Catalunya | BarcelonaTech, Spain, lluis.marco@upc.edu*

[2] *Linköpings Universitet, Sweden, Simon.Schutte@liu.se*

Abstract: Some type of product development method is applied in all industrial branches. In food industry, most of these development methods involve a food designer preparing a number of prototypes to be tested with potential consumers. Several feedback loops allow the designer to improve the product until it is satisfactory. However, it is often not clear to what extend the resulting product is optimized regarding affective aspects. This study presents a method for affective food product development, deeply based in the classical Kansei Engineering model widely used in other sectors, but that integrates ideas presented in the Kansei Food Model suggested by M. Shibata. Basically, the new method incorporates both sensory items and hedonic expressions as Kansei words, and evaluates not only the link between them and the space of properties, but also the relationship between them. The new method is applied in three case studies (two Swedish companies and one Spanish company). Data collection is conducted in both countries, allowing comparisons based on the origin. The method developed worked as expected, and details are given in an applied way based on the case studies. The paper also shows that sometimes results were surprising or unexpected – such as differences and similarities between countries, or the fact that customer preferences ("like it") and desire ("want it") do not exactly match. Difficulties met and advice on how to conduct the proposed method is also given in the text.

Keywords: Affective design in food industry, Kansei Food Model, regression analysis, Quantification Theory Type 1

1. INTRODUCTION

In all industrial branches some type of product development method is applied. In food industry most of these development methods mean that a food designer (or a team of food designers)

prepare a number of prototypes and test them with potential consumers (Meiselman, 2000). Several feedback loops allow the designer to improve the product until it is satisfactory (Meiselman, 2000). One weakness in this process is that the fact that many of the decisions are made by the designer and only the final result is evaluated by customers (MacFie, 2007). Even if the design team is experienced, they still are biased by their own background as well as by corporate culture (MacFie, 2007). This means that products cannot be optimized regarding affective aspects. It is apparent that only measuring sensory preferences using e.g. test panels is not enough (Meiselman, 2000). Food products must today also express certain values (such as luxurious, healthy, etc.) (Jordan, 2001). They must be desirable. Consumer goods industry understood that about 20 years ago and utilizes today methods to cope with those affective aspects in product development (Jordan, 2002). Hence, integration of those methods in food industry can complement traditional methods and lead to superior products.

The research project described in this paper, and funded under the Vinnova program of the Swedish government, develops an affective sensorial analysis method for the food industry. Section 2 of this paper describes the procedure. The method is successfully applied to three companies. Sections 3, 4 and 5 gives detailed explanations on these case studies. Section 6 summarizes the main conclusions of the experience.

2. THEORETICAL FRAMEWORK

2.1. The model for affective product development

The model for developing Kansei Engineering in product development shown in Figure 1 (Schütte, Eklund, Axelsson, & Nagamachi, 2004) has proven very successful in multiple applications.

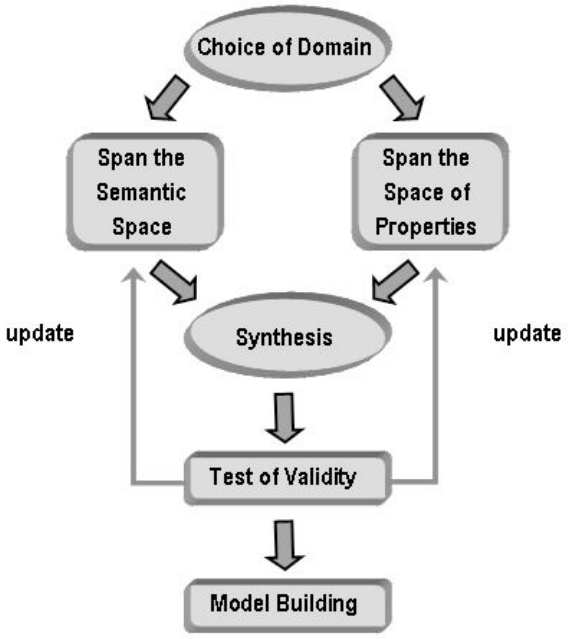

Figure 1: A proposed model of Kansei Engineering method (taken from Schütte, Eklund, Axelsson, & Nagamachi, 2004).

After choosing a domain, two different perspectives are developed: the semantic description and

the description of product properties. These two descriptions each span a kind of vector space. Subsequently these spaces are analyzed in relation to each other in the synthesis phase, indicating which of the product properties evokes which semantic impact. After these steps have been carried out, is it possible to conduct a validity test, including several types of post-hoc analyses. As a result of this step, the two vector spaces are updated and the synthesis step is run again. When the results from this iteration process appear satisfactory, a model can be built describing how the Semantic Space and the Space of Properties are associated.

2.2. A food Kansei Engineering model

Thinking in food, Sagara (1994) defines the term “Kansei” as: 1) the ability to sense and perceive external stimuli through sensory organs; 2) emotional dynamics elicited by all the senses; 3) sensory desires under the control reason and mind. The term “food Kansei” is coined later and defined by the same research group as “an alternative concept of reciprocal relations between foods and humans to proposes an interdisciplinary academic paradigm of Food Kansei Engineering” (Shibata, Araki, & Sagara, 2008)

Ikeda et al. suggested the Food Kansei Model as presented in Figure 2 (Ikeda, Naga, & Sagara, 2004). Its purpose is to correlate physical properties of food and food perception. Ikeda et al. hypothesize that food has both intrinsic and extrinsic attributes. As intrinsic attributes they define physical properties such as chemical compositions and structures. In short all sensory perceptions perceived inside the mouth. Extrinsic attributes, on the other hand, are according to them product properties which are stated externally, in form of package (design and text), ads, commercial, health benefits, etc.

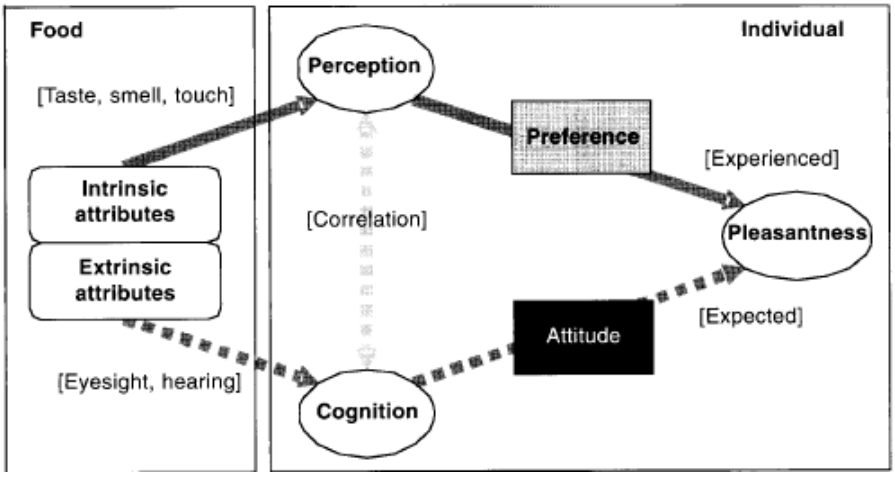

Figure 2: Food Kansei Model (taken from Ikeda et al., 2004).

The Kansei Food model is subdivided into two parts. The left hand part represent the perception, the right hand part the acceptance. It becomes clear that the acceptance part consists out of two paths. The “intrinsic path” deals with the sensory evaluation of the actual product, while the “extrinsic path” generates the exceptions of the product. Both lead ultimately to pleasantness. Pleasantness is in this context defined as the combination of perceptual factors (intrinsic), cognitive factors (extrinsic) and appetitive factors (motivation) (Ito, Umemmoto, Ono, Tokosumi, & Ikeda, 1994).

Ikeda’s model in Figure 2 is rather complex. A number of studies have been carried out by the same research group Ikeda is working in. Going through their publication in chronological order a

development can be seen. After the Kansei Engineering food model was developed their studies focused on the “intrinsic” part only (Ito et al., 1994; Shibata et al., 2006). When they integrated the extrinsic part they apparently discovered that it had to be modified in order to comply with the structure of the intrinsic path (Ueda et al., 2008). First after 2010 the model can handle the intrinsic and extrinsic part (Akiyama et al., 2011) without problems.

All of the publications mentioned in the section above, however, are rather vague on how the Kansei Engineering Food Model can be interpreted and applied. Shibata et al. (2008) present a possible flowchart and suggest a number of tools in order to achieve affective food evaluation. This suggested structure is presented in Figure 3.

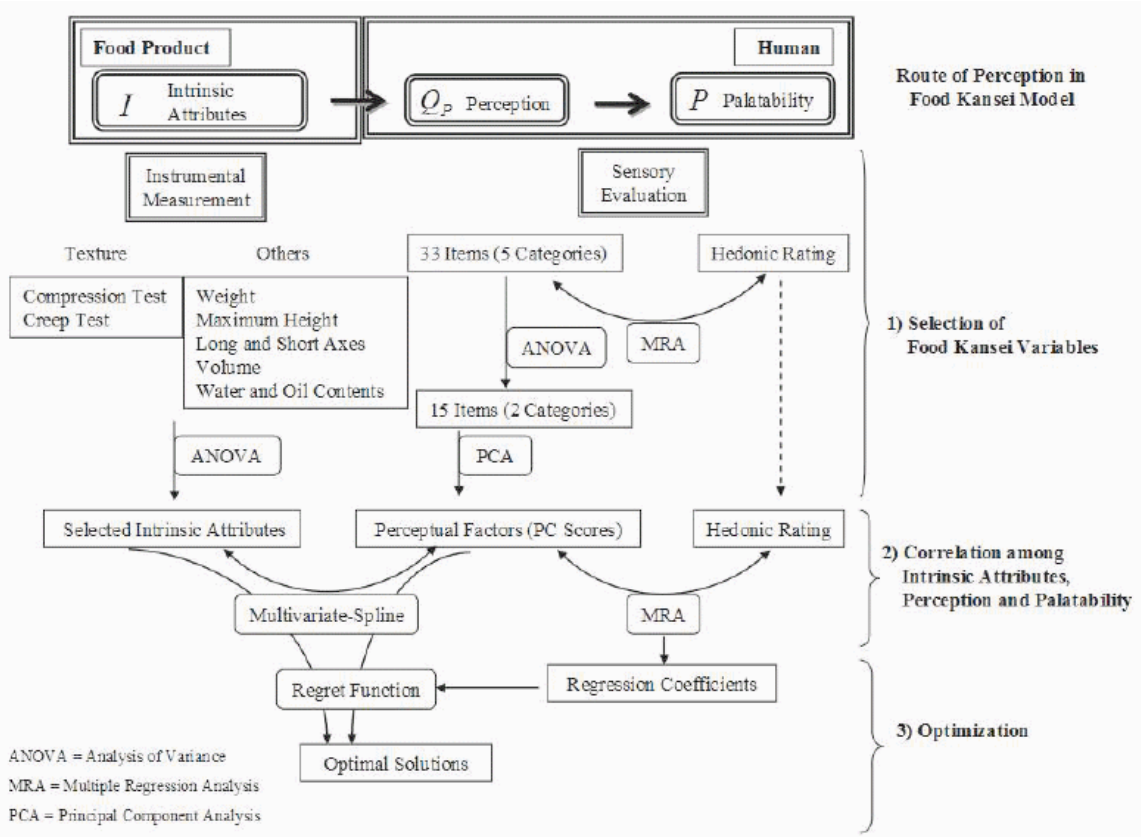

Figure 3: Route of perception according to Ikeda et al. (2004) and Shibata et al. (2008)

As the general Kansei Engineering model in Figure 1; the Kansei Food Model in Figure 3 makes a distinction between product properties (intrinsic attributes/ Space of Application) and human perception (Palatability/ Semantic Space). Both areas are initially explored and then linked together in a synthesis step.

The procedure suggested in this paper is a hybrid between the Kansei Engineering model as it is used for hardware products (Figure 1) and the Kansei Engineering Food model (Figure 2). Comparing those two figures it becomes obvious that they have a lot in common. They create a mathematical relationship between intangible affective values in the user’s minds and physical properties of the product. By matching the activities in the Kansei Engineering Food model with the stages in the Kansei model, it becomes possible to identify separate action and intermediate results. It also makes it possible to replace certain tools used in the Kansei Engineering Food model with other tools with the same purpose.

The hybrid model used here has two main areas. The Identification of Intrinsic attributes which is equivalent to the erection of the Space of Properties. Physically measurable product properties are found and selected according to their ability to create an affective impact of the consumer.

In a parallel step, semantic properties are selected. While hardware products usually only require the evaluation of hedonic values (often verbally expressed adjectives) food has an additional dimension: sensory items. Those are semantic descriptions close related to the physical impression of taste and mastication (i.e. flaky, oliy, crunch, etc.). Accounting for this the spanning of the Semantic Space as it is described by Osgood et al. (1957) is a bit different. Firstly the semantic descriptions are collected and subsequently separated into “Hedonic Expressions” and “Sensory Items”. Outgoing from the data collected on Semantic Visual Scales using KESo software (Schütte & Schütte, 2009), a Principle Component Analysis (PCA) is performed on both sets of terms separately. This step reduces the number of terms and identifies those terms which have the highest impact on the users affect. Regression analysis can be conducted to link the hedonic expressions with the sensory items (something not done in a classical Kansei Engineering study, as this distinction among kansei words does not exist).

Subsequent both sections of the semantic space are linked to the Space of application. In Ikeda’s Kansei Engineering Food model this was done using multiple regression analysis (MRA). However, other methods have been used in consumer industry such as Quantification Theory Type 1 (QT1) (Komazawa & Hayashi, 1976b), Rough Sets Analysis (RSA) (Nishino, Nagamachi, & Ishihara, 2001), Ordinal Linear Regression Analysis (OLR) (Marco-Almagro, 2011) and others.

The suggested procedure will become apparent in the following three Section, which present three case studies. Two of them (Cloetta, a confectionary manufacturer, and Espuña, a charcuterie manufacturer) strictly follow the modified Kansei Engineering food model presented previously. The third one, Lantmännen, which produces breakfast cereals, presents some particular characteristics.

3. THE CLOETTA CASE STUDY

Cloetta AB is a leading confectionary manufacturer, which produces chocolate products, sugar confectionary, pistils and chewing gum in Scandinavia, The Netherlands and Italy. Their products are sold in more than 50 countries. Cloetta’s R&D department identified a new trend for product development: “power bars”, i.e. chocolate bars providing energy. Amongst other products they produce two sister power bars containing out several layers of wafer covered with chocolate (Figure 4).

Figure 4: Cloetta Kex-Choklad (left) and Sportlunch (right).

Both products are very similar, but Kex choklad has a thinner chocolate cover and is selling better to a wider market. Sportlunch suggests a closer connection to physical activity and is therefore consumed at more limited occasions. Also Sportlunch is preferred by male consumers.

Having this in mind the Cloetta development team is eager to differentiate these products further.

3.1. Aim of the Cloetta study

In this particular case study, the aim was to determine a filling with an emotional profile corresponding to the brand image of Sportlunch of being sporty and refreshing (Swedish: uppiggande). More concrete, a suitable combination of ingredients shall be found which at the same time is preferred ("like it") and desired ("want it") by the consumers. A secondary aim is to find a combination which works most likely in both Sweden and Spain.

3.2. Study structure of the Cloetta study

The study was carried out in accordance to the modified Kansei Engineering food model suggested. Firstly, a domain was chosen. From this the Semantic Space and the Space of Application were determined. For erecting the Semantic Space, emotional words were collected. These words derived from previous studies ((Schütte, 2013)(Prithivirat & Grzechnik, 2011)), competing product ads consumed at sport occasions and Cloetta's own development team. In order to complement these data pilot study was performed, asking 25 consumers to semantically describe their impression when eating Sport Lunch. These words were then screened manually and separated into hedonic expressions and sensory items. After applying affinity diagram technique the number of semantic terms was reduced and expressions with overlapping meanings eliminated.

In parallel the product development division of Cloetta identified key ingredients and combinations thereof with high emotional impact. In cooperation with LiU an experimental plan was established and the selected prototypes produced.

Kansei Engineering Software (KESo) (Schütte & Schütte, 2009) was used for establishing a data collection homepage. The consumers were provided an assortment box containing samples of individually numbered chocolates containing different samples. Despite the different taste the samples looked identical. Using the website, the consumers were asked to take a specified sample and test it, giving a rate on a visual analogue scale (VAS) in a position which "felt" right (Figure 5, left). The data collection was carried out in 2 stages. In the first stage Swedish chocolate consumers, with medium to high chocolate consumption answered the survey. In the second stage, the survey was answered by Spanish chocolate consumers. Additional data was provided by two chocolate experts in a third group, which however was too small to include in the final evaluation.

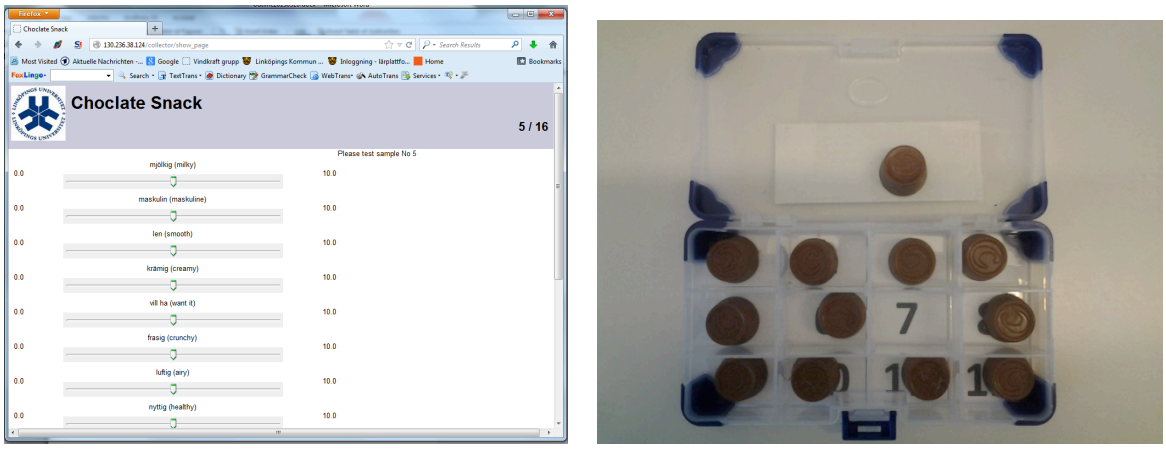

Figure 5: Data collection using KESo software (left, data collection site; right: samples provided in an assortment box).

KESo provided instant results by applying QT1 analysis (Komazawa & Hayashi, 1976a) and Rough Set Analysis (Nishino et al., 2001). The data was also checked for data quality and consistency.

3.3. Results of the Cloetta study

As a result of the semantic data collection a total number of 151 expressions were collected. Of those 55 expressions were hedonic expressions, 32 were sensory items (20 described the texture and 12 the taste). The rest were either variants of expressions (sweet, sugary, sugar, etc) or deemed irrelevant. After the affinity analysis the following words remained and were used in the following data collection (Table 1).

Table 1: Kansei Words used in the Cloetta study and their translations.

Type		Svenska	English	Català	Español
Hedonic expressions		Vill ha	Want to have	Ho vull	Lo quiero
		Nyttig	Healthy	Sa	Sano
		Energi	Energy	Energia	Energía
		Maskulin	Maskuline	Masculí	Masculino
		Tycker om	Like it	M'agrada	Me gusta
Sensory items	Texture	Len	Smooth	Suau	Suave
		krämig	Creamy	Cremós	Cremoso
		Frasig	Crunchy	Cruixent	Crujiente
		Luftig	Airy	Flonjo	Ligero
	Taste	Mjölkig	Milky	Lletós, amb llet	Lechoso, con leche
		nötigt	Nut-like	De nous	De nueces
		uppiggande	Refreshing	Refrescant	Refrescante

As mentioned above, different recipes of combinations of ingredients were prepared. In order to get best results a reduced factor table with dummy coding was developed. The ingredients chosen were caffeine, three different flavours, yoghurt and chilly spice (to produce a hot feeling). **Error! Reference source not found.**2 shows the 12 combinations which were tested by the participants.

Table 2: Set of stimuli used in the Cloetta case study.

Sample No.	Caffeine	Flavour	Yoghurt	Spice
1	Yes	Salt	No	Chilli
2	Yes	Salt	No	None
3	No	Salt	Yes	Chilli
4	No	Salt	Yes	None
5	No	Nut	No	Chilli
6	No	Nut	No	None
7	No	Nut	Yes	Chilli
8	No	Nut	Yes	None
9	Yes	Fruit	No	Chilli
10	Yes	Fruit	No	None
11	No	Fruit	Yes	Chilli
12	No	Fruit	Yes	None

The data collected in KESo software were checked according to its quality. A K-S test was performed to check whether the data was normally distributed. That was the case for all Kansei words used. Also, it was checked if the gender, the age and the nationality (Swedish, Spanish) made a difference in how the test samples were perceived. As for the gender significant differences were found only for the word “smooth in sample 1”. Otherwise no significant differences were found for man and women. The age range of the participants was quite narrow. That might be the reason that no significant difference could be observed. For the nationality the Levene’s Test show 3 significances regarding the variances. However, no significant differences were found for the means of the nationality rankings in the t-test. As a consequence all data was pooled for further evaluation.

Figure 6 shows the average rating values plotted in a radar chart. These presentations are commonly known as emotional profiles of the samples.

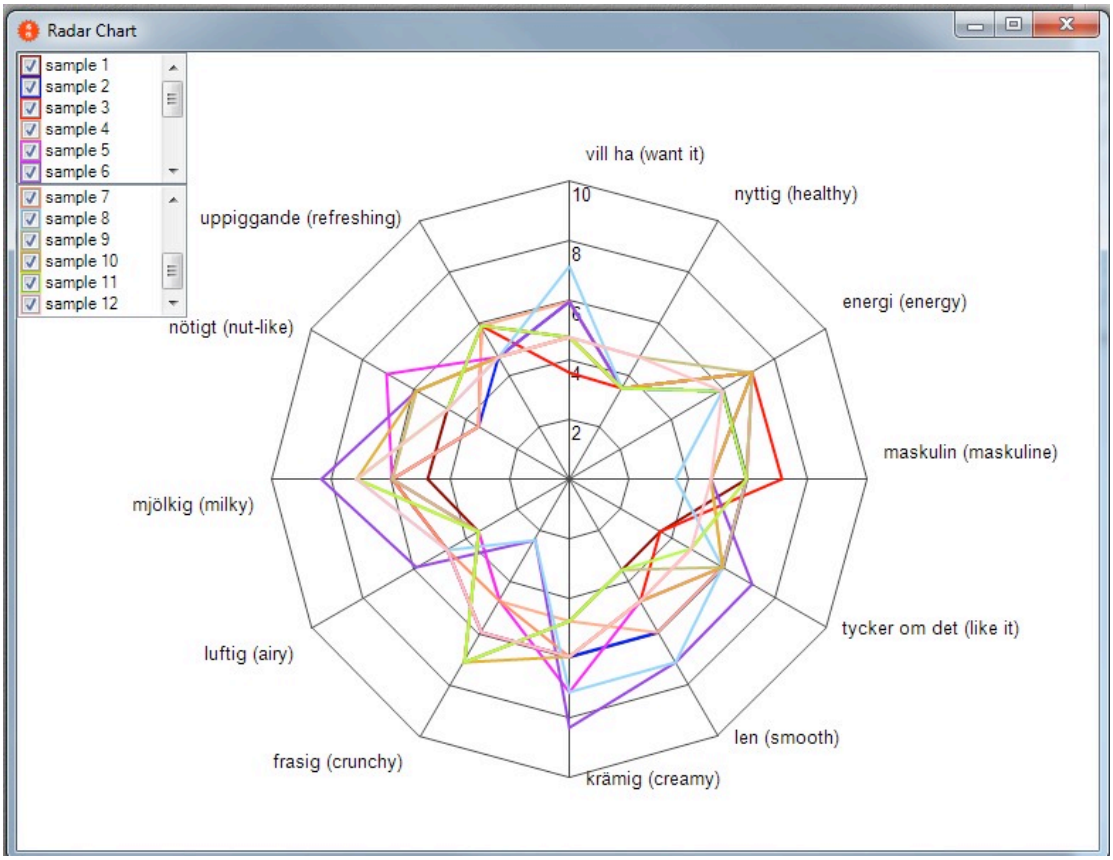

Figure 6: Emotional Profiles for each sample; all participants’ average.

3.3.1. Principal component analysis (semantic space)

A principal component analysis (PCA) has been conducted separately on sensory items and hedonic expressions for both Swedish and Spanish results. The results are incredibly similar for both countries when dealing with sensory items (Figure 7).

Sweden Spain

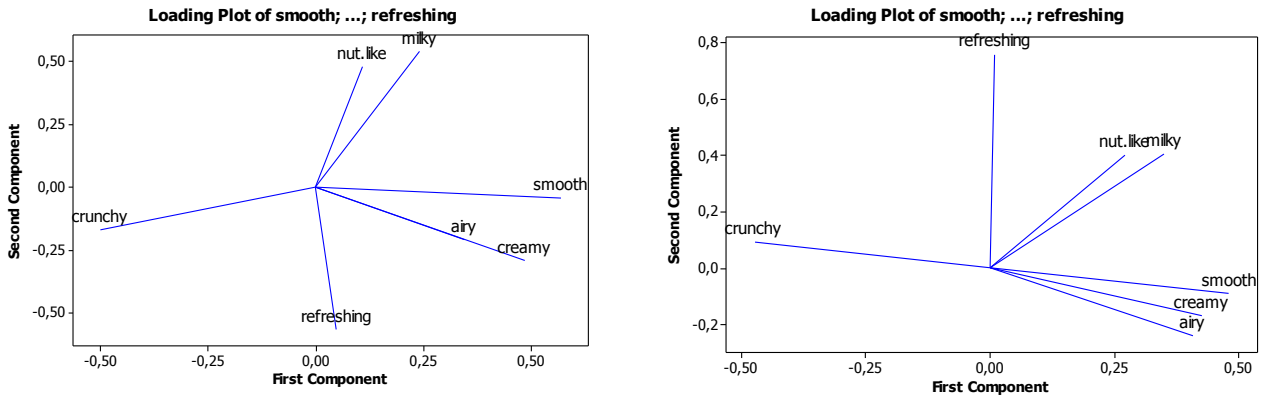

Figure 7: Principal component analysis (PCA) for sensory items in the Cloetta study.

Creamy, smooth and airy fall very close in the semantic space; and these three sensory items are perceived as contrary to crunchy. Nut-like and milky are also close together. Refreshing falls quite alone in the semantic space, and this is the only word with a different location depending on the country.

The fact that the deployment of this semantic space of sensory items is very similar to both countries makes sense. Participants in the study seriously rated all sensory items and arrived to similar conclusions in both countries, as these sensory items are intrinsic attributes of the chocolates, easier to "objectivize".

The PCA for the hedonic expressions (Figure 8) show more dissimilarities between both countries. Basically, all hedonic expressions fall far away one from the other. The exception is for expressions "want to have" and "like it" for the Spanish results, where both words are quite close.

Sweden Spain

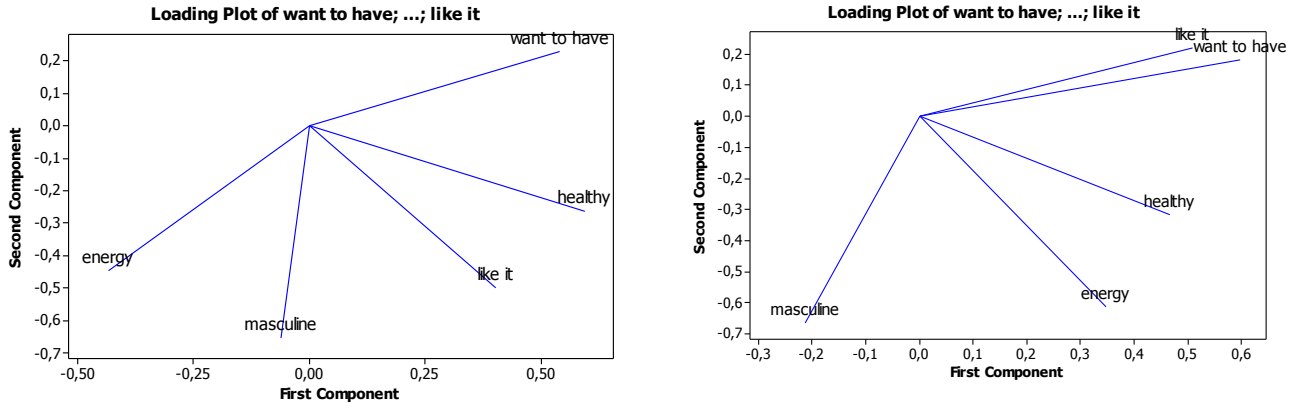

Figure 8: Principal component analysis (PCA) for hedonic expressions in the Cloetta study.

3.3.2. Regression analysis

A linear regression analysis has been done using each one of the hedonic expressions (want to have, like it, healthy, energy and masculine) as responses, and the sensory items (smooth, creamy, crunchy, airy, milky, nut-like and refreshing) as possible regressors.

The selection of the best model for each response has been done using a best subsets procedure (doing all possible regressions and choosing the best one based on adjusted squared R^2 and Mallow's Cp indicator).

Figure 9 summarizes the results for both Swedish and Spanish data collections. The figure % response explanation is the value of adjusted R^2 in the linear regression analysis. It represents the percentage of variability of the response that can be explained by the given variables.

Sweden

	Smooth	Creamy	Crunchy	Airy	Milky	Nut-like	Refreshing	% response explanation
Want it	+	–						54
Like it				–		–		39
Healthy				–		–		54
Energy	–	+						30
Masculine			+		+		+	69

Spain

	Smooth	Creamy	Crunchy	Airy	Milky	Nut-like	Refreshing	% response explanation
Want it	+				+			61
Like it			–		+			76
Healthy		–		+		+		57
Energy			–		–	+		29
Masculine	–	–				+	–	77

Figure 9: Relationship between hedonic expressions and sensory items based on regression analysis for the Cloetta study.

3.3.3. Quantification Theory Type 1

The evaluation using QT1 yielded a great amount of data. An example of a QT1 output is displayed in Figure 10. It compares the results for the terms "want it" and "like it". The diagrams in each figure can be interpreted in the way that the combination of caffeine, nut taste, Yoghurt and no chilli spice will maximize the rating for "want it". The picture is similar for "like it" where the combinations of no caffeine, nut or fruit taste, no yoghurt and no chilly spice produce the highest ratings. This means that a product which people like AND want need to have nut flavor, and no chilli spice. It also shows that liking and wanting are different concepts when it comes to food products.

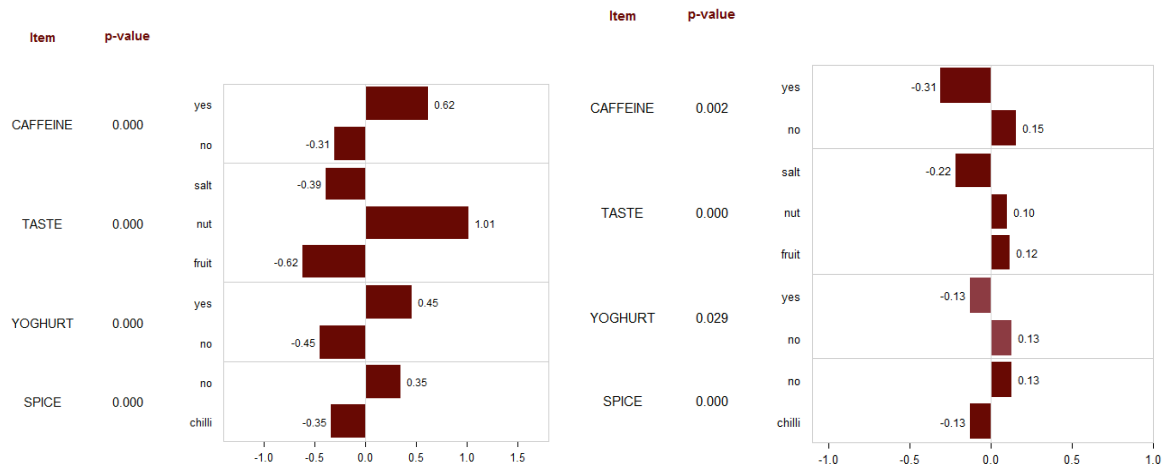

Figure 10: QT1 output from all pooled data for "want it" (left) and "like it" (right).

Figure 11 displays all the QT1 result in only one table. It can be seen that in some points there are differences in the ratings of the Spanish and Swedish groups. However, it can also be seen that despite those differences it is possible to find a common pattern for both groups. This implies that a chocolate product designed for either market probably will be perceived similar on the other market as well.

		Kansei word	Dataset	Caffeine		Taste			Yoghurt		Spice	
				Yes	No	Salt	Nut	Fruit	Yes	No	no	chilli
Hedonic expressions (Kansei Words)		Want it	Sweden	+	-	-	+	-	+	-		
			Spain			-	+	-	+	-	+	-
			All	+	-	-	+	-	+	-	+	-
		Like it	Sweden	-	+	+	-	+			-	+
			Spain	-	+	-	+	+	-	+	+	-
			All	-	+	-	+	+	-	+	+	-
		Healthy	Sweden	+	-	+	-	-	+	-		
			Spain	-	+		+	-			+	-
			All	+	-	+	+	-	+	-	+	-
		Energy	Sweden	-	+	+	-	+	-	+	-	+
			Spain	+	-	-	+	-	+	-	-	+
			All	-	+	-	+	-	-	+	-	+
		Masculine	Sweden	+	-	0	-	+	+	-	-	+
			Spain	-	+	+	-	-	-	+	-	+
			All			+	-	0	-	+	-	+
Sensory items	Textures	smooth	Sweden	+	-	-	+	-	+	-	+	-
			Spain	-	+	-	+	+	-	+	+	-
			All	+	-	-	+	-	+	-	+	-
		Creamy	Sweden			+	+	-	-	+		
			Spain			-	+	0	-	+	+	-
			All			0	+	+	-	+	+	-
		Crunchy	Sweden	+	-	-	-	+	-	+	-	+
			Spain	+	-	+	-	+	+	-	-	+
			All	+	-	+	-	+	+	-	-	+
		Airy	Sweden	+	-	-	+	-	+	-	+	-
			Spain	-	+						+	-
			All			-	+	-	+	-	+	-
	Taste	Milky	Sweden			-	+	-	+	-	+	-
			Spain	-	+				-	+	+	-
			All	-	+	-	+	-			+	-
		Nut-like	Sweden	-	+	-	+	0	-	+	+	-
			Spain	-	+	-	+	+	-	+	-	+
			All	-	+	-	+	+	-	+		
		Refreshing	Sweden			+	-	-			-	+
			Spain			-	-	+	+	-		
			All			+	-	-	+	-	-	+

Figure 11: Assembly of all QT1 results. "+"/"-" means positive impact of the respective category on the average rating. Empty boxes mean that the data is not significant.

3.4. Conclusions of the Cloetta case

When collecting data also a number of demographic questions were asked. This was meant in order to be able to stratify the data afterwards. Except for the citizenship, it was difficult to find

subgroups regarding age or chocolate eating habits. The reason for this might be twofold. Partly, the low number of participants did not allow clear results. Partly, the group of participants was deliberately chosen as homogenous as possible (for instance, age range was very narrow).

Most important kansei words for the company were the terms “want it”, “like it”, to ensure that consumers will repeatedly buy the product. Also the words “masculine”, “healthy” and “refreshing” were chosen by Cloetta to be prominent for this product group. The rest of the words were chosen in a way that they had positive influence on the product.

The best compromise with those prerequisites was:

- Sweden: Caffeine: yes, Taste: fruit (or possibly salt), Yoghurt: Yes and Spice: No (only to emphasise masculine chilli can be added)
- Spain: Caffeine: No, Taste: nut (or possibly fruit), Yoghurt: Yes and Spice: No (except for masculine)

Considering those selections it is not impossible to find a combination which works for both countries. It can be speculated that such product might work for more than just the Swedish and Spanish market.

4. THE LANTMÄNNEN CASE STUDY

The conglomerate of Lantmännen is entirely owned by Swedish farmers. Founded in 1924 and reorganized in 2001 their goal is to refine agricultural raw products and market them using their own brands. This case study was carried out for the branch Lantmännen cereals. A research project started in January 2013 evaluated different recipes of rye based breakfast flakes. The aim was to determine the physiological effects on the feeling of satiating (Isaksson, 2011). For this the participants would consume a number of pre-fabricated product variants. Consecutively, physiological measurements (blood sample, breath hydrogen measurements) but also subjective measurements of appetite registration using VAS scales were taken. As a final result an optimized mixture of ingredients should be determined. The hypothesis was that if consumers of breakfast cereals feel satiated for a longer time after consumption they will consume less food leading to a healthier life style. It is however known that food products’ visual appearance (structure, colour, etc) and physical properties (such as taste, consistence, etc.) have a major impact on the acceptance of the product (Ueda et al., 2008). These affective properties were not being tested in the study carried out at Lantmännen themself.

4.1. Aim of the Lantmännen study

The aim with this case study was to determine the affective impression of the visual sensation and compare it to the actual impression when consuming the product.

Particular questions to be answered were:

- Does the degree of satiation vary over time and is it possible to determine the degree of satiation visually before consumption?
- Is there an association between personal taste preference (like it) and desire (want it)?

This will be done by defining a Semantic Space, and emotional profiles of the five products selected.

4.2. Study structure of the Lantmännen case study

The study is carried out in accordance to the modified Food Kansei Engineering model presented previously.

The Semantic Space was determined using brainstorming technique, as well as gathering semantic descriptions from sources such as adds, TV spots, Internet representation and popular scientific health magazines. These words and terms were manually separated into hedonic expressions and sensory items. Unlike in the other studies the time since consumption were deemed important. Hence both the hedonic descriptions and the sensory items were ordered into three groups of “before consumption, during (or directly after) consumption and 3 hours after consumption”. Affinity analysis grouped the terms in clusters and together with sensory experts the final set of Kansei rating words was selected.

Figure 12: Taste samples for Lantmännens protoyptes.

21 selected customers participated in the data collection. They were provided a data collection form, and five product samples. They were supposed to prepare one sample every morning as a replacement of their normal breakfast. Then they evaluated the dish visually on affective visual analogue scales (VAS). During or directly after consumption they evaluated the product again on a second set of scales. A third and final evaluation was done 3 hours later the same day. After one week the collection sheet was returned.

4.3. Results of the Lantmännen case study

The set of products to be evaluated were picked from an on-going study at Lantmännen. Table 3 depicts the products given. It can be seen that two of the samples were for control purposes (C40 and C55). They are identical, except for the weight. The other three products varied in the content of Inulin and Gluten. In fact all products varied in their visual appearance and sensory texture.

Table 3: Set of products for the Lantmännen study

Product sample	Weight per portion	Inulin per portion	Gluten per portion
C 40	40g	-	-
C 55	55g	-	-
6:6	40g	Medium	Medium
3:9	40g	Low	High
9:3	40g	High	Low

The words on which the products were evaluated on are presented in Table 4. The participants were asked to evaluate a different set of words at different times as seen in the columns. The word “satiating” appears in all three columns in order to evaluate the progression over time. The terms “like it” (personal preference) and “want it” (desire) are asked with a 3 hour gap inbetween.

Table 4: Selected words for evaluation of Lantmännens products with Swedish word in parenthesis.

Words for visual evaluation (before consumption)	**Words for sensory evaluation (during or short after consumption)**	**Words for residual evaluation (3h after consumption)**
Tasty (god)	Smooth (len)	Satiating (mättande)
Appetizing (aptitlig)	Creamy (krämig)	Want it (vill ha)
Satiating (mättande)	Healthy (nyttig)	
Energy giving (energigivande)	Satiating (mättande)	
	Like it (Tycker om det)	

Of 21 Participants who received samples one participant obviously mistreated the data collection, 2 data sets were merely incomplete and 2 were not returned. In total 16 participants finished the study and returned the completed data set. The mistreated and incomplete answers were not taken in account for further evaluation.

Analysing the data, no significant differences were found regarding gender or age group.

A paired samples t-test revealed that all ratings for C40 and C55 were not significantly different. Since they are basically the same product in a different quantity this was expected and insured that the data had good quality. In the following only the data from C40 were compared to the rest of the products, since they had the same quantity of 40 grams.

Paired samples t-tests were carried out checking whether the three different ratings of “satiating” (visual, at consumption and three hours after consumption) were similar. This was done for all products separately. Some significant differences could be observed. All of them were in the comparison between visual and at consumption as well as visual and 3 hours after consumption. This meant that it was difficult for the participants to estimate the degree of satiation just from visual inspection. However it was also found that for the samples 6:6, 3:9, 9:3 the differences were bigger which might mean that the products with additional hunger damping ingredients (Inulin and gluten) were easier to estimate visually.

4.4. Conclusions of the Lantmännen case study

The visual sensory perception yielded different ratings of the products. Some of the properties such as the texture and partly even the taste could be estimated just from looking at the product.

One question Lantmännen was particularly interested in was how consumers evaluate satiation. This case study showed clearly that it was more difficult to estimate the degree of satiation from visual inspection alone. Samples with more ingredients (all but the control) were apparently easier to estimate than those with only one ingredient (C 40 and C 55). It was significantly easier for the participants to estimate the satiation they would feel after 3 hours already directly after consumption.

Regarding for the semantic terms expressing personal taste preference (“like it”) and desire (“want it”) high correlations were found. But since those terms were not entirely rated alike, it can be assumed that the mental picture is not entirely the same, i.e., products that customers like are

not necessarily those they want. Hence, more studies should be conducted to clarify this point.

5. THE ESPUÑA CASE STUDY

Espuña was founded in 1947 in Olot (Spain) as a manufacturer of charcuterie products. Espuña has a presence in European countries (France, Portugal, UK, Germany) and in the South American and Japanese markets. Although serrano ham slices are the most successful product, Espuña has launched two new totally innovative product ranges over the last years: the Minute Tapas range (in 2002) and the "Cañitas" range (in 2011). Both products are quick and easy to prepare and have attractive packaging. The case study presented here is focused on the “Cañitas” range. The aim is discovering the effect of new tastes and shapes on the sensations conveyed by the products when viewed and tasted.

Currently, there are three main flavours of *Cañitas* in the market: chorizo, fuet and salami. All these are products coming from pork, but with different additives and preparation. Salami is a common product in many European countries. Chorizo is popular in the whole Spain, whereas fuet is much more linked to Catalonia, and especially to the counties of Osona and La Garrotxa (the motherland of Espuña).

Figure 13: Two different tastes and lengths of *Cañitas* (fuet, short, on the left; and chorizo, long, on the right)

Cañitas is a product sold in Spain and other European countries. It is now being introduced in Asia, particularly in Japan. Espuña experts were very interested in experimenting with the tastes in the market, together with new “more extreme” ones.

5.1. Aim of the Espuña study

In this case study, the aim was to study the emotional profile conveyed by *Cañitas*. Both the visual impression before being eaten, but especially the taste, had to be evaluated. Some hedonic expressions were of high interest: the perception of an innovative and cool & trendy product, a convenient product, easy to eat everywhere and at any time; and the idea that it is a product for everybody.

5.2. Study structure of the Espuña study

The study was carried out in accordance to the modified Kansei Engineering food model previously presented. Firstly, a domain was chosen. From this the Semantic Space and the Space of Properties were determined.

For erecting the Semantic Space, emotional words were collected. An initial list of 103 words was collected by Espuña experts. The list was made based on personal work by each team member in the company, followed by a brainstorming session to share all the ideas. This initial list of emotional words was reduced using an affinity diagram (Figure 14).

Figure 14: Espuña team working with the affinity diagram

Two properties were used to prepare the set of stimuli: different flavours (the three existing flavours plus two new ones and the shape

So, the items and categories to be used for the study were:

- Taste: salami, chorizo, fuet, ginger pork, curry chicken.
- Shape: long sticks, short sticks, balls, slices.

Some combinations of taste and shape were not feasible (or at least, not easy to produce in the short period of time – a few weeks – allocated for the preparation of all samples). These were not included in the set of products to be evaluated. Table 5 shows the set of products that were prepared.

Table 5: Set of products prepared for the data collection

	Taste	Shape		Taste	Shape
1	Curry chicken	Short stick	9	Salami	Sliced
2	Chorizo	Ball	10	Fuet	Long stick
3	Salami	Long stick	11	Chorizo	Short stick
4	Ginger pork	Short stick	12	Ginger pork	Long stick
5	Fuet	Sliced	13	Salami	Short stick
6	Chorizo	Sliced	14	Fuet	Ball
7	Fuet	Short stick	15	Curry chicken	Long stick
8	Chorizo	Long stick	16	Salami	Ball

Data collection was organized in a different way in Sweden and Spain (Figure 15). In Sweden, Kansei Engineering Software (KESo) (Schütte & Schütte, 2009) was used for both building the

data collection homepage and for actually collecting the data. So each participant was seated in front of a laptop, tasted each sample, and gave ratings moving a slider on the website. In Spain, and to avoid the difficulties of having many computers in a room that was not excessively spacious, the data collection was done on forms printed on pieces of paper. Each participant had 16 pieces of paper (one for each product that had to be rated). To make results from the Spanish data collection totally comparable with those from Sweden, visual analogue scales (VAS) were drawn in the form of 100 mm long lines. Participants, instead of moving a slider on the computer screen, had to write a vertical mark on the VAS (later on, we measured distances with a rule, and extracted all figures, in an easy but time consuming task).

Figure 15: Data collection in Sweden (left), and in Spain (right)

As usual in these studies, and besides the actual ratings, participants also provided personal information such as age and gender.

5.3. Results of the Espuña study

Each product sample was rated on 13 different kansei words, divided into hedonic expressions and sensory items. Table 6 shows the list of words used. Swedish participants were shown the Swedish and English version of the words. Participants in Spain were shown the Spanish and Catalan version of the words.

Table 6: Kansei Words used for the Espuña study, and their translations.

Type		Svenska	English	Català	Español
Hedonic expressions		Cool och trending	Cool & trendy	*Cool & trendy*	*Cool & trendy*
		Innovative	Innovative	Innovador	Innovador
		Bekvämt	Convenient	Convenient	Conveniente
		Närande	Nutritive	Nutritiu	nutritivo
		För alla	For everybody	Per tothom	Para todos
		Närhelst varhelst	Whenever wherever	Per qualsevol moment I lloc	Para cualquier momento y lugar
		Vill ha	I want it	El vull	Lo quiero
		Tycker om det	I like it	M'agrada	Me gusta
Sensory Items	Texture	Len	Smoot	Suau	Suave
		Tuggyg	Chewy	Gomós	Gomoso
	Taste	Köttig	Meaty	Amb gust de carn	Con gusto de carne
		Fetty	Greasy	Greixós	Graso
		Kryddig	Spicy	Picant	Picante

A descriptive analysis of all data collected was performed in order to assure its quality. No outlier participants were detected. Furthermore, there were no significant differences based on gender or age. Although great differences were expected between the Swedish and the Spanish group (basically based on knowledge and familiarity with this kind of product), this was not the case. All data analysis has been done separately for Sweden and Spain. However, as results are very similar for both countries and for the sake of simplicity and facilitate understanding, the analysis of all data together will be offered in this section.

5.3.1. Principal component analysis (semantic space)

A principal component analysis (PCA) has been conducted separately on sensory items and hedonic expressions. In this case, the semantic space was better summarized using not only the first two principal components, but three of them. To achieve this, words have been represented in three dimensional scatterplots.

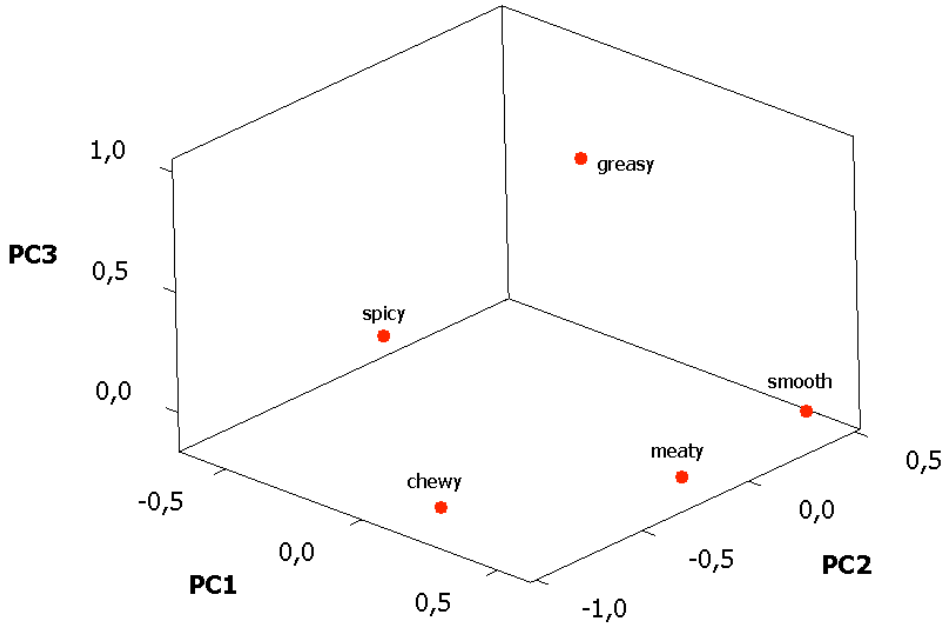

Figure 16: Principal component analysis (PCA) for sensory items in the Espuña study.

As can be seen in Figure 16 the five sensory items are spread on the whole spectrum of semantic space. There is no word perceived as very close to another one. This is not bad; on the contrary, it shows that the selected sensory items cover well all the spectrum of possible sensory items.

The PCA for the hedonic expressions does show words in groups (Figure 17).

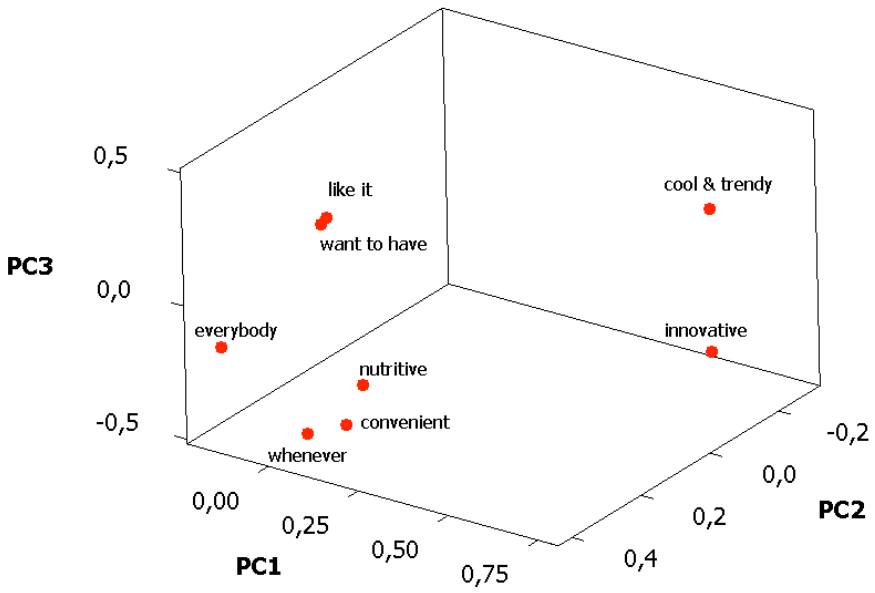

Figure 17: Principal component analysis (PCA) for hedonic expressions in the Espuña study.

These groups are quite logical. “Like it” and “want to have” are very close one to the other. Although this is not always the case (remember the Cloetta study, where this fact did not happen), in this occasion both concepts are perceived as the same: the desire for the product is linked to the preference for that product. “Cool & trendy” and “innovative” are another group, something that can be easily justified by the semantics of both hedonic expressions. “Nutritive”, “convenient” and “whenever-wherever” form another group. “For everybody” is, basically, alone.

5.3.2. Regression analysis

A linear regression analysis has been done using each one of the hedonic expressions as responses, and the sensory items as possible regressors. As in the Cloetta study, the selection of the best model for each response has been done using a best subsets procedure.

Models have been built with data from Sweden and Spain altogether. Figure 18 summarizes the results. The figure % response explanation is the value of adjusted R^2 in the linear regression analysis. It represents the percentage of variability of the response that can be explained by the given variables. Those models having this figure higher than 50% are shown shaded on the table.

	Greasy	Meaty	Smooth	Chewy	spicy	% response explanation
Want to have	–	+		–		73
Like it		+				60
Convenient	–	+			–	74
Cool & trendy	–	+			+	47
For everybody	–	+		–	–	93
Whenever wherever	–	+			–	80
Nutritive	–	+	+			78
Innovative	–				+	72

Figure 18: Relationship between hedonic expressions and sensory items based on regression analysis for the Espuña study.

A quick inspection of the table above shows that greasy affects negatively in almost all hedonic

expressions, whereas meaty affects positively. Smooth and chewy affect very few hedonic expressions, whereas spicy affects positively or negatively depending on the hedonic expression.

5.3.3. Ordinal logistic regression analysis

Data from the Espuña case study was analyzed using QT1 and ordinal logistic regression (OLR), as suggested in Marco-Almagro (2011). The analysis with OLR is able to detect more clearly how each category affects each kansei word. Results from OLR are shown using bars that represent the odds ratio, with the category acting as reference level having the value 1.

Results for Sweden and Spain are very similar. Therefore, results are offered for the whole dataset, with data coming from both countries.

Analysis was conducted for both sensory items and hedonic expressions.

Figure 19 shows the OLR output for some hedonic expressions. Some relevant conclusions are that the preferred tastes are fuet, salami and chorizo. Curry chicken is perceived as the most innovative flavour.

Related to shape, short sticks are seen as the most convenient format.

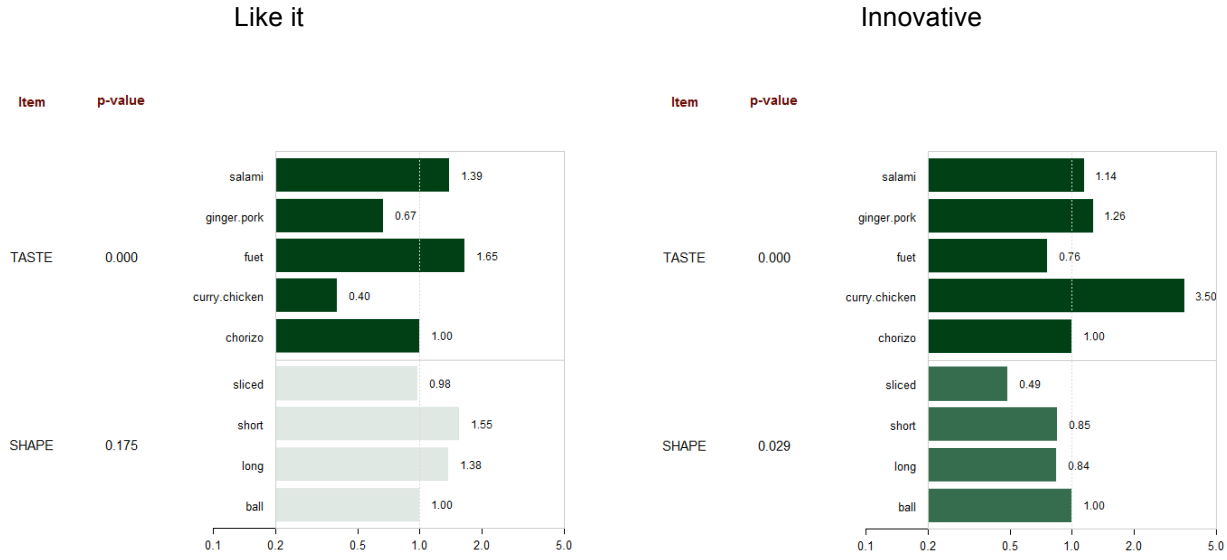

Figure 19: OLR Output for some hedonic expressions in the Espuña study

5.4. Conclusions of the Espuña case study

Very interesting results from the methodological point of view derive from the Espuña case analysis. The principal component analysis (PCA) for sensory items shows that the selection of these five words has been appropriate to cover a good spectrum of sensory perceptions in charcuterie products (all five words fell far apart one from the other). The PCA for the hedonic expressions made it possible to establish groups of words. These groups of hedonic expressions have been later confirmed by the regression analysis, as results from the regression for words in the same group are very similar.

Regarding the products, main conclusions from the Espuña case study, are the following:

- Contrary to what initially was expected, results from Sweden and Spain are very similar.
- In general, the most preferred flavours are the ones already in the market (fuet, salami, chorizo).
- Shape affects the perception of convenience and innovation (with slices being the least convenient and innovative, a quite logical conclusion).

6. CONCLUSIONS

A methodology capable of integrating affective consumer needs into food products has been developed and explained in this study. The methodology is based on Kansei Engineering technology and combines parts of the Kansei Engineering model developed by Ikeda et al. (2004), together with the model suggested by Schütte (2004), leading to an integrated model of Kansei Engineering for food products. A major addition to this model is the separation of Kansei words (Semantic Space) in sensory items and hedonic expressions.

The model was applied in three European companies, Cloetta AB (confectionary), Lantmännen AB (breakfast cereals) and Espuña (charcuterie products). The method can map the specific product affective properties into an emotional fingerprint and link each of the hedonic and sensory attributes to one or a combination of physical product attributes. The results of the case studies also show that the method is working equally well for both Swedish and Spanish consumers. They also show that Spanish and Swedish consumers in many ways have similar preferences. This means that the cultural background and local food habits do have an impact on the consumer's experience of food products, but that common preferences can be found in order to develop products aiming for international markets.

The terms "like it", expressing individual preference, and the term "want it", expressing desire, were used on all studies. As expected, they show high correlation but also differences. This means that some products might be liked but not wanted and vice versa. Also, it is possible to find products which are wanted and liked. Using the suggested methodology, combinations of attributes can be found increasing preference and making products more desirable at the same time.

ACKNOWLEDGMENTS

This research study was founded by the Vinnova program of the Swedish government.

The authors are very grateful to:

- All the staff from the participating companies, who enthusiastically collaborated with the study. A special thank you to Anita Storm from Cloetta, Christan Malmberg from Lantmännen and Neus Quintana from Espuña.
- All the participants in the studies, both in Sweden and Spain.

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BIOGRAPHY

Simon Schütte Short biography has a degree of mechanical engineering and a PhD in Human Systems Engineering. Currently, he is an associated professor at the division of machine design at Linköping University. He has been working with Kansei Engieering since 1999 and proposed the first European model on the method in 2004. Since then he has been working in many projects with companies such as Volvo, Scania, Cloetta, Danone, etc.

Lluís Marco-Almagro has a degree in Industrial Engineering and a PhD in statistics. He is

currently an assistant professor at the Statistics Department of UPC · BarcelonaTech. His PhD thesis dealt with the use of statistical methods in Kansei Engineering studies. One of his research interests is the application of multivariate analysis and experimental design in Kansei. He has also acted as a consultant in quality improvement projects with several companies.