KEER2010, PARIS | MARCH 2-4 2010
INTERNATIONAL CONFERENCE ON KANSEI ENGINEERING AND EMOTION RESEARCH 2010

REVISITING THE DEFINITION OF PREFERENCE IN PREFERENCE MAPPING STUDIES

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ABSTRACT

In order to model consumers' hedonic responses on the basis of product characteristics, sensory scientists and developers in the food industry frequently apply preference mapping techniques. The synthetic representation of response surfaces proposed by Danzart (1998) for preference mapping is based on the discretization of individual model surfaces. To do this, the sensory map is split for each consumer into two regions of either preference or rejection according to the consumer's "preference threshold". The mean of each individual's liking scores is usually chosen as the preference threshold for the discretization. This choice is however arbitrary and other thresholds may also be chosen. In this study, we tested the effect of setting the preference threshold to stricter levels, namely to the upper 50%, 30% and 20% of the scored products. These possibilities have been tested on data from a preference mapping study of French cheeses, carried out with 10 products and evaluated by 486 French consumers. A clear shift of the optimal sensory region is observed when the preference threshold is raised. Interestingly, this shift could not be fully anticipated by a consumer segmentation achieved using cluster analysis of hedonic data. Further analysis of each consumer cluster shows different patterns of evolution of the preference map when raising the preference threshold to 30%. The implications of this new type of preference analysis for optimization strategies are discussed. These changes in the preference threshold also raise the question of the definition of preferences when consumers are asked to give liking scores.

Keywords: *preference threshold, quadratic modeling, sensory characteristics, product optimization*

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1. BACKGROUND

In order to model consumers' hedonic responses and behaviors on the basis of product characteristics, sensory scientists and developers in the food industry frequently apply preference mapping techniques. Such techniques are necessary to find the link between analytical sensory data and consumers' hedonic responses. Preference mapping techniques are all based on the assumption that products with similar perceptive characteristics will be equally liked by consumers in the absence of other external variables (price, brand image, etc...). The technique that is presented here derives from the Response Surface Methodology (RSM) and is called external preference mapping. It allows finding regions of a descriptive sensory map (usually a factorial map of the domain of study) that correspond to potentially optimal products from the consumer point of view. The classical RSM is based on linear regression modeling and it is here applied to principal component regression. Note that other types of models, such as PLS-regression or qualitative regression may also be used for this purpose. Below is a visual representation of an individual model fitting (Figure 1). Here the consumer's liking is fitted using a quadratic model on the basis of a factorial map of the sensory characteristics of the tested product set.

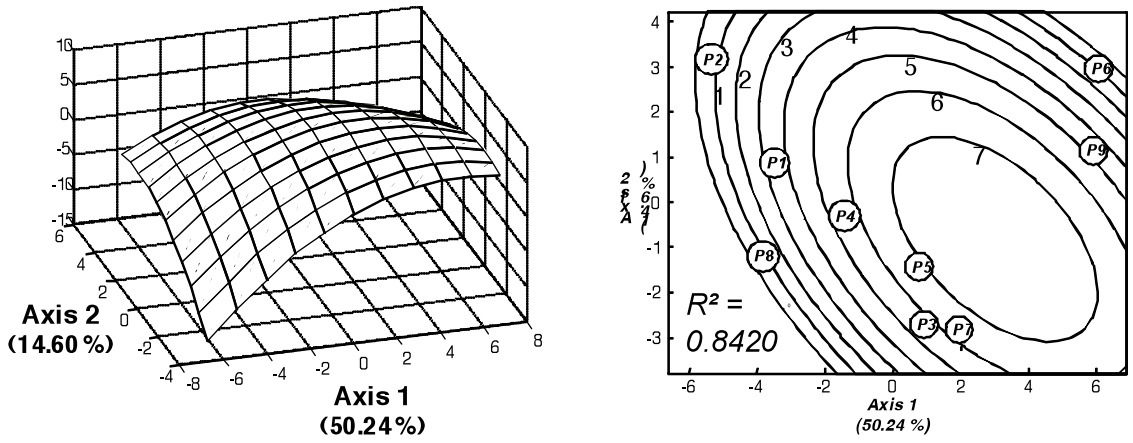

Figure 1: Example of a 3D (left) and 2D (right) representation of an individual model of liking based on a sensory map of the products under consideration.

In quadratic model-based external preference mapping, each consumer's individual liking pattern is modeled. Whatever the regression technique or the chosen model, it is indeed very informative to analyze liking patterns on an individual basis. However, summarizing the results of hundreds of consumers in a representative, insightful and yet efficient way is very challenging and there is certainly no ideal solution. First thing one wants to avoid is the use of averaged data that drastically reduce the level of information and may be conducive to erroneous conclusions [1]. One approach proposed by Danzart (1998) [2] is to simplify individual models in order to sum up predicted preference scores for each point of the domain of investigation.

The simplification is based on the discretization of individual model surfaces. The principle of this discretization is to determine for each consumer and for each point of the domain of investigation whether the corresponding product would fall into the consumer's preferred

products (i.e. products that he likes the most) or into the rejected products (i.e. products that he likes the least). To do this, a preference threshold is defined for each consumer. Consequently, the sensory map is split into two regions of either preference or rejection according to the consumer's preference threshold (Figure 2). The mean of the consumer's liking scores is usually chosen as the preference threshold for this consumer.

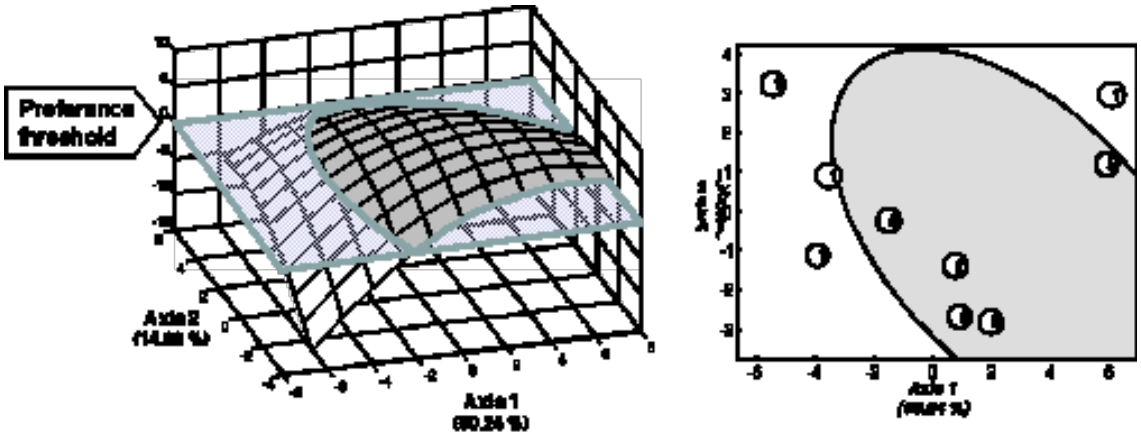

Figure 2: Example of a 3D (left) and 2D (right) representation of the discretization of an individual model according to a preference threshold set to the mean

The obtained simplified preference maps are then summed up, resulting in a global preference response surface usually represented as a contour map of the percentages of preference (Figure 3).

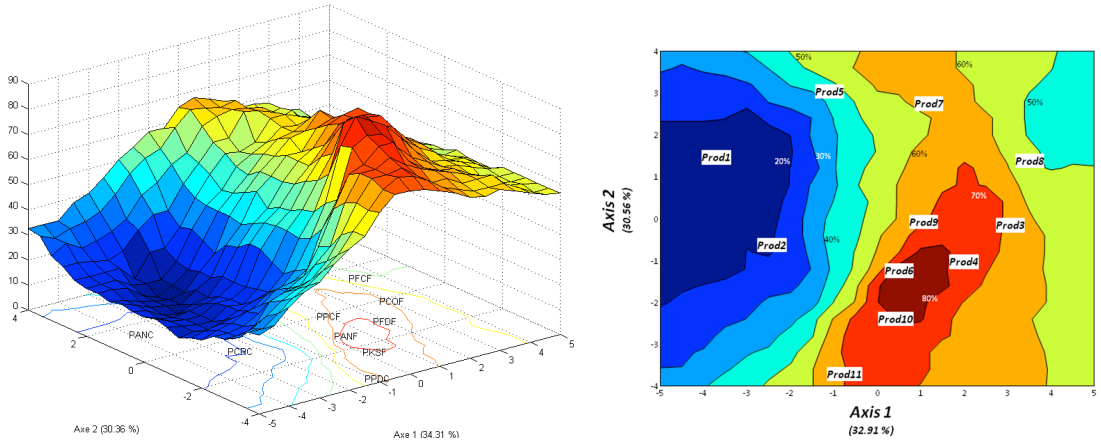

Figure 3: Example of a 3D (left) and 2D (right) representation of a sensory-based preference mapping.

Using the mean as the preference threshold allows departing from inter-individual scaling differences. Naturally, this is a purely arbitrary choice of a preference threshold and other thresholds may also be chosen [3]. In this study, we tested the effect of setting the preference threshold to stricter levels, namely to the upper 30% and 20% of the scored products.

2. MATERIALS AND METHODS

2.1. Data

The data were from a preference mapping study of French cheeses. A total of 10 products were evaluated in a monadic sequential way by 486 French consumers in a central location test facilities. Participants had to taste and score each sample using a 0-10 scale (0 being "I really don't like it" and 10 being "I like it very much"). All samples were coded and no additional information was given regarding the samples.

The same 10 products were described by a sensory panel (25 trained judges), according to the conventional sensory profile procedure using 24 attributes. The resulting descriptive data could be summarized in 2 main dimensions using a principal component analysis (Figure 4).

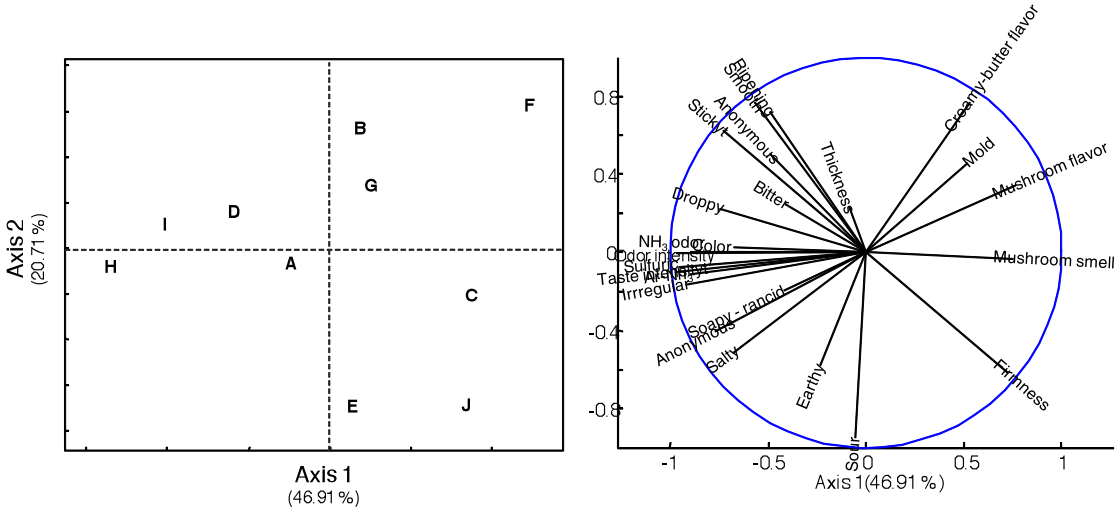

Figure 4: PCA plot of the descriptive sensory profile of the 10 evaluated cheeses.

2.2. Software

All analyses were computed with home-made routines using Matlab 7.0.1 (R14). Preference mappings were obtained using the full quadratic model as proposed by Danzart [2].

3. RESULTS

3.1. Effect of a raise in the preference threshold: overall preference mapping

Figure 5 presents the results of the preference mappings obtained with three different preference thresholds: respectively the upper 50% (median), 30% and 20% of the scored products. A first observation is that, as could be expected, there is a decrease of the overall percentage of preferences in optimal sensory regions. This is a direct mathematical consequence of setting the preference threshold to a stricter level. Secondly and more intriguing, a clear shift of the optimal sensory region is observed. In this case, raising the preference threshold indeed results in a shift toward the left-hand part of the sensory map. The optimal sensory region thus moves to less *mushroom* smell but stronger *odor* and *taste*

intensity with marked *sulfuric* and *ammoniac odor* notes. It can also be noted that areas of least preference spread wider and that the product D which is initially in the optimal region falls in a 10%-preference region. Interestingly, this product which is rather centered on the sensory map could be sensory defined as a well-balanced product. We may hypothesize that this product is typically an average consensual product that may please everyone but that does not elicit particularly high hedonic scores and hence falls in regions of lesser preference when the preference criterion is stricter. This result indicates that some inter-individual differences in the preference patterns are overlooked when dealing with the overall data set. A more detailed analysis that would take into account the possibility that differing consumer segments are present is thus needed.

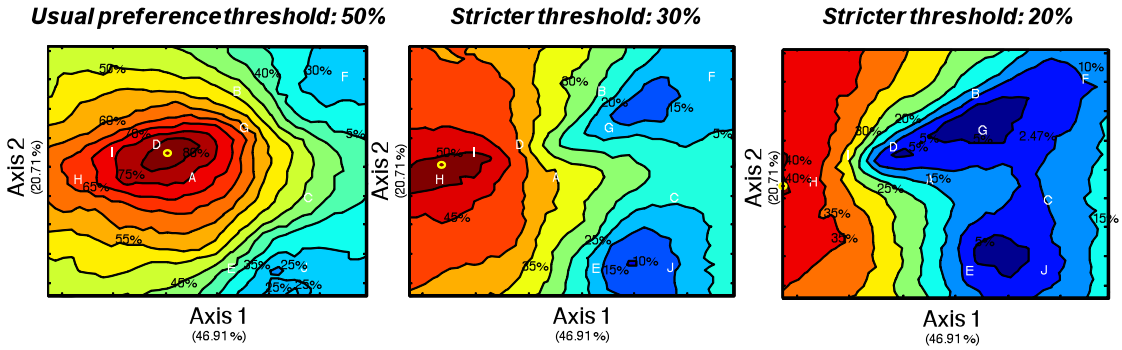

Figure 5: Evolution of the regions of preference when the preference threshold is raised

3.2. Preference threshold and consumer segmentation

As suggested above, the analysis of the threshold effect can be combined with a cluster analysis of the preference patterns. Accordingly, a Hierarchical Cluster Analysis was performed on the hedonic data (using Wards' criterion). As can be seen from Figure 6, four clusters of consumers can be well-separated. Now for each cluster, a preference mapping was computed with two different preference thresholds.

Interestingly, the shift observed for the whole data set could not be fully anticipated by the separate analysis of each consumer segment. The evolution of the maps between 50% and 30% is indeed less striking. In this example, the most important changes are for clusters 2 and 3 that exhibit not only a drift of the optimal sensory region but also a spread of the optimal region (cluster 2) and a split into two optimal sensory regions (cluster 3).

This detailed analysis is also consistent with our initial hypothesis that an average consensual product may appear to be the optimal solution when all consumers are pooled in the same analysis. Here, product D is in fact optimal only for consumer clusters 1 and 2 (71% of the consumers) when the threshold is set at 50% and it remains optimal only for the cluster 2 (31% of the consumers) when the threshold is set at 30%.

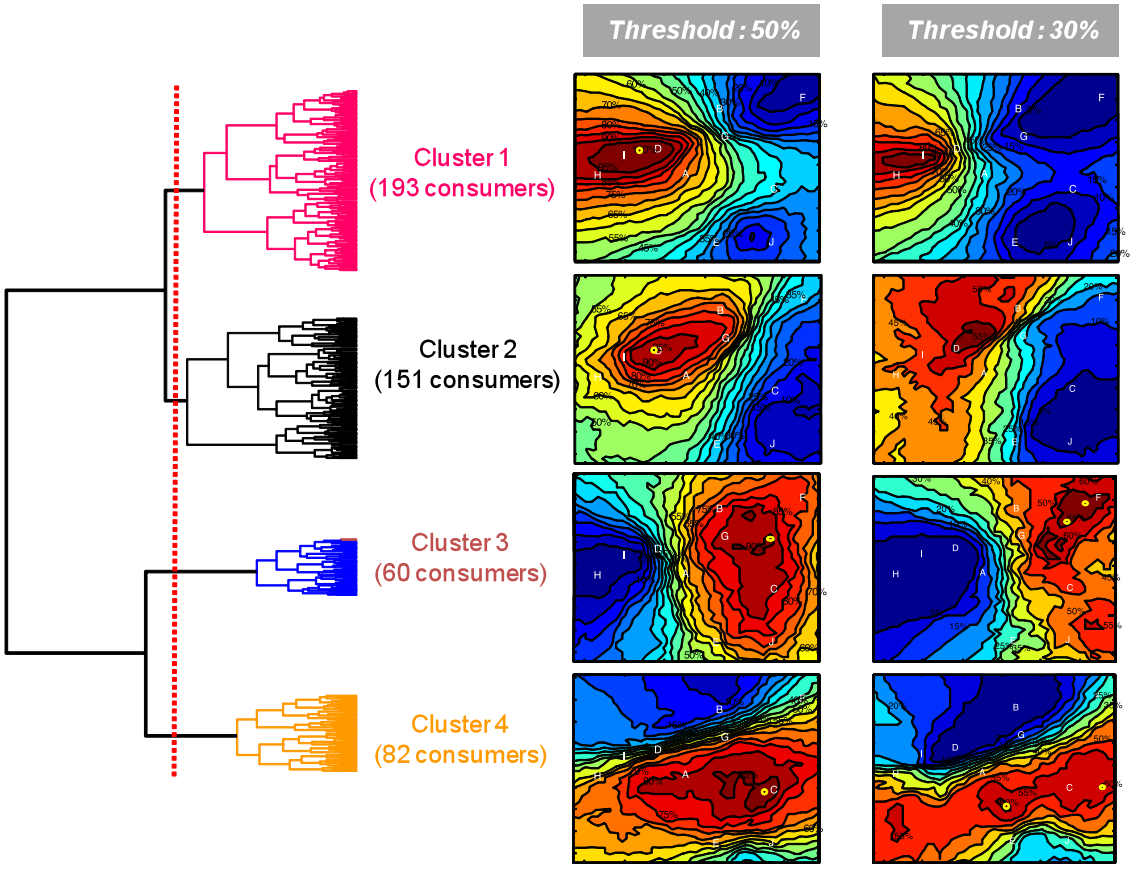

Figure 6: Effect of a raise of the preference threshold for each cluster of consumers

4. DISCUSSION

Defining a higher preference threshold is conducive to notably different global response surfaces. Deciding which threshold should be used is thus strategic. A stricter threshold implies a stricter definition of preferences, which is a key point. For instance, many survey institutes in France consider that a score of 7 on a 10-point scale is a minimal acceptance score. We chose not to use an absolute value but to define a threshold for each individual consumer. In the example presented here, using the median as the individual preference threshold would lead to the conclusion that one tested product is preferred by 80% of the consumers. Based on this result, a logical strategic decision would be to launch (or to copy) this product. However this choice might not be the best since this product may rather be considered as a least common denominator, as revealed by the analysis with a raised threshold. Depending on the company's strategy, it may thus be wiser to target sensory regions of sharper preferences.

This raises the question of the meaning of preferences when participants to the survey are only asked to give a liking score. First, it could be said that so-called preferences are artificially made up since participants do not express actual choices or preferences. However, real choice experiments also bear some biases, not to mention the experimental difficulties. In practice, many preference studies rely on hedonic ratings. A better definition of the preference threshold may then come from improved protocols in consumer appraisal surveys. For instance, surprisingly little work has been done in order to increase participants'

commitment in the outcome of hedonic tests [4]. Certainly more work would be needed to better define what preferences are in the context of consumer testing.

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