

# Sensory characterization of products and preference study using paired comparison experiments

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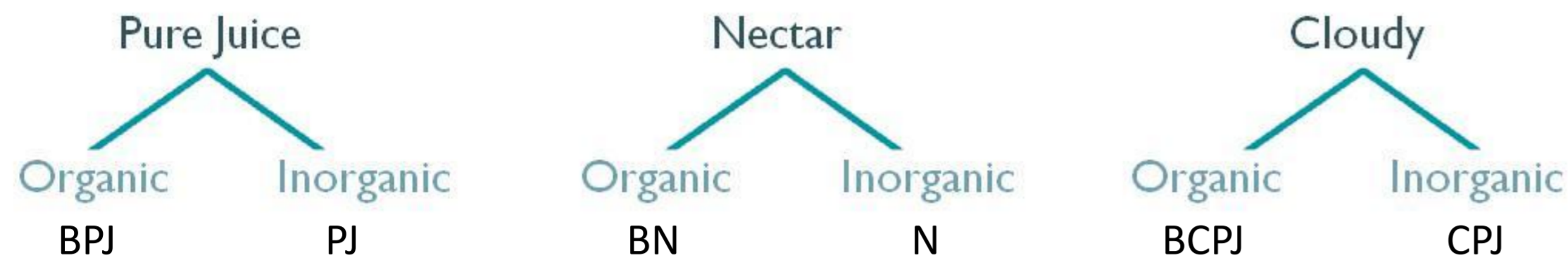
## Objective

Usually, the products' sensory characterization is performed by a trained panel of judges. However, we suggest to establish the sensory profile of products using a panel of consumers and also to study their preferences, using paired comparison experiments.

## Material and method

### • Products

6 apple juices were chosen :



**Sensory evaluation:** 6 products evaluated by 90 consumers, for 7 attributes in paired comparison.

**Preference study:** 90 consumers evaluating products in paired comparison experiments.

### • Experimental design (based on a Kraitchik's design [1])

Balanced Incomplete Block with 90 consumers → ∅ order effect  
→ ∅ report effect



## Data analysis

### • Bradley-Terry-Luce model [2] for sensory data

Supposing that :  $\begin{cases} n & \text{the number of products} \\ H & \text{the number of consumers} \end{cases}$

$$y_{ij,h} = \begin{cases} 0 & \text{if } j \text{ was chosen against } i \\ 1 & \text{if } i \text{ was chosen against } j \end{cases}$$

The probability of stimulus  $i$  to be chosen to the stimulus  $j$ , is noted  $p_{ij}$ . Therefore the Bradley-Terry-Luce model (BRADLEY, 1952) states that:

$$p_{ij} = \frac{\pi_i}{\pi_i + \pi_j} \quad \text{Where } \pi_i \text{ is the Bradley's score for the product } i, \text{ such as } \pi_i \in ]0; 1[ \text{ for } i = 1, \dots, n \text{ and } \sum \pi_i = 1$$

The estimation of  $\pi$  is obtained by solving the maximum likelihood equation [3]

### • Model of segmentation [4] taking into account differences in consumers' preferences

Supposing the existence of  $T$  segments of consumers and  $\alpha(t)$  the probability that an ordinary individual belongs to the group  $t$ .

We note  $p_{ij,t}$  the probability that the stimulus  $i$  to be preferred to the stimulus  $j$  for the segment  $t$ . As previously, for each class  $t$ , the probability can be written following the Bradley model:

$$p_{ij,t} = \frac{\pi_{i,t}}{\pi_{i,t} + \pi_{j,t}}$$

Parameters  $\alpha(t)$  and  $\pi(t)$  will be estimated for any  $t = 1 : T$  by maximum likelihood, using an algorithm type EM [5]. The selection of the number of classes can be achieved with a likelihood ratio test by Monte Carlo simulations.

## Products' profile obtained by the sensory analysis

## Segmentation of consumers in homogeneous classes

All the following results were calculated using the R package CompR [6]

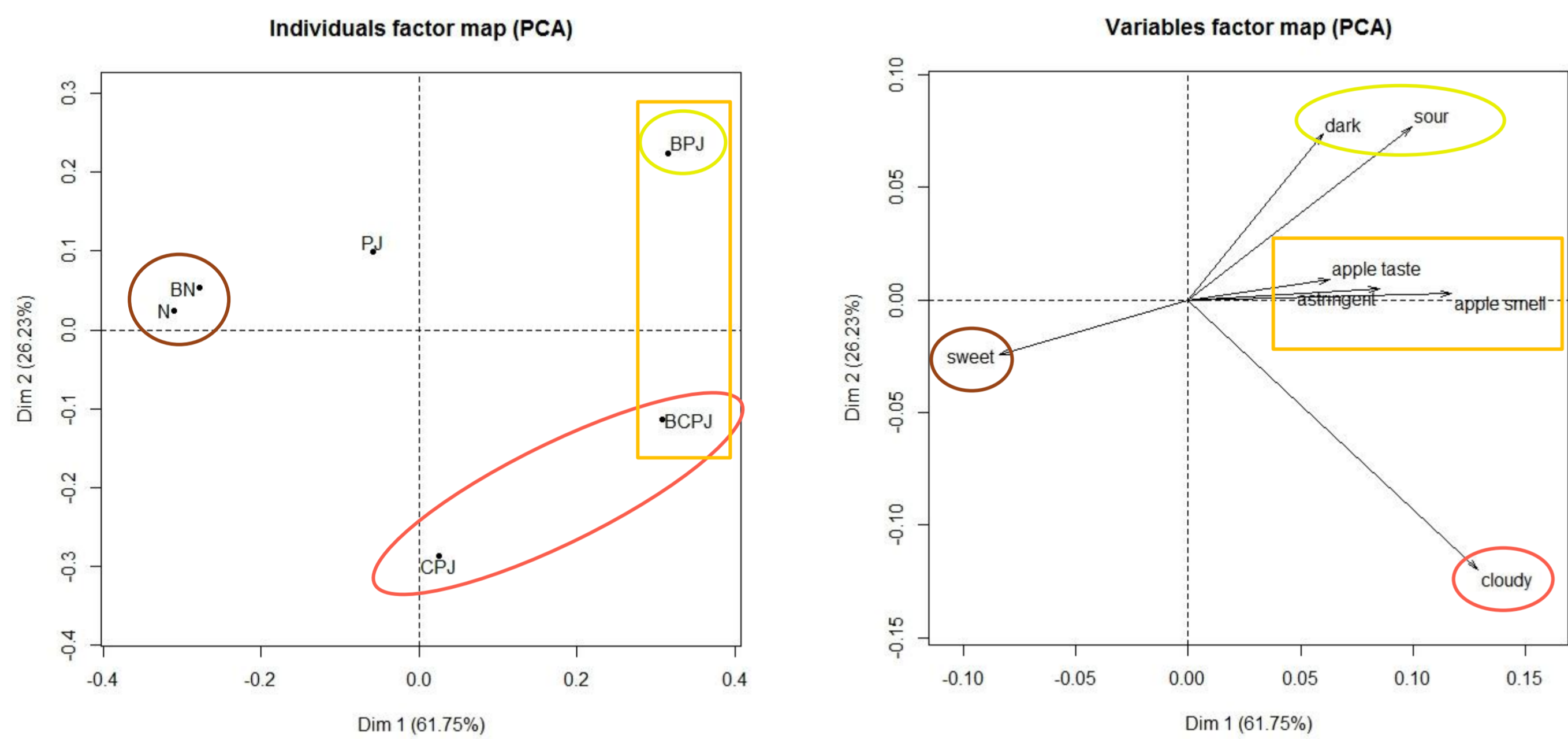


Figure 1 : Representation of the products and descriptors obtained by non-normed PCA on the Bradley's scores



A segmentation of consumers based on Monte Carlo simulation (P\_Value = 12%), leads us to retain the two classes solution, with the following results.

	Class 1	Class 2
Weight	49%	51%
BCPJ	0.03	0.18
CPJ	0.11	0.21
BN	0.11	0.07
N	0.55	0.01
BPJ	0.07	0.21
PJ	0.12	0.32

Table 1 : Product's Bradley's scores in each class and class's weight

Discriminative product

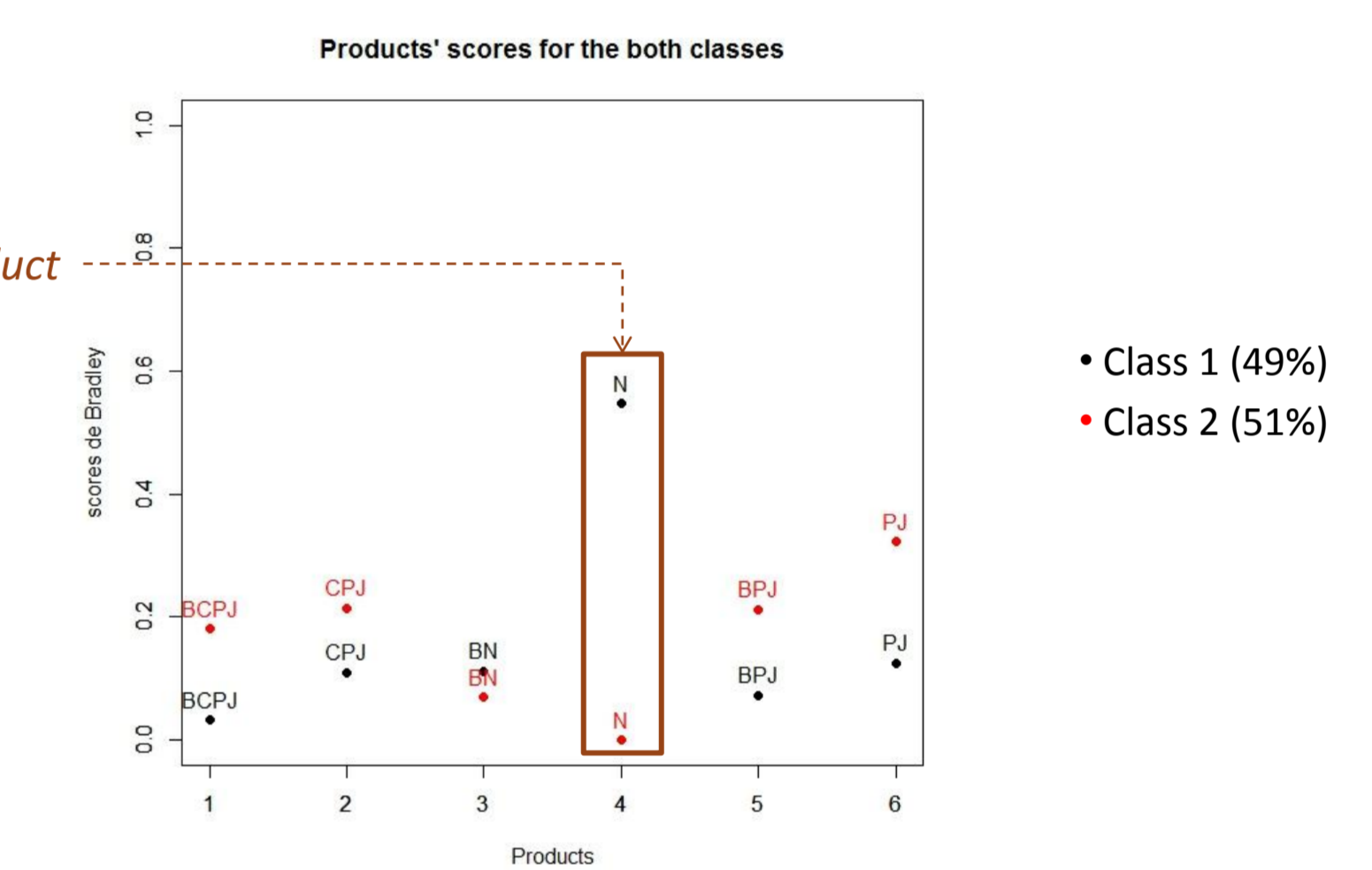


Figure 2 : Bradley's scores obtained in each class

- Class 1 (49%)
- Class 2 (51%)
- Nectar = the most appreciated product by consumers of the 1<sup>st</sup> class
- The 2<sup>nd</sup> class does not have a significantly preferred product

## Link between sensory analysis and preferences

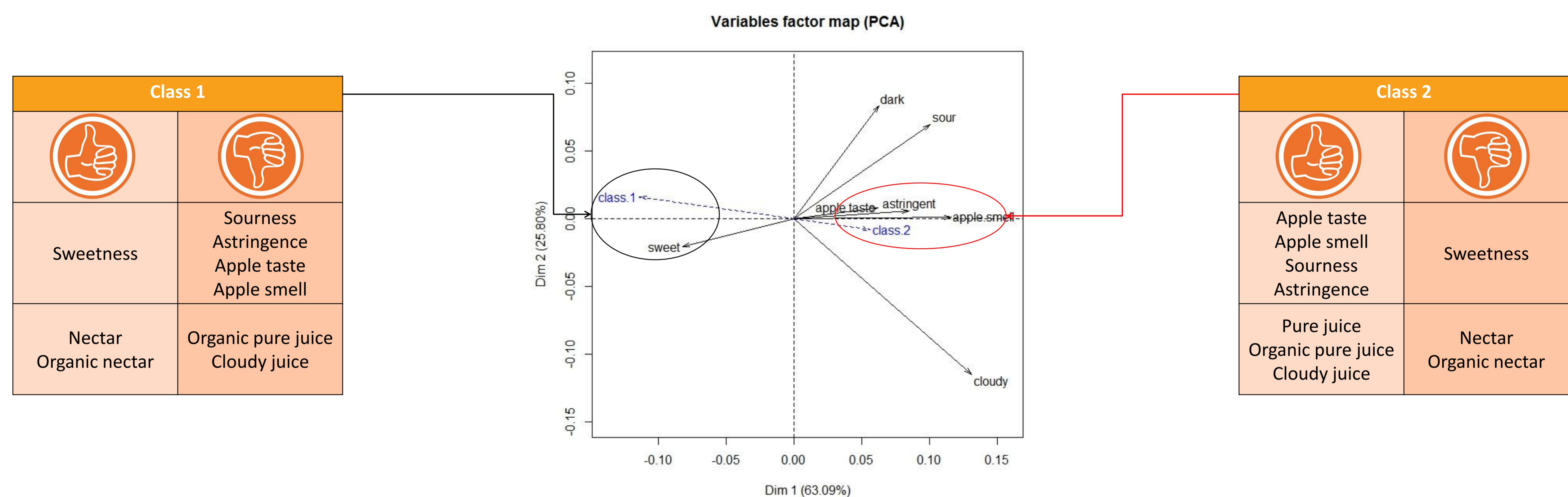


Figure 3 : Representation of descriptors with the preferences by class as supplementary variables

## Conclusion

- Establishing a sensory profile from a panel of consumers with a paired comparison approach ✓
  - Suggesting a consumer's segmentation based on their preferences ✓
  - Finding the link between consumer's preferences and consumer's perception of the products ✓
  - Paired comparison easily achieved ✓
  - Test found playful by the panelists ✓
  - An increase of the number of products could lead to an important degree of incompleteness of the experimental design and so weaken the conclusions. ✗
- Profits in marketing :**
- Targeting the favourite products
  - Pointing out the sensory characteristics expected
  - Considering new products which respond to market demands

## References

[1] DAVID H. A. (1988). Designs. In : STUART A., *The Method of Paired Comparisons*. New-York : STUART A., 83-103.  
 [2] BRADLEY R. A., TERRY M. E. (1952). Rank analysis of incomplete block designs: The method of paired comparisons. *Biometrika*, 39, 324-45.  
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 [4] COURCOUX Ph., SEMENOU M. (1997). Une méthode de segmentation pour l'analyse de données issues de comparaisons par paires. *Revue de Statistique Appliquée*, XLV(2), 59-69.  
 [5] DEMPSTER A. P., LAIRD N. M., RUBIN D. B., (1977). Maximum likelihood from incomplete data via the EM algorithm. *Journal of the Royal Statistical Society*, B, 39, 1-38.  
 [6] SEMENOU M. (2015). CompR: Paired Comparison Data Analysis. R package version 1.0. <https://CRAN.R-project.org/package=CompR>