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:
    - Pure juice
    - Organic nectar
    - Cloudy juice

  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 Krutchik’s design [1]):
  - Balanced Incomplete Block with 90 consumers
  - 3 pairs
  - every product
  - 1 judge

Data analysis

- **Bradley-Terry-Luce model** [2] for sensory data
  - Supposing that:
    - the number of products
    - the number of consumers
  - 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:
    \[
    P_{ij} = \frac{\pi_i}{\pi_i + \pi_j}
    \]
    Where \( \pi_i \) is the Bradley's score for the product i, such as \( i \in \{1, 2, ..., n\} \) and \( j \in \{1, 2, ..., n\} \).
  - The estimation of \( \pi_i \) 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 \( p(t) \) the probability that an ordinary individual belongs to the group t.
  - We note \( p_{ij,t} \) the probability that the stimulus i is 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 \( p(t) \) and \( p(t) \) will be estimated for any \( t = 1 : 7 \) 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

![Image](image1.png)

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

 Segmentation of consumers in homogeneous classes

![Image](image2.png)

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 (49%)**
- **Class 2 (51%)**

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

<table>
<thead>
<tr>
<th>Class</th>
<th>Products</th>
<th>Bradley's score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>Organic pure juice, Cloudy juice</td>
<td>0.21</td>
</tr>
<tr>
<td>Class 2</td>
<td>Pure juice, Organic nectar</td>
<td>0.79</td>
</tr>
</tbody>
</table>

Link between sensory analysis and preferences

![Image](image3.png)

- 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

**Profits in marketing:**
- Targeting the favourite products
- Pointing out the sensory characteristics expected
- Considering new products which respond to market demands

Conclusion

- 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.

References