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The perception of tactile feeling and corresponding textile attributes worldwide

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Abstract: The textile industry has been exploring sensory analysis as means to evaluate different products as a strategy to improve product comfort. The sensory analysis uses a set of attributes standardized for sensory evaluation: the lexicons. This paper compares three lexicons developed to assess the sensory comfort of textile fabrics, by researchers from France, Portugal and Brazil. Quantitative Descriptive Analysis was conducted for the development of these lexicons. The study showed that France and Portugal have thirteen attributes in common and seven attributes are common in France, Portugal and Brazil: Light-Heavy, Gross-Fine, Fresh-Hot, Soft, Plushy, Elasticity and Falling.

1. Introduction

Different types of fabrics are usually classified according to their physical characteristics that influence the quality of the textile products. Among several attributes of textile quality one of the properties that motivates the acceptability of the consumer and repeat their purchase, is comfort. The sensorial comfort is the result of a complex series of sensory stimuli between the fabric and human skin when wearing or touches a garment.

The textile comfort has been studied by instrumental and sensorial methods. The sensory comfort influences by the feeling that the clothing provides the user when in contact (mechanical or thermal) with the skin is the touch. Descriptive sensory analysis, much explored by the food and cosmetic industries, can characterize the attributes of different product types qualitatively or quantitatively [1,2]. Textile hand properties evaluate quantitatively through adaptations of methods of sensory analysis. This assessment is the result of descriptive psychological and physiological responses of individuals.

The sensory analysis is a technique where the sensations, when a material is touched, are quantified, and the human hand is the only instrument applied. Therefore, the sensory analysis is a new and significant tool for general textile materials where the tactile feeling is of paramount importance for the consumer. The development of a global lexicons for tactile sensory analysis is an important tool for tactile evaluation of products. Before the evaluation process of the textile comfort is necessary to develop descriptive terminologies attributes that best define the characteristics of a product- Lexicons.

Among the methods of sensory analysis, researchers from France [3] and Portugal [4] adapted the Quantitative Descriptive Analysis (QDA) [5], with the purpose of quantifying the quality of touch in textiles. The researchers used this method to develop lexicons for the evaluation of the tactile sensorial attributes in textiles. Each national panel creates its own consumer-based (lexicon) word for the evaluations of a product type.
A Brazilian lexicon was developed by Nagamatsu et al. They used the same method as the French and Portuguese researchers, resulting in a lexicon of 11 attributes [6].

After the three lexicons were compared, seven terms revealed to be common among the three countries: three bipolar (light & heavy; thin & thick; Cold & warm) two describing the surface (soft; plush) and two describe the material (elasticity; falling) [7].

2. Materials and methods

The procedure of selection and identification of the descriptors was adapted from ISO 11035 [8]. A panel of Brazilian textile sensorial evaluators were invited to participate in the development of the Brazilian lexicon. They are 14 assessors (five men and nine women) from the city of Apucarana/Brazil, with different personal taste, education level and expertise participated in this study.

20 samples with different textile structures and fiber composition, were cut into 20x20 centimeters pieces. Sensor Assessors touched the fabric samples behind a cabin and described the sensations when touching the samples without seeing them and using free vocabulary (Figure 1).

![Figure 1.](image)

They generated 299 terms that were reduced in four steps, the first three by the panel during 3 meetings. First eliminating hedonic terms (128); Second reduction was rejecting descriptors with same meaning (122); Third reduction was combining singular terms (28); and in the fourth and last reduction, the panel quantified the perceived intensity of the attributes and these data were treated by means of statistical methods obtaining the last eleven attributes (figure 2).
For the development of the tactile sensory comfort lexicon for Brazilian textile products, four statistical models were applied. In Geometric Analysis it was possible to classify the order of perceived intensity. The interpretation of Correlation Analysis and the map of Principal Component Analysis - PCA (figure 3) allowed the identification of some differences and similarities between the attributes (positive correlation) as Itches and Rugged; Relief & Rough. Soft & Smooth and Fit and Flowing, as well as identifying the opposing attributes (negative correlation) that contributed to the classification of the bipolar terms: Light – Heavy; Thick – Thin; Fresh – Hot; Dry – Humid; Rough – Smooth.

The \( t \)-test was conducted to verify if there are significant differences between the arithmetic mean of the attributes. The attributes Kneaded obtained the \( p \)-value > 0.05. The attribute Kneaded was excluded because it does not contribute to differentiate the hand sensorial qualities between the textile samples. (table 1).
Table 1. Test-t of mean against reference constant p > 0.05

| VARIABLE   | MEAN     | N   | STD. ERR | REFERENCE CONSTANT | T-VALUE | DF     | P       |
|------------|----------|-----|----------|--------------------|---------|--------|---------|
| LIGHT      | 2.268519 | 108 | 0.167757 | 0.00               | 13.52266| 107    | 0.000000|
| HEAVY      | 1.583333 | 108 | 0.153490 | 0.00               | 10.31554| 107    | 0.000000|
| PLUSHY     | 1.027778 | 108 | 0.147940 | 0.00               | 6.94727 | 107    | 0.000000|
| SMOOTH     | 4.425926 | 108 | 1.584813 | 0.00               | 2.79271 | 107    | 0.006193|
| ITCHES     | 2.018519 | 108 | 0.934232 | 0.00               | 2.16062 | 107    | 0.032956|
| SOFT       | 2.768519 | 108 | 0.929182 | 0.00               | 2.97952 | 107    | 0.003573|
| ELASTICITY | 0.962963 | 108 | 0.148796 | 0.00               | 6.47171 | 107    | 0.000000|
| KNEADED    | 1.453704 | 108 | 0.934640 | 0.00               | 1.55536 | 107    | 0.122813|
| ROUGH      | 2.064815 | 108 | 0.141857 | 0.00               | 14.55560| 107    | 0.000000|
| FLAT       | 1.333333 | 108 | 0.147084 | 0.00               | 9.06510 | 107    | 0.000000|
| THICK      | 2.768519 | 108 | 0.931600 | 0.00               | 2.97179 | 107    | 0.003657|
| THIN       | 1.527778 | 108 | 0.161369 | 0.00               | 9.46762 | 107    | 0.000000|
| FIT        | 2.259259 | 108 | 0.148472 | 0.00               | 15.21671| 107    | 0.000000|
| COLD       | 1.564815 | 108 | 0.158564 | 0.00               | 9.86868 | 107    | 0.000000|
| WARM       | 2.259259 | 108 | 0.142525 | 0.00               | 15.85169| 107    | 0.000000|
| RIGID      | 1.759259 | 108 | 0.155587 | 0.00               | 11.30722| 107    | 0.000000|
| FLOWING    | 1.879630 | 108 | 0.162576 | 0.00               | 11.56156| 107    | 0.000000|
| DRY        | 3.287037 | 108 | 0.924181 | 0.00               | 3.55670 | 107    | 0.000561|
| SLIPPERY   | 1.675926 | 108 | 0.157224 | 0.00               | 10.65948| 107    | 0.000000|
| RUGGED     | 1.537037 | 108 | 0.157002 | 0.00               | 9.78991 | 107    | 0.000000|
| RELIEF     | 2.314815 | 108 | 0.177795 | 0.00               | 13.01959| 107    | 0.000000|

The analysis of the results of the application of the statistical models in the 21 attributes allowed decision making for a more precise formation of the Brazilian lexicon. The final list is composed of 11 most significant attributes (Table 2).

The final list of Brazilian lexicons was composed with 11 descriptors. The panel also determined the definition, valuation techniques and references for each attribute. The lexicon in this study was made to assess the comfort of textile materials.

Table 2. Brazilian lexicons

| BIPOLAR ATTRIBUTES | SURFACE ATTRIBUTES | MATERIAL ATTRIBUTES |
|--------------------|--------------------|---------------------|
| LIGHT-HEAVY        | SOFT               | ELASTICITY          |
| ROUGH - FLAT       | PLUSHY             | RIGID               |
| THICK - THIN       | RUGGED             | FIT                 |
| FRESH - HOT        |                    |                     |
| DRY - HUMID        |                    |                     |
3. Results and discussion

Comparison between consumers of the three countries/different continents was made and obtained a sensory profile, as introduced in table 3. The French and Portuguese lexicons have fourteen terms and Brazilians developed eleven terms.

The study showed that France and Portugal have thirteen attributes in common and seven attributes are common in France, Portugal and Brazil: Light-Heavy, Gross-Fine, Fresh-Hot, Soft, Plushy, Elasticity and Falling.

Table 3. Lexicons French, Portuguese and Brazilian

|                   | FRANCE         | PORTUGAL       | BRAZIL         |
|-------------------|----------------|----------------|----------------|
| **BIPOLAR**       | Light-Heavy    | Light-Heavy    | Light-Heavy    |
| Attributes        | Thin-Thick     | Thin-Thick     | Gross-Fine     |
|                   | Cold-Warm      | Cold-Warm      | Fresh-Hot      |
|                   | Supple-Rigid   | Supple-Rigid   |                |
|                   | Sleek – Rugoss | Rough – Smooth | Rough – Flat   |
| **SURFACE**       |                |                |                |
| Attributes        | Soft           | Fluffy         | Soft           |
|                   | Pilous         | Pilous         | Plushy         |
|                   | Granulous      | Granulous      |                |
|                   | Sticky         | Sticky         |                |
|                   | Slippery       | Slippery       |                |
|                   | Greasy         |                |                |
|                   | Grooved        |                |                |
| **MATERIALS**     | Elastic        | Elastic        | Elasticity     |
| Attributes        | Falling        | Falling        | Falling        |
|                   | Responsive     | Shape Recovery |                |
|                   | Crumple-Like   | Crumple        | Rigid          |

The rigid and supple bipolar attribute were not considered by Brazilians. Brazilians grouped Portuguese bipolar terms Sleek - Rough and Smooth Rough differently.

Only the French introduced terms such as Greasy and Grooved and the Brazilians presented Dry-Humid.

Although these three lexicons were developed for textile hand assessment of textile fabrics, Nagamatsu et al. [9] adapted three attributes to sports cap wear trial evaluation: tridimensional products (Light-Heavy; Gross-Fine; Fresh-Hot). The authors compared the results of the Fresh-Hot attribute between objective evaluation with wear trial and objective evaluation with thermal/humid sensors.

4. Conclusion

In this work, the three developed lexicons, by France, Portuguese and Brazilian panels, were developed in different countries and compared in this research. We can consider, that the seven common attributes are the most mentioned among panelists and offer higher improvement in the development of innovative clothing, resulting in greater comfort to the consumer.
Furthermore, we can consider these seven attributes form the lexicon of tactile comfort and they can be exploited worldwide for hand textile assessment.

**Key words:** Tactile Feeling, Thermal comfort, Textile Lexicon, Attributes

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