MSI Journal of
Multidisciplinary Research (MSIJMR)

Evaluation of textile comfort properties through sensory analysis methodology in Brazil

Rosimeiri Naomi Nagamatsu[1*], Maria José Araújo Marques Abreu[2], Josiany Oenning Favoreto[3], Giulia Minosso de Almeida Pirozi[4]

[1*] Universidade do Minho.

[2] Universidade Tecnológica Federal do Paraná.

[3,4] Universidade Tecnológica Federal do Paraná.

***Correspondence:** Rosimeiri Naomi Nagamatsu

The authors declare that no funding was received for this work.

OPEN ACCESS

Received: 01-August-2025
Accepted: 15-August-2025
Published: 01-September-2025

This article is published in the **MSI Journal of Multidisciplinary Research (MSIJMR) ISSN 3049-0669 (Online)**

The journal is managed and published by MSI Publishers.

Volume: 2, Issue: 8 (September-2025)

ABSTRACT: This study investigates tactile comfort in textile samples through sensory analysis conducted in Brazil, aiming to understand how fabrics used in sports caps influence user perception. The research applied a trained panel using the Brazilian Textile Lexicon and a descriptive quantitative analysis under controlled conditions (BS ISO, 2003). Results show distinct sensory profiles: cotton and wool were strongly associated with warmth and softness, polyester with dryness and rigidity, cork with heaviness and stiffness, and blends with enhanced drape but reduced softness. These findings highlight how material composition directly shapes tactile comfort, offering evidence that sensory evaluation can serve as a reproducible and comparable method across different regions. Beyond technical assessment, the study reinforces the role of comfort, ergonomic, psychological, thermophysiological, and sensory, as a strategic factor in product development and consumer decision-making. By bridging sensory science and textile design, this research provides practical tools for designers and researchers seeking to align material selection with user-centered comfort in apparel.

KEYWORDS: *Cap, Sensory comfort, Tactile comfort, Overall clothing comfort, Textile lexicon.*

INTRODUCTION

"Clothing is a dynamic microenvironment of the human body" (Tamura, 2016).

Tamura's statement has stimulated a wide range of inquiries among researchers, particularly with regard to comfort in apparel. The clothing microenvironment refers to the space between the garment and the skin, closely associated with the transfer of heat and moisture in contact with the body. If apparel is indeed a dynamic microenvironment, the central question becomes: how can this microclimate be optimized to enhance wearer comfort?

In major urban centers of southern Brazil, it is common to experience significant daily thermal fluctuations, with temperature variations ranging from 10°C to 15°C. Locally, this phenomenon is often described as "the four seasons in a day." In response, wearers frequently adopt the so-called "onion effect," layering garments in the morning and progressively removing them as the temperature rises, in an effort to regulate the thermal conditions of their microenvironment and maintain comfort. Managing the sensory properties of textiles in the face of such changing climatic conditions is therefore a key factor in sustaining thermophysiological balance.

According to Broega (2007) and Broega, Silva and Silva (2010), drawing on Slater (1997), four fundamental dimensions are essential to achieve overall clothing comfort: ergonomic, psychological, thermophysiological, and sensory comfort. Each dimension comprises a set of attributes that directly influence apparel performance. Within this framework, the present study focuses specifically on the tactile–sensory comfort of textile samples, with particular emphasis on fabrics employed in the manufacturing of sports caps produced in the municipality of Apucarana, in the state of Paraná, Brazil.

In Brazil, research on clothing comfort has predominantly centered on usability improvements and the development of innovative approaches to apparel patternmaking. Most investigations have addressed ergonomic comfort, especially user anthropometry. However, studies specifically examining the comfort of sports caps are notably absent in the national context, where existing research is largely restricted to market analysis and production system evaluations.

The originality of this study lies in its focus on the sports cap, an emblematic product of the regional textile and apparel industry of Apucarana, recognized as the largest producer and exporter of caps in Brazil. By defining a Brazilian textile lexicon for this product and conducting objective assessments under controlled conditions, this research contributes significantly to the global discourse on sensory analysis in apparel design.

Accordingly, the aim of this study is to evaluate the sensory comfort of textile samples used in the production of sports caps through Quantitative Descriptive Analysis (QDA), thereby establishing a deeper understanding of their sensory comfort characteristics.

SENSORY COMFORT

Sensory comfort is one of the key aspects used to assess and compare the quality of different products from the user's perspective. In textiles, research on sensory comfort has focused primarily on tactile perception, as investigated by Philippe Abreu, Schacher, Adolphe, and Silva (2003a); Guest and Spence (2003); Chollakup, Sinoimeri, Philippe, Schacher, and Adolphe (2004); Li and Wang (2005); Nogueira (2011); Bacci et al. (2012); and Sabir and Doba Kadem (2016).

According to Das and Alagirusamy (2010b), recent developments in psychophysical methodology allow for a more precise quantification of descriptive aspects of tactile sensations, while emotional attributes also contribute to the study of sensory and comfort-related characteristics. Tactile–sensory comfort in textiles is largely determined by the level of mechanical stress generated when the fabric comes into contact with the skin. Consequently, there is a strong correlation between tactile perception and the mechanical properties of fabrics.

Touching fabrics at the point of purchase is among the most common consumer practices for assessing textile comfort. Through the tactile sensory system, consumers perceive product characteristics, which may elicit comfort recognition or hedonic emotional responses, either positive or negative. Thus, touch remains a primary criterion in consumer decision-making when purchasing apparel and textile products.

Sensory comfort in textiles results from a complex set of interactions between the fabric and human skin, whether during wear or upon direct touch. These stimuli are perceived by various sensory receptors and transmitted to the brain, generating both physiological and psychological responses depending on the nature and intensity of the stimuli (Barker, 2002; Tamura, 2006, 2011; Das & Alagirusamy, 2010b). Sensory comfort is not influenced solely by thermal balance but also by the sensations elicited through mechanical and thermal interactions between apparel and the skin. It also represents a psychological judgment made by the wearer, often based on prior experiences with similar products or influenced by behavioral intentions (You et al., 2002; Das & Alagirusamy, 2010a). Furthermore, consumer preferences are shaped by social, cultural, and environmental factors, as well as the intended end use of the product (Kweon, Lee & Choi, 2004; Issa et al., 2004; Silva & Abreu, 2008; Das & Alagirusamy, 2010a).

Another approach to evaluating textile sensory comfort involves physical and mechanical testing methods. The physical properties of fabrics have been studied with the aim of promoting comfort in wear, commonly assessed through parameters such as thermal resistance, moisture absorption, and tactile sensations (including friction and roughness) on the skin (Kweon et al., 2004). Desired comfort levels can often be explained by evaluating a limited set of properties. Several researchers employ methods for both sensory and instrumental characterization of fabric hand, including Handfeel Spectrum Descriptive Analysis (HSDA), the Kawabata Evaluation System (KES) (Chollakup et al., 2004; Sztandera et al., 2013), and Fabric Assurance by Simple Testing (FAST). These systems are designed to measure the physical, mechanical, and surface properties of textiles under low-stress conditions, using specialized instruments (Ciesielska-Wrobel & Van Langenhove, 2012; Kweon et al., 2004). Such methods provide indirect characterizations of fabric hand (Vasile et al., 2016), simulating handling experiences.

Among these, the KES is the most widely recognized (Barker, 2002). Several of Kawabata's studies emphasize that, for fabric hand evaluation, it is essential to understand the mechanical behavior of fabrics under low-stress conditions, including shear, tensile, compression, bending, friction, and surface roughness, closely resembling the real conditions fabrics experience during daily wear or when touched by hand for assessment (Abreu, 2008; Issa et al., 2004). The KES provides an objective methodology based on the assumption that fabric hand derives from a combination of primary sensory factors such as softness, stiffness, and roughness (Barker, 2002). However, one of its main limitations is the difficulty of aligning instrumental sensor data with the complex neurophysiology of human sensory perception (Sabiri et al., 2008).

Wear comfort research highlights that fabric development cannot be fully explained through purely physical parameters alone (Wong, Li & Yeung, 2003; Abreu, 2008; Liu & Little, 2009; Park & Kim, 2012; Bishop et al., 2013). Subjective evaluation represents a complex synthesis of psychological and physiological variables associated with the physical properties of textiles (Kweon et al., 2004; Rombaldoni, Demichelis & Mazzuchetti, 2010; Tamura, 2016; You et al., 2002). Such evaluations often rely on scaling the intensity of sensory attributes to investigate fabric characteristics, typically conducted in controlled temperature and humidity environments, providing responses that may be correlated with instrumental assessments of physical properties (Barker, 2002).

As a result, defining comfort remains a challenge. To achieve both the desired level of wearer satisfaction and product-specific performance, it is necessary to clearly establish the intended end-use context of apparel and the specific comfort attributes valued by consumers (Fayala, Alibi, Jemni & Zeng, 2015).

SENSORY ANALYSIS: METHODOLOGY APPLIED TO TEXTILES

As a strategy to enhance product commercialization, sensory analysis has increasingly been adopted by non-food industries to evaluate different products. In the textile field, sensory analysis has become a focus of research in order to measure and compare the quality of various textile products with regard to wearer comfort.

According to Philippe et al. (2004), investigations into sensory analysis originated in the 1950s with the development of quantitative descriptive methods in the food sector. From the 1970s onwards, the complete methodology of descriptive sensory analysis was proposed by Herbert Stone and Joel Sidel (Spence & Gallace, 2011), becoming a standard in the United States during the 1980s. Today, it is recognized as an international standard, ISO 8586:2014 Sensory Analysis, General guidelines for the selection, training and monitoring of selected assessors and expert sensory assessors (Philippe et al., 2004). These methods generally employ human senses as measurement tools.

Tactile–sensory comfort in textiles results from the amount of stress generated when the material comes into contact with the skin, highlighting the strong correlation between tactile perception and the mechanical properties of fabrics. In textile products, sensory studies began in the 1980s, with evaluations carried out by both trained and untrained assessors. Standardization of tactile sensory comfort assessments emerged in the 1990s through descriptive sensory and psychophysical analysis techniques (Sztandera et al., 2013). However, as noted by Yenket, Chambers IV, and Gatewood (2007), relatively few studies employed trained assessors for tactile fabric evaluation.

This methodology was adapted from international standards originally developed for the assessment of food and cosmetic products. Traditionally, sensory evaluation employs human perception, vision, olfaction, audition, taste, and touch, to assess product attributes.

In 1968, according to Broega (2007), Kawabata initiated a series of investigations aimed at objectively assessing fabric hand. This led to the creation of the Hand Evaluation and Standardisation Committee (HESC), formed by experts from the Japanese textile and apparel industries as well as academic institutions. The committee developed the first Japanese textile lexicon, comprising eight attributes: stiffness (Koshi), crispness (Hari), flexibility and suppleness (Shinayakasa), smoothness (Numeri), softness and lightness (Sufutosa), fullness and bulk (Fukurami), roughness (Shari), and the “frou-frou” sensation characteristic of silk fabrics (Kishimi) (Abreu, 2004).

Philippe et al. (2004) later conducted the first French investigations, developing tactile sensory lexicons for fabrics. Nogueira (2011) subsequently compared

Portuguese and French lexicons, adding visual sensory assessment to his studies. Other works in quantitative sensory analysis of textiles were carried out by Barker (2002), Bertaux et al. (2010), Bacci et al. (2012), Chollakup et al. (2004), Kweon et al. (2004), Ryu and Roh (2010), Strazdienė et al. (2006), Sztandera et al. (2013), and Wong et al. (2003). However, only the Portuguese study conducted a comparative analysis with two trained panels, one Portuguese and one French, thus validating the methodology.

Yenket et al. (2007) noted that in some studies assessors were allowed to see the materials during haptic evaluation, whereas in others (Philippe et al., 2004; Nogueira, 2011), participants were blindfolded or tested in booths that prevented visual access to textile samples. This highlights the growing need for training and monitoring of specialized sensory panels for textile tactile comfort evaluation. Moreover, given the human factor involved, careful screening of panelists is essential for final selection (ABNT, 2016; Teixeira, 2009).

In textiles, sensory analysis has been investigated primarily through tactile perception (Philippe et al., 2003a; Guest & Spence, 2003; Chollakup et al., 2004; Li & Wang, 2005; Bacci et al., 2012; Sabir & Doba Kadem, 2016). This type of sensory evaluation is based on descriptive psychological and physiological responses, where sensations elicited upon touching a material are quantified, relying solely on the human hand as the instrument.

Thus, sensory analysis represents a novel and significant tool for textile materials, where the sense of touch plays a decisive role in consumer perception and product acceptance.

TACTILE–SENSORY COMFORT EVALUATION IN TEXTILES

To better understand the evaluation of tactile–sensory comfort in textiles, it is first necessary to define the concept of touch. Touch has long been employed as a tool for assessing consumer acceptance and product performance, serving as a means of continuous improvement across multiple fields. It is the first sense to develop in infants and can convey meanings that cannot be easily expressed through formal language (Spence & Gallace, 2011). In textiles, touch is central in judging essential characteristics and determining the suitability of fabrics for specific end uses (Kweon, Lee & Choi, 2004).

The skin contains various cutaneous receptors located across different layers. Bertaux et al. (2010) examined three categories of receptors that characterize tactile perception: mechanoreceptors, which transmit information about surface roughness and pressure exerted on the skin by fabrics; thermoreceptors, which detect temperature (heat/cold); and nociceptors, which respond to pain. The researchers noted that there is no specific receptor for the perception of moisture. However, moisture can be perceived indirectly through heat transfer and evaporation: when sweat is produced by the sweat glands, the epidermis absorbs the moisture and swells, thereby stimulating tactile receptors (Bertaux et al., 2010).

In their research on the role of multisensory design, Spence and Gallace (2011) emphasized that after vision, touch is the first sense engaged in product evaluation and is often decisive for final consumer acceptance. They observed that, when assessing textiles, consumers frequently rub fabrics against highly sensitive areas of the body, such as the cheeks, to evaluate softness and warmth. Moreover, they highlighted that when consumers touch a low-quality textile article, it often results in a negative hedonic evaluation, contrasting with the typically positive hedonic responses associated with visual assessment alone.

Touch is thus embedded within a multisensory perceptual system, incorporating the cutaneous system, which detects pressure, vibration, and thermal changes, with tactile perception emerging from the interpretation of these stimuli (Warren, Santello & Tillery, 2011; Johansson & Flanagan, 2009; Lederman & Klatzky, 1996b; Lederman, 1997). Vision, in contrast, provides only indirect information regarding such mechanical interactions (Johansson & Flanagan, 2009; Kweon et al., 2004). Klatzky and Lederman developed a multidimensional haptic model, classifying the haptic system into three distinct categories of data (Klatzky & Lederman, 1987):

> Substance: material properties, such as hardness, elasticity, surface texture, and temperature;
>
> Function: the functions directly associated with object use; and
>
> Structure: object size, shape, and weight.

Similarly, Philippe, Abreu, Schacher, Adolphe, and Silva (2003) and Philippe, Schacher, Adolphe, and Catherine (2004) categorized textile attributes into three distinct groups: Bipolar, Surface, and Material, which were later employed by Nogueira (2011) in studies assessing textile product quality through sensory analysis methodologies.

According to Spence and Gallace (2011), tactile experience can be deliberately manipulated by altering product surface properties, thereby influencing consumer preferences. This indicates that the exploration of tactile attributes is fundamental to understanding user expectations and to driving the continuous improvement of textile products. The authors further suggest that in design practice, tactile quality should be considered alongside visual quality during product development.

The Sports Cap

The sports cap is a highly popular accessory among Brazilian youth, featuring a wide variety of brands, models, and styles. However, the brand name of a given product does not always guarantee the expected levels of quality and comfort.

Kelly (2018) conducted an exploratory study on the chronology and commercialization of baseball caps. According to the author, the jockey hat may have inspired the cap's design, considering it one of the most popular forms of headwear. The New Era company played a key role in popularizing caps when it introduced the 59Fifty wool model in 1954. In the 21st century, the baseball cap experienced a shift in its use: what was previously worn for leisure and work became a fashion code and a marker of identity in contemporary dress.

Driven by this trend, the municipality of Apucarana has become the largest producer of sports caps in Brazil, accounting for approximately 80% of national production. Apucarana manufactures around 50 million caps per year, a significant volume considering that all textile and apparel companies in the state of Paraná produced approximately 150 million garments in total (SEBRAE, 2012). Most sales of caps produced in Apucarana occur indirectly, which limits direct interaction between manufacturers and end consumers, and consequently their understanding of consumer expectations. This highlights the relevance of experimental studies aimed at evaluating the comfort of sports caps produced in Apucarana, contributing to product improvement and innovation and ultimately enhancing user comfort.

The main textile and structural components of a basic or baseball cap include the crown, sweatband, binding tape, and adjuster (Figure 1):

- The visor is composed of a polyethylene insert covered with fabric.
- The sweatband typically consists of a layer of polyamide/polyurethane foam and/or nonwoven fabric, lined internally with a polyethylene film and externally with 100% cotton fabric.
- The crown is formed by the assembly of panels, with the front panels laminated to provide structure.
- The button serves as a finishing element at the intersection of the crown panels.
- The binding tape is used to reinforce and finish the seams between the panels.

Comparing this construction with the findings of Kang (2007), it is observed that the areas exerting the greatest pressure on the wearer’s head are the sweatband and the rear crown panels.

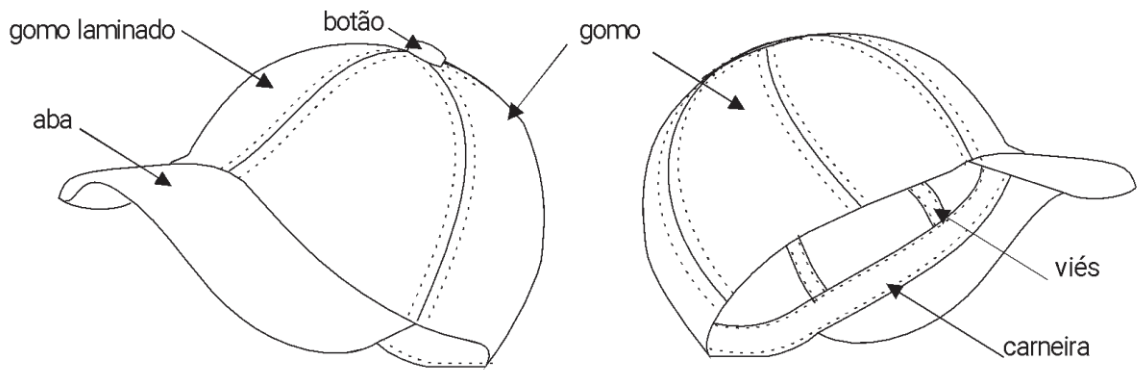


Figure 1 – Basic cap design: front, side, back, and internal views. Source: Authors

Materials and Methods

This study aims to address the research question regarding the comfort of sports caps, focusing specifically on tactile–sensory comfort. To approach the research question and meet the proposed objectives, the methodological procedures employed in this study involve descriptive research based on experimental procedures using Quantitative Descriptive Analysis (QDA), in order to establish an understanding of the tactile comfort characteristics of the caps.

Descriptive research seeks to describe the characteristics of a phenomenon or to establish relationships between variables. Sensory analysis methodologies employ descriptive investigations to characterize the attributes of different product types and involve quantitative analysis of sensory perceptions. This approach requires a well-defined lexicon and a panel of assessors. Assessors can be classified into different types, such as untrained consumers, semi-trained (experienced), and trained (highly trained) (AFNOR, 2014; Ellendersen & Wosiacki, 2010; Philippe et al., 2004).

The recommended procedure for recruiting, selecting, training, and monitoring qualified assessors follows these stages (AFNOR, 2014):

a) recruitment and preliminary selection of naïve assessors;

b) familiarization of naïve assessors to become initiated assessors;

c) selection of initiated assessors to determine their ability to perform specific tests;

d) training of selected assessors to become specialized sensory assessors.

Although bibliographic references for these procedures are abundant in the food sector, several international standards are frequently cited, including ISO 6658 – Sensory Analysis – Methodology – General Guidance (ISO, 2005), ISO 13299 – Sensory Analysis – Methodology – General Guidance for Establishing a Sensory Profile (BS ISO, 2003), ISO 8589 – Sensory Analysis – General Guidance for the Design of Test Rooms (ABNT, 2015), ISO 8586 – Sensory Analysis – General Guidelines for the Selection and Training of Assessors (AFNOR, 2014), ISO 11035 (ISO, 1994), NBR ISO 4120 – Sensory Analysis – Methodology – Triangle Test (ISO, 2013), and NBR 14140 – Food and Beverages – Sensory Analysis – Quantitative Descriptive Analysis (QDA) Test (ABNT, 1998). These standards have been adapted for tactile sensory evaluation of textiles, as demonstrated by Philippe et al. (2004) and Nogueira (2011).

Data collection was carried out through a panel of assessors selected via triangle tests and trained to form a tactile sensory panel, as described by Nagamatsu, Abreu, and Santiago (2018). This panel developed the Brazilian textile lexicon (Table 1) to evaluate textile samples used in the manufacture of sports caps. This stage of the research took place over 15 months, including the recruitment of volunteers (Nagamatsu et al., 2018) and concluding with the evaluation of the samples.

Table 1 – Tactile sensory lexicon for the cap. Source: Nagamatsu, Abreu, & Santiago (2017)

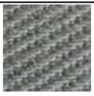
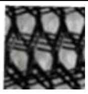
Bipolar	Surface	Material
Light – Heavy	Soft	Elastic
Thick – Thin	Fuzzy	Structured
Cool – Warm	Rough	
Dry – Humid		
Smooth – Harsh		

As a tool for statistical data analysis in descriptive research, the software SPSS – Statistical Package for the Social Sciences was employed to process the data collected from the sensory evaluations of textile samples.

The evaluation environment followed the ISO 8589 standard (ABNT, 2015), with ambient temperature maintained at 22°C (± 2°C) and relative humidity at 65% (± 5%). In each session, a maximum of three samples were assessed in three repetitions.

Nine types of raw materials were cut into 20 × 20 cm specimens for tactile–sensory evaluation. Among them, five samples corresponded to different types of fabrics used by sports cap manufacturing industries in Apucarana, three samples were wool-based, and one originated from Portugal, as shown in Table 2. The textile samples were randomized for evaluation, with three samples tested in three repetitions, in accordance with ISO 13299 (BS ISO, 2003).

Table 2 – Textile samples. Source: Authors

									
Sample	A1	A2	A3	A8	A9	A4	A5	A6	A7
Composição	100% Cotton	100% Cotton	100% Cotton	100% Polyester	100% Polyester	100% Wool	65% Polyester / 35% Wool	65% Polyester / 35% Wool	100% Cork

The results of the experimental study provided data for the determination of sensory comfort through Quantitative Descriptive Analysis (QDA) of textile samples, evaluated by a trained sensory panel and supported by an analytical method based on models discussed in the theoretical framework.

A two-way ANOVA with repetitions was conducted for the statistical analysis of the data, in which the variabilities of both assessors and products were first examined (BS ISO, 2003). The purpose was to reduce the overall variability of the profile ratings, thereby ensuring greater homogeneity in the sensory profile evaluation.

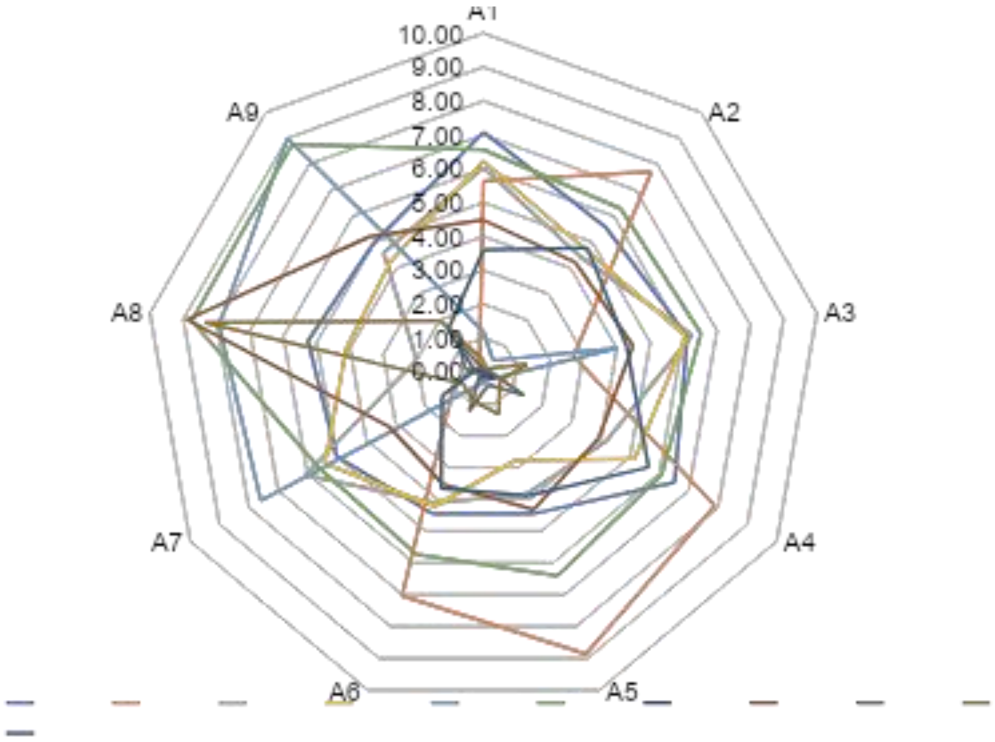
As this research involved human participants, the experimental protocols of the project were submitted to the Research Ethics Committee for Studies Involving Human Subjects of the Federal University of Technology – Paraná (UTFPR), under registration number CAAE 45651115.5.0000.5547, and approved in August 2015.

RESULTS AND DISCUSSION

The development of a lexicon represents a crucial stage in sensory evaluation. In this study, the Brazilian Textile Lexicon, developed and validated by Nagamatsu, Abreu, and Santiago (2016), was employed, together with a trained sensory panel established by Nagamatsu et al. (2018).

Figure 2 presents the mean values of the samples in relation to the evaluated attributes. This graphical representation makes it possible to observe the intensity of each attribute: the closer the score is to the outer edge of the vector, the greater the perceived intensity of the attribute.

Figure 2 – Sensory profile of textile samples. Source: Authors



It is observed that the estimated mean values of the evaluations characterize each sample. In addition, it is possible to notice that Sample A1 (100% Cotton) is characterized by a warm touch, with medium drape, weight, and thickness. Its texture was considered neither dry nor moist, with low softness and slightly smooth. The low scores in the attributes rigid, rough, fuzzy, and elastic indicate that these are not part of its characterization.

Sample A2 (100% Cotton) is qualified by good drape and by presenting average scores in the bipolar attributes dry–moist, warm–cool, light–heavy, thin–thick, and smooth–rough. The soft sensation was also considered average by the panel. The attributes rigid, elastic, rough, and fuzzy do not characterize Sample A2.

Sample A3 (100% Cotton) is identified as very warm, heavy, thick, and dry. The attributes rigid, soft, and rough were considered moderate, with low drape. Elastic, fuzzy, and rough are not characteristics of Sample A3.

Sample A4 (100% Wool) shows good drape, is warm, and has a dry touch. Thickness, weight, and softness are average, and it is slightly smooth. The mean values of the attributes rigid, elastic, fuzzy, and rough do not characterize Sample A4.

Sample A5 (65% Polyester / 35% Wool) is extremely drapable and very dry, slightly smooth, soft, cool, light, and thin. The attributes that do not characterize Sample A5 are rigid, elastic, and fuzzy.

Sample A6 (65% Polyester / 35% Wool) shows good drape. In relation to temperature, weight, thickness, and dryness, the sample was considered average. It is not characterized by the attributes rigid, elastic, fuzzy, and rough.

The characteristics of Sample A7 (100% Cork) are: very rigid, heavy, thick, dry touch, and median sensation of cool and warm, being slightly smooth. It is not characterized by drape, elasticity, fuzziness, softness, or roughness.

Sample A8 (100% Polyester) is extremely dry, rough, and coarse. It was considered by the panel as very rigid, with average temperature and weight, and light. It is not characterized by drape, elasticity, fuzziness, or softness.

Sample A9 (100% PES) is extremely dry, smooth, and coarse. It was considered very rigid, with median temperature and thickness. It is not characterized by drape, elasticity, fuzziness, or softness.

FINAL CONSIDERATIONS

As presented in the introductory chapter, achieving total clothing comfort requires meeting four fundamental aspects: ergonomic, psychological, thermophysiological, and sensorial comfort. All aspects of comfort are consistent or in harmony with one another; in other words, they are dynamic in order to meet the specific needs of the user for a given use.

The combination of these aspects of comfort can be used as a strategy for the development of high-performance textile products and as a strong influence on consumer decision-making at the moment of purchase.

This investigation focused on the evaluation of tactile sensorial comfort in textile samples. The assessment of the tactile sensation of textile samples is a way of classifying the level of comfort to the touch as perceived by a trained textile panel.

The sensorial evaluation of tactile comfort depends on the work of well-trained professionals capable of conducting sensory analyses in a standardized manner. Such standardization enables the use of the same methodology in different regions of Brazil, making the sensory analysis data comparable and reproducible.

REFERENCES

1. ABNT. (1998). *NBR14140_ Alimentos e bebidas - Análise sensorial - Teste de análise descritiva quantitativa (ADQ).pdf* (p. 5). Associação Brasileira de Normas Técnicas.

2. ABNT. (2015). *ISO 8589 - Análise sensorial - Guia geral para o projeto de ambientes de teste*. www.abnt.br

3. ABNT. (2016). *NBRISO11132_ Guia para monitorar o desempenho de um painel sensorial quantitativo.pdf* (p. 29). Associação Brasileira de Normas Técnicas.

4. Abreu, M. (2008). An investigation of the thermal comfort behaviour for active wear using a thermal manikin. *7th International Thermal Manikin and Modelling Meeting*, *September*, 0–2. http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:AN+INVESTIGATION+OF+THE+THERMAL+COMFORT+BEHAVIOUR+FOR+ACTIVE+WEAR+USING+A+THERMAL+MANIKIN#0

5. Abreu, M. J. A. M. (2004). *Contribuição para o estudo da parametrização de têxteis hospitalares*. Universidade do Minho.

6. Abreu, M. J., Nagamatsu, R. N., & Santiago, C. D. (2018). The Perception of Tactile Feeling and corresponding Textile Attributes Worldwide. *AITAE Aegean Internationa Textile and Advanced Engineering*, *September*, 36–38. https://aegeanconference.org/

7. AFNOR. (2014). *ISO 8586 - Sensory analysis - General guidelines for the assessors and expert sensory assessors* (p. 28). Association Française de Normalisation.

8. Bacci, L., Camilli, F., Drago, S., Magli, M., Vagnoni, E., Mauro, a., & Predieri, S. (2012). Sensory evaluation and instrumental measurements to determine tactile properties of wool fabrics. *Textile Research Journal*, *82*(14), 1430–1441. https://doi.org/10.1177/0040517512438125

9. Barker, L. R. (2002). From fabric hand to thermal comfort the evolving role of objective measurements in explaining human comfort response to textiles. *International Journal of Clothing Science and Technology*, *14*(3/4), 181–200. https://doi.org/http://dx.doi.org/10.1108/MRR-09-2015-0216

10. Bertaux, E., Derler, S., Rossi, R. M., Xianyi Zeng, Koehl, L., & Ventenat, V. (2010). Textile, Physiological, and Sensorial Parameters in Sock Comfort. *Textile Research Journal*, *80*(17), 1803–1810. https://doi.org/10.1177/0040517510369409

11. Bishop, P. A., Balilonis, B., Davis, J. D., & Zhang, Y. (2013). Ergonomics and Comfort in Protective and Sport Clothing: A Brief Review. *Journal of Ergonomics*, *S2*(02), 1–7. https://doi.org/10.4172/2165-7556.S2-005

12. Broega, A. C. da L. (2007). *Contribuição para a Definição de Padrões de Conforto de Tecidos Finos de Lã*. Universidade do Minho.

13. Broega, A., Silva, M., & Silva, R. (2010). *A neural network approach in the sensorial comfort of wool light fabrics by subjective and objective evaluation*. http://repositorium.sdum.uminho.pt/handle/1822/19255

14. BS ISO. (2003). *ISO 13299 - Sensory analysis—Methodology—General guidance for establishing a sensory profile*.

15. Chollakup, R., Sinoimeri, a., Philippe, F., Schacher, L., & Adolphe, D. (2004). Tactile sensory analysis applied to silk/cotton knitted fabrics. *International Journal of Clothing Science and Technology*, *16*(1/2), 132–140. https://doi.org/10.1108/09556220410520423

16. Ciesielska-Wrobel, I. L., & Van Langenhove, L. (2012). The hand of textiles - definitions, achievements, perspectives - a review. *Textile Research Journal*, *82*(14), 1457–1468. https://doi.org/10.1177/0040517512438126

17. Das, A., & Alagirusamy, R. (2010a). Introduction of clothing comfort. In A. Das & R. Alagirusamy (Eds.), *science in clothing comfort* (pp. 1–12). Wooldhead Plubishing India Pvt. Ltd. https://doi.org/10.1533/9780857092830.1

18. Das, A., & Alagirusamy, R. (2010b). *Science in Clothing Comfort*. Wooldhead Plubishing India Pvt. Ltd.

19. Ellendersen, L. de S., & Wosiacki, G. (2010). *Análise sensorial descritiva quantitativa* (B. G. Nadal (ed.); 1ª). UEPG.

20. Fayala, F., Alibi, H., Jemni, A., & Zeng, X. (2015). A new hybrid artificial intelligence approach to predicting global thermal comfort of stretch knitted fabrics. *Fibers and Polymers*, *16*(6), 1417–1429. https://doi.org/10.1007/s12221-015-1417-7

21. Guest, S., & Spence, C. (2003). What role does multisensory integration play in the visuotactile perception of texture? *International Journal of Psychophysiology*, *50*, 63–80. https://doi.org/10.1016/S0167-8760Ž03.00125-9

22. ISO. (1994). *ISO 11035 - Sensory analysis - Identification and selection of descriptors for establishing a sensory profile by a multidemensional approch* (p. 31). International Organization for Satandardization.

23. ISO. (2005). *ISO 6658 Sensory analysis — Methodology — General Guidance* (p. 20). International Standard Organization.

24. ISO, I. O. for S. (2013). *NBRISO 4120_ Análise sensorial - Metodologia - Teste triangular parte 2.pdf* (p. 16).

25. Issa, M., Abreu, M. J., Schacher, L., Adolphe, D., & Cabeco Silva, M. E. (2004). The influence of the sterilisation process on certain thermal properties. *European Journal of Applied Physiology*, *92*(6), 673–678. https://doi.org/10.1007/s00421-004-1129-y

26. Johansson, R. S., & Flanagan, J. R. (2009). Coding and use of tactile signals from the fingertips in object manipulation tasks. *Nature Reviews Neuroscience*, *10*(5), 345–359. https://doi.org/10.1038/nrn2621

27. Kelly, W. W. (2018). The ubiquitous baseball cap: Identity, style, and comfort in late modern times. *Journal of Consumer Culture*, *18*(2), 261–278. https://doi.org/10.1177/1469540517744693

28. Klatzky, R. L., & Lederman, S. J. (1987). The Intelligent Hand. *Psychology of Learning and Motivation - Advances in Research and Theory*, *21*(C), 121–151. https://doi.org/10.1016/S0079-7421(08)60027-4

29. Kweon, S.-A., Lee, E.-K., & Choi, J.-M. (2004). A comparative study on the subjective fabric hand according to gender for winter sleepwear fabrics. In *Fibers and Polymers* (Vol. 5, Issue 1, pp. 6–11). https://doi.org/10.1007/BF02875488

30. Lawless, L. J. R., & Civille, G. V. (2013). DEVELOPING LEXICONS: a review. *Journal of Sensory Studies*, *20*, 270–281. https://doi.org/10.1111/joss.12050

31. Li, Y., & Wang, Z. (2005). Thermal sensory engineering design of textile and apparel products. *Elsevier Ergonomics Book Series*, *3*(C), 473–476. https://doi.org/10.1016/S1572-347X(05)80074-6

32. Liu, R., & Little, T. (2009). The 5Ps Model to Optimize Compression Athletic Wear Comfort in Sports. *Journal of Fiber Bioengineering and Informatics*, *2*(1), 41–52. https://doi.org/10.3993/jfbi06200907

33. Nagamatsu, R.N., Abreu, M. J., Santiago, C. D., & Braga, I. (2018). Selection and training of a panel of evaluators for sensory analysis of tactile comfort in Brazil. *Textiles, Identity and Innovation: Design the Future*, 9–14. https://doi.org/10.1201/9781315100210-4

34. Nagamatsu, Rosimeiri Naomi, Abreu, M. J., & Santiago, C. D. (2017). *Tactile feeling of textile : a comparative study between textiles comfortable attributes of France , Portugal and Brazil* (FIBER SOCIETY (ed.)). FIBER SOCIETY.

35. Nagamatsu, Rosimeiri Naomi, José, M., Marques, A., & Santiago, D. (2016). LEXICON DEVELOPMENT FOR BRAZILIAN TEXTILE SENSORY ANALYSIS. In Universidade do Minho (Ed.), *CIMODE - international Fashion an Design Congress* (pp. 1–6).

36. Nogueira, C. (2011). *Análise sensorial de produtos têxteis*. 218. http://repositorium.sdum.uminho.pt/handle/1822/19619

37. Park, Y., & Kim, E. (2012). *Wearing Comfort of Temperature-Adaptable Textiles by Dual-Phase Coatings between Phase-Change Materials and Silicon Carbide Particles*. https://doi.org/10.1002/app

38. Philippe, F, Schacher, L., Adolphe, D. C., & Dacremont, C. (2004). Tactile feeling: Sensory analysis applied to textile goods. *Textile Research Journal*, *74*(12), 1066–1072. https://doi.org/10.1177/004051750407401207

39. Philippe, Flora, Abreu, M. J., Schacher, L., Adolphe, D. C., & Silva, M. E. C. (2003). Influence of the sterilisation process on the tactile feeling of surgical gowns. *Science And Technology*, *15*, 268–275. https://doi.org/10.1108/09556220310478378

40. Philippe, Flora, Schacher, L., Adolphe, D. C., & Dacremont, C. (2003). The Sensory Panel Applied to Textile Goods – A New Marketing Tool. *Journal of Fashion Marketing and Management*, *7*(3), 235–248. https://doi.org/10.1108/13612020310484799

41. Rombaldoni, F., Demichelis, R., & Mazzuchetti, G. M. (2010). Prediction of human psychophysical perception of fabric crispness and coolness hand from rapidly measurable low-stress mechanical and thermal paramenters. *Journal of Sensory Studies*, *25*(6), 899–916. https://doi.org/10.1111/j.1745-459X.2010.00312.x

42. Ryu, H.-S., & Eui Kyung Roh. (2010). Preference and subjective evaluation of washed fabric hand using conjoint analysis. *Textile Research Journal*, *80*(20), 2167–2175. https://doi.org/10.1177/0040517510376270

43. Sabir, E., & Doba Kadem, F. (2016). Comfort and Performance Properties of Raised and Laminated Denim Fabrics. *Fibres and Textiles in Eastern Europe*, *24*(5(119)), 88–94. https://doi.org/10.5604/12303666.1198064

44. Sabiri, N., Leblond, L., Villoutreix, J., Lavergne, M., Acétarin, J. D., & Villoutreix, G. (2008). Touch study of polymer materials surfaces -description of raspiness by a correlation approach between sensorial analysis and physical measurements. *Advanced Engineering Materials*, *10*(4), 407–413. https://doi.org/10.1002/adem.200700296

45. SEBRAE. (2012). *Vestuário: mercado do Paraná*.

46. Silva, H., & Abreu, M. J. (2008). *Marcas Sensoriais Na Moda*. 3539–3545.

47. Slater, K. (1997). Subjective textile testing. *Journal Textile Institute*, *88*(2), 79–91. https://doi.org/10.1080/004050009708658532

48. Spence, C., & Gallace, A. (2011). Multisensory design: Reaching out to touch the consumer. *Psychology and Marketing*, *28*(3), 267–308. https://doi.org/10.1002/mar.20392

49. Strazdienė, E., Ben Saïd, S., Gutauskas, M., Schacher, L., & Adolphe, D. C. (2006). The evaluation of fabric treatment by Griff tester and sensory analysis. *International Journal of Clothing Science and Technology*, *18*(5), 326–334. https://doi.org/10.1108/09556220610685267

50. Sztandera, L. M., Cardello, A. V, Winterhalter, C., & Schutz, H. (2013). Identification of the most significant comfort factors for textiles from processing mechanical, handfeel, fabric construction, and perceived tactile comfort data. *Textile Research Journal*, *83*(1), 34–43. https://doi.org/10.1177/0040517512438121

51. Tamura, T. (2006). Development of a two-layer movable sweating thermal manikin. *Industrial Health*, *44*(3), 441–444. https://doi.org/10.2486/indhealth.44.441

52. Tamura, T. (2016). Climate and Clothing. *Journal of the Human Eviroment System*, *19*(1), 65–69. https://doi.org/10.5604/12303666.1215532

53. Teixeira, L. V. (2009). Análise Sensorial Na Indústria De Alimentos. *Revista Do Instituto de Laticínios Cândido Tostes*, *64*(366), 12–21.

54. Vasile, S., Malengier, B., De Raeve, A., Louwagie, J., & Vanderhoeven, M. (2016). Assessment of sensorial comfort of fabrics for protective clothing. *7th European Conference on Protective Clothing ECPC*, *September*, 0–2.

55. Warren, J. P., Santello, M., & Tillery, S. I. (2011). Effects of fusion between tactile and proprioceptive inputs on tactile perception. *PLoS ONE*, *6*(3). https://doi.org/10.1371/journal.pone.0018073

56. Wong, A. S. W., Li, Y., & Yeung, P. K. W. (2003). *Performances of Artificial Intelligence Hybrid Models' in Prediction of Clothing Comfort from Fab.pdf* (pp. 429–436).

57. Yenket, R., Chambers IV, E., & Gatewood, B. M. (2007). COLOR HAS LITTLE EFFECT ON PERCEPTION OF FABRIC HANDFEEL TACTILE PROPERTIES IN COTTON FABRICS. *Journal of Sensory Studies*, *22*, 336–352.

58. You, F., Wang, J. M., Luo, X. N., Li, Y., & Zhang, X. (2002). Garment's pressure sensation (1): subjective assessment and predictability for the sensation. *International Journal of Clothing Science and Technology*, *14*(5), 307–316. https://doi.org/10.1108/09556220210446121

ACKNOWLEDGMENTS TO INSTITUTIONS

To Fundação Araucária (Support for Scientific and Technological Development of Paraná), through CP20/2013, Doctoral Program in Textile Engineering in Partnership with a Foreign Institution (UMINHO/UEM/UTFPR).

To the Universidade Tecnológica Federal do Paraná (UTFPR), e Diretoria de Pesquisa e Pós-Graduação (DIRPPG).