The Longzhou Zhuang Brocade: Evaluation of the Tactile Sensation of Machine-Woven and Handmade Fabrics

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Abstract

Zhuang brocade is an exquisite handicraft prevalent in Guangxi Zhuang Autonomous Region, known for its unique pattern design, rich colors, and exquisite weaving techniques. People often struggle to distinguish the tactile differences between machine-woven and handmade fabrics when purchasing. The objective of this study is to investigate the differences in tactile characteristics between machine-woven and handmade Zhuang brocade. To achieve this, a mixed-methods approach combining qualitative and quantitative research was employed to collect and analyze quantitative data. A total of 14 samples, each measuring 20 cm × 20 cm, were selected, with 7 machine-woven and 7 handmade Zhuang brocade samples. Twenty-three experienced weavers with extensive knowledge of Zhuang brocade weaving were invited as evaluators to subjectively assess six tactile indicators: thickness、softness、velvet feel、fineness、smoothness、elasticity .The experiment was conducted under standard atmospheric conditions (temperature of 20±2° C and relative humidity of 65%±2%) to ensure the accuracy and reliability of the evaluation results.

Tools used included an evaluation guide, two standardized evaluation forms, and a laboratory with constant temperature and humidity. In terms of data collection, the sources of this study mainly comprised tactile evaluation experiments, academic papers, interview results, and non-scaled questionnaires. Data processing was performed using Microsoft Excel, and the collected data were analyzed using descriptive statistics and hypothesis testing methods. The research findings indicate that handmade Zhuang brocade significantly outperforms machine-woven Zhuang brocade in terms of softness, elasticity, delicacy, thickness, and nap. Based on these findings, specific recommendations are provided for different stakeholders, including encouraging consumers to choose Zhuang brocade products based on personal needs and budget, and advising producers to focus on quality improvement and product innovation.

Keywords: Longzhou Zhuang Brocade; Machine-woven; Handmade; Tactile Evaluation

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Introduction

Longzhou County, located in the west of Chongzuo City, Guangxi Zhuang Autonomous Region, China, boasts a superior geographical position and serves as a model of harmonious coexistence among multiple ethnic groups, with the Zhuang population being the most concentrated. On this land, Zhuang brocade, a treasure of ethnic culture, not only carries profound historical connotations but also captivates the world with its unique artistic charm. With its exquisite pattern design, rich color application, and exquisite weaving techniques, Zhuang brocade vividly displays the Zhuang people's love for natural beauty and their boundless aspirations for life. As a representative of traditional handicrafts, Longzhou Zhuang Brocade not only plays a significant role in daily life but also becomes a sought-after item for collectors due to its high artistic value and cultural connotations (Longzhou County Local Records Compilation Committee, 2020).

However, with the rapid development of technology and the advancement of globalization, the widespread application of machine weaving technology has posed unprecedented challenges to the traditional handmade brocade industry. Machine weaving technology has swiftly dominated the market with its advantages of efficiency and low cost, but it has also raised concerns about the uniqueness, cultural value, and emotional connection of handicrafts. To comprehensively understand the differences in tactile experience between machine-woven and handmade Zhuang brocade, this study selected representative samples of both types and conducted a systematic evaluation using scientific methods. This research not only helps us gain a deeper understanding of the characteristics of the two weaving methods but also provides consumers with a basis for selection, offers directions for improvement for producers, and supplies references for government cultural institutions in formulating relevant policies, jointly promoting the sustainable development and cultural heritage of the Longzhou Zhuang Brocade industry.

This study aims to reveal the differences between machine-woven and handmade Zhuang brocade and the reasons behind them by comparatively analyzing their performance in tactile indicators such as thickness、softness、velvet feel、fineness、smoothness、elasticity. Through deep research, we hope to provide new ideas and strategies for the inheritance and development of Longzhou Zhuang Brocade, allowing this ancient handicraft to radiate new vitality and vigor in the context of the new era. At the same time, this study also hopes to arouse attention from all sectors of society towards the protection and inheritance of traditional culture, jointly guarding this precious cultural heritage.

Research Objectives

To study the Differences in Tactile Sensation between Machine-Woven and Handmade Longzhou Zhuang Brocade.

Literature Review

Longzhou Zhuang brocade, as a traditional handicraft in Guangxi Zhuang Autonomous Region, is renowned for its exquisite patterns, rich colors, and unique tactile feel. With the advancement of industrialization, woven technology has gradually taken a place in the production of Zhuang brocade, but the difference in tactile feel between woven and hand-woven brocades has always been a focus of attention in academic and industrial circles. This paper aims to review the existing literature on the research results of tactile characteristics of woven and hand-woven Longzhou Zhuang brocade, and to explore its scientific value and significance for the inheritance and development of Zhuang brocade culture.

The concepts of fabric tactile feel and subjective evaluation method used in this study have been researched and defined by predecessors. Qi et al. (2017) proposed in their study that fabric tactile feel refers to the sensation produced when touching the fabric by hand, which is a comprehensive reflection of the fabric's intrinsic properties and human sensory perception. The evaluation methods of fabric tactile feel can be divided into subjective evaluation and objective evaluation. Subjective evaluation relies on sensory organs to touch the fabric and evaluate its surface physical properties.

Subjective evaluation method, also known as sensory evaluation method, is based on the definition of fabric style in a narrow sense, using people's subjective feelings to measure and identify fabric style (Wang, 2000). In fact, this subjective judgment is very important and serves as the basic basis for evaluating fabric style. When people wear clothes, they understand the performance of the fabric through subjective feelings. Therefore, in terms of whether a fabric is suitable for wearing, sensory evaluation is the most primitive method for evaluating fabric quality. (Zeng, 2022)

Qi et al. (2021) mentioned the experimental design of subjective evaluation of fabric tactile feel in their research. They selected 15 representative woven fabrics mainly composed of polyester and polycotton. After ironing and equilibration treatment, the fabrics were cut into specific sizes for physical performance testing. At the same time, square samples were cut for subjective evaluation. Thirty-five students aged 20-30 from the School of Textiles, Donghua University participated in the evaluation, with 5 responsible for tactile scoring (within the range of 0-10) and the other 30 for modal selection experiments. Under constant temperature and humidity conditions, trained scorers used a unified gesture to conduct multi-dimensional perceptual evaluations of the samples, mainly considering factors such as roughness and softness. The final subjective evaluation result was the average of the scores given by the 5 scorers.

Zhu & Ma (2020) also used the subjective evaluation method to study and compare the tactile style of Zhuang brocade in their research. By consulting with technicians from a Zhuang brocade manufacturer in Binyang, Guangxi, and local consumers, and referencing relevant literature, they selected six tactile terms from about 40 vocabulary words after discussion: thickness, softness, nap, delicacy, smoothness, and elasticity. Through experiments, the study concluded that there are certain differences in subjective hand feel between hand-woven and woven Zhuang brocade. The difference in thickness is slight, while the difference in smoothness is significant. The smooth hand feel of woven Zhuang brocade is significantly higher than that of hand-woven Zhuang brocade. Hand-woven Zhuang brocade has higher softness and elasticity than woven Zhuang brocade, and the nap effect of hand-woven Zhuang brocade is more pronounced than that of woven Zhuang brocade.

Wang (2021) proposed a method in his research to control the temperature, humidity, and atmospheric pressure of brocade samples. To ensure the accuracy and reliability of the experimental results, all samples were placed under standard atmospheric conditions (temperature of 20±2°C, relative humidity of 65%±2%) and allowed to equilibrate for more than 24 hours. This was done to eliminate the effects of temperature and humidity changes that the samples may have experienced during storage and transportation, allowing the samples to reach a stable state and ensuring the accuracy and reliability of subsequent subjective evaluations.

Based on the research conducted by these researchers, the subjective evaluation of fabric tactile feel is a relatively mature field of study, providing valuable paradigms and data for our subsequent research. However, a review of the literature reveals that there is currently only one study using subjective methods to evaluate Zhuang brocade, and there is no literature available on the evaluation of Longzhou Zhuang brocade. Therefore, to obtain data in this area, it is necessary to conduct this study.

Research Methodology

1. Research methodology

This study adopts a mixed method approach. In terms of qualitative research, in-depth interviews and experiments were conducted with experienced weavers of Zhuang brocade to obtain detailed subjective evaluations of the tactile qualities of machine-made and hand-made Zhuang brocade, including thickness、softness、velvet feel、fineness、smoothness、elasticity. This directly captures the professional insights of weavers on the texture of the fabric. In terms of quantitative research, tactile evaluation experiments were designed and conducted to obtain data on the tactile characteristics of machine-made and hand-made Zhuang brocade.

2. Population and sample group

The target group of this study is weavers with experience in making Zhuang brocade, who have a deep understanding and unique insights into the texture, quality, and hand feel of Zhuang brocade. To ensure the representativeness and reliability of the experimental results, we carefully selected 23 weavers to participate in the evaluation. In terms of sample selection, we chose 7 samples of Zhuang brocade from both machine-made and hand-made weaving methods, totaling 14 test samples. Each sample was sized at 20 centimeters × 20 centimeters and underwent strict edge removal processing and environmental equilibration to ensure consistency of the samples and accuracy of the evaluation.

3. Research tools

Our research tools mainly include an interview guide, an observation guide, and a detailed evaluation guide. The evaluation guide clearly defines six evaluation indicators: thickness、softness、velvet feel、fineness、smoothness、elasticity. Additionally, to unify the evaluation techniques, we have developed specific touch gestures and a description form to ensure that each evaluator can perform the evaluation using the same method. Furthermore, the experimental environment is strictly controlled, and a conference room with constant temperature and humidity is selected as the experimental site to minimize interference from external factors.

4. Data collection

The data are mainly derived from evaluation experiments, interviews, and literature, with the data collection process strictly adhering to established experimental procedures and evaluation criteria. Prior to the start of the experiment, all evaluators received systematic training to ensure they were familiar with the experimental procedures, evaluation methods, and scoring standards. During the evaluation process, each evaluator provided a score ranging from 0 to 5 for each of the six indicators based on their tactile sensations. To ensure data reliability and consistency, we compiled the scores assigned by each evaluator to the same sample and calculated the average as the final subjective evaluation result for that sample on each indicator. After data collection, thorough checks and discussions were conducted to confirm the validity of the data.

5. Data analysis

The paper primarily adopts descriptive statistics as its data analysis method. Specifically, through organizing and analyzing the data collected from interviews and evaluation experiments, the data analysis stage initially calculates the average score for each evaluation indicator, subsequently generating a score coefficient matrix for both handmade and machine-woven Zhuang brocade across various indicators. By comparing the score coefficients, it visually demonstrates the differences in tactile characteristics between handmade and machine-woven Zhuang brocade. Specifically, handmade Zhuang brocade exhibits higher score coefficients in terms of thickness、softness、velvet feel、fineness、smoothness、elasticity, while machine-woven Zhuang brocade scores higher in smoothness. These analysis results provide solid data support for subsequent recommendations and discussions. In terms of data presentation, we utilize intuitive methods such as bar charts to make the results clearer and easier to understand.

Research Conceptual framework

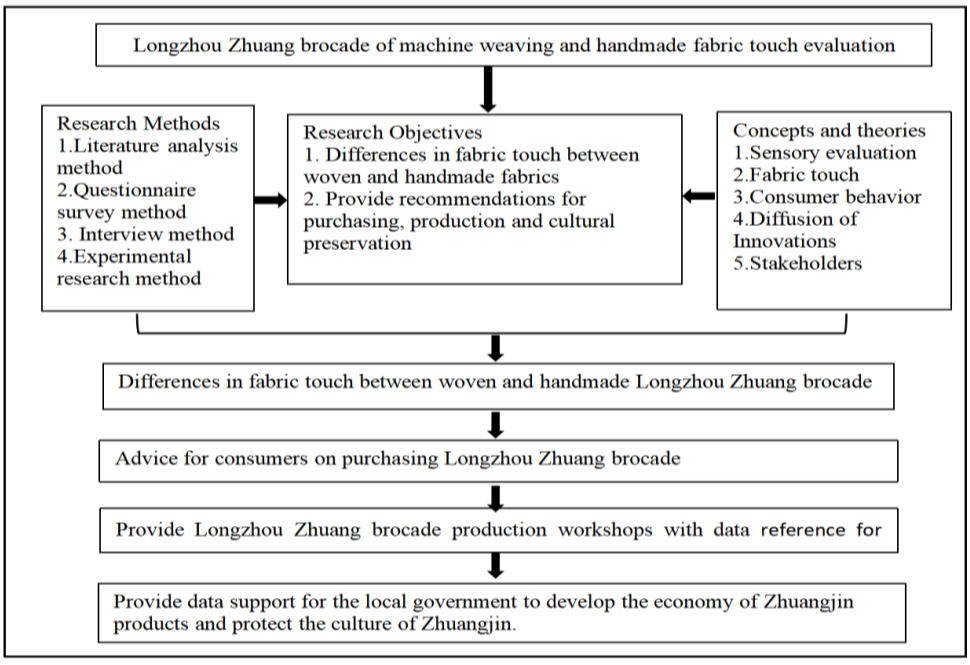


Figure 1: Research Conceptual Framework

Evaluation Of Experiments

1.Selection of Experimental Samples

In the subjective evaluation experiment on the style of Zhuang brocade fabrics, we carefully selected two types of Zhuang brocade samples: machine-woven Zhuang brocade and handmade Zhuang brocade. To ensure the comprehensiveness and representativeness of the experiment, we chose 7 pieces of Zhuang brocade from each type, totaling 14 samples. Each sample measured 20 cm × 20 cm and underwent meticulous edge trimming to ensure that the fabric edges were free of broken threads and remained neat. Additionally, we rigorously screened the quality of the fabric surface to ensure that each sample was flat and wrinkle-free, with no defects or stains, thereby minimizing the impact of external factors on the experimental results.

To ensure the accuracy and reliability of the experimental results, we strictly controlled the environmental conditions for all Zhuang brocade samples before the experiment. All samples were placed under standard atmospheric conditions (temperature of 20±2° C and relative humidity of 65%±2%) for equilibration for over 24 hours, in order to eliminate the effects of temperature and humidity changes that the samples may have experienced during storage and transportation, allowing the samples to reach a stable state and ensuring the accuracy and reliability of the subsequent subjective evaluations. (Wang, 2021)

2.Selection of Experimental Evaluators

To ensure the accuracy and reliability of the experiment, we carefully selected 23 evaluators for this tactile evaluation of Zhuang brocade fabrics. These evaluators are skilled weavers deeply involved in the production of Zhuang brocade. They not only possess extensive experience in weaving Zhuang brocade but also have profound and unique insights into its texture, quality, and hand feel. During the experiment, we required the evaluators to strictly follow the established evaluation criteria and procedures. They were tasked with conducting detailed evaluations of various properties of the Zhuang brocade fabrics, including thickness, softness, and more. To ensure objectivity and accuracy in the evaluations, we provided detailed evaluation guidelines and standardized evaluation forms. During the initial instructions, the evaluators demonstrated understanding of the experimental requirements.

3.Selection of Evaluation Indices

The study employed six evaluation indices, namely: thickness, softness, velvet feel, fineness, smoothness, and elasticity. These indices were first proposed by Zhu Huaping and Ma Yuli in their research (Zhu & Ma, 2020). Their study was conducted after listening to the experiences of technical personnel from Zhuang brocade manufacturers in Binyang, Guangxi, gathering opinions from local consumers in Guangxi, referring to literature related to Zhuang brocade, and finally discussing with experts and technical personnel involved in Zhuang brocade production.

Table 1: Definitions of Terms Used in Tactile Evaluation

Touch	Definition of terms
thickness	Thickness of fabric, thick as opposed to thin
softness	Degree of resistance to compression and bending of fabrics, softness versus stiffness.
velvet feel	Feeling of linting on the surface of the fabric
fineness	The degree of refinement of the structure of the material and the degree of evenness of the cloth surface.
smoothness	The size and amount of particles or bumps on the surface of the fabric, smooth fabrics have less friction and are easier to slip.
elasticity	The ability of the fabric to deform and rebound

Before the official commencement of the tactile test, a foundational explanation of tactile evaluation terminology will be conducted, elucidating the definitions to ensure that the evaluators have a basic understanding of these terms. After confirming that the participants understand the definitions of the evaluation terms, we will proceed to create a table outlining the testing techniques and instruct the subjects on the methods of touch, ensuring that their evaluation techniques are consistent. For detailed instructions on how to touch the samples, please refer to Table 2.

Table 2: Touch Techniques for Conducting Tactile Evaluation

Indices	Touch gestures and descriptions
thickness	Gently press the sample with the palm of your hand to feel its thickness and resistance to pressure. Scoring can be based on the perceived thickness and amount of resistance.
softness	The samples are gently kneaded with fingers to observe the degree of deformation and recoverability. Scoring can be based on the softness of the sample and its ability to recover from deformation.
velvet feel	Gently rub the surface of the sample with the palm of your hand to feel the fluffiness and warmth of the surface. Scoring can be based on the density, length and feel of the fleece.
fineness	Touch the surface of the sample delicately with your fingers to feel the fineness of the texture. Scoring can be based on the fineness and uniformity of the fibers, as well as the overall smoothness to the touch.
smoothness	Feel the smoothness of the surface by gently sliding the palm of your hand in the direction of the fibers. Scoring can be based on the smoothness of the slide and the smoothness of the surface.
elasticity	The samples are stretched and then quickly released to observe how quickly and how much they return to their original state. Scoring can be based on the resilience of the sample.

4.Experimental environment

In order to ensure that the experiment was carried out in an environment with a temperature of 20° C and a relative humidity of 65%, a small hotel conference room with air conditioning was chosen for this experiment, which could accommodate the 23 volunteers and 4 staff members of the hands-on assessment for this experiment at the same time. Before the start of the experiment, the management of the hotel had been asked to adjust the indoor temperature to 20° C and the humidity to 65%, and to use the thermo-hygrometer to check the acceptance of the experiment. After the temperature and humidity were adjusted, all windows were closed and all curtains were opened to ensure that the room was quiet and bright, so as to exclude as much as possible the influence of external environmental factors on the experimental results.

5.Experimental procedure

Before the experiment began, we convened all the evaluators for systematic training. The training encompassed familiarizing them with the overall experimental process, the specific evaluation methods, and how to score each tactile index of the brocade samples based on their touch sensations. We emphasized that the evaluators needed to assign scores ranging from 0 to 5 for the six indices: thickness, softness, velvet feel, fineness, smoothness, and elasticity, according to their actual tactile experiences with the Zhuang brocade samples. A higher score indicated better tactile sensation for that particular index. To ensure accuracy and objectivity in the evaluations, we required the evaluators to keep their hands clean and dry before each evaluation, thereby eliminating any potential impact of hand conditions on the tactile assessment.

After completing the preliminary preparations, the evaluators were brought to seven tables where the Zhuang brocade samples were placed. Each table had two samples arbitrarily placed, with each sample numbered in the top left corner. The evaluators touched each brocade sample and assigned scores for each index based on the scoring criteria, writing down the corresponding sample number and scores on paper. To ensure data reliability and consistency, we compiled the scores from each evaluator for the same sample and calculated the average score of the five evaluators, using this as the final subjective evaluation result for the sample on each index.

Research Results

This table presents the compiled data from all 23 evaluation participants collected after the experiment. Following review and discussion, the data were confirmed to be valid. Subsequently, we calculated the arithmetic mean scores for the six evaluation indices using the formula: $\bar{X}n = (X1 + X2 + X3 + ... + X23) / 23$, where $\bar{X}n$ represents the arithmetic mean score for any of the six evaluation indices (thickness, softness, velvet feel, fineness, smoothness, elasticity) for a given sample, and X refers to the corresponding index score. The scores in this table represent the calculated arithmetic mean scores for each index.

Table 3: Scores of Machine-made and Handmade Zhuang Brocade Samples

Category	Sample	softness	elasticity	smoothness	fineness	thickness	velvet
Machine-made	1	3.2	3.3	4.3	3.4	4.1	2.7
Machine-made	2	3.1	3.2	4.5	3.6	4.0	2.6
Machine-made	3	3.0	3.1	4.4	3.5	3.9	2.5
Machine-made	4	3.3	3.4	4.6	3.7	4.2	2.8
Machine-made	5	2.9	3.0	4.2	3.3	3.8	2.4
Machine-made	6	3.4	3.5	4.7	3.8	4.3	2.9
Machine-made	7	3.1	3.2	4.1	3.4	3.9	2.6
Handmade	1	4.6	4.1	3.6	4.7	4.1	4.2
Handmade	2	4.7	4.3	3.7	4.8	4.2	4.3
Handmade	3	4.5	4.0	3.4	4.5	3.9	4.0
Handmade	4	4.4	3.8	3.3	4.4	3.8	3.9
Handmade	5	4.3	3.7	3.2	4.2	3.7	3.7
Handmade	6	4.8	4.4	3.8	4.9	4.3	4.4
Handmade	7	4.5	4.0	3.5	4.6	4.0	4.1

Based on the aforementioned data, we can calculate the average score for each sample across various indices and subsequently generate a scoring coefficient matrix for both handmade and machine-made samples. Initially, we compute the average scores for handmade and machine-made samples separately for each index. These average scores are then utilized to determine the scoring coefficients, which are calculated by dividing the score of each sample by the average score of its respective category.

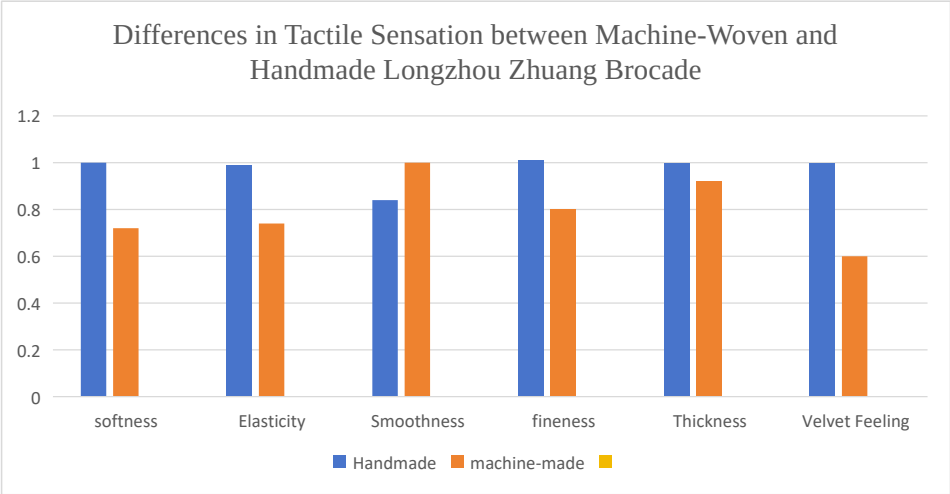
Average scores for handmade samples：
softness: (4.6 + 4.7 + 4.5 + 4.4 + 4.3 + 4.8 + 4.5) / 7 = 4.54
elasticity: (4.1 + 4.3 + 4.0 + 3.8 + 3.7 + 4.4 + 4.0) / 7 = 4.07
smoothness: (3.6 + 3.7 + 3.4 + 3.3 + 3.2 + 3.8 + 3.5) / 7 = 3.49
fineness: (4.7 + 4.8 + 4.5 + 4.4 + 4.2 + 4.9 + 4.6) / 7 = 4.57
thickness: (4.1 + 4.2 + 3.9 + 3.8 + 3.7 + 4.3 + 4.0) / 7 = 4.0
velvet feel: (4.2 + 4.3 + 4.0 + 3.9 + 3.7 + 4.4 + 4.1) / 7 = 4.09

Average scores for machine-made samples：
softness: (3.2 + 3.1 + 3.0 + 3.3 + 2.9 + 3.4 + 3.1) / 7 = 3.14
elasticity: (3.3 + 3.2 + 3.1 + 3.4 + 3.0 + 3.5 + 3.2) / 7 = 3.23
smoothness: (4.3 + 4.5 + 4.4 + 4.6 + 4.2 + 4.7 + 4.1) / 7 = 4.37
fineness: (3.4 + 3.6 + 3.5 + 3.7 + 3.3 + 3.8 + 3.4) / 7 = 3.51
thickness: (4.1 + 4.0 + 3.9 + 4.2 + 3.8 + 4.3 + 3.9) / 7 = 4.0
velvet feel: (2.7 + 2.6 + 2.5 + 2.8 + 2.4 + 2.9 + 2.6) / 7 = 2.63

Table 4: Scoring Coefficient Matrix for Handmade and Machine-made Samples

Category	Handmade	Machine-made
softness	1.00	0.72
elasticity	0.99	0.74
smoothness	0.84	1.00
fineness	1.01	0.80
thickness	1.00	0.92
velvet feel	1.00	0.60

This table presents the scoring coefficients of handmade and machine-made Zhuang brocade on various indices, facilitating a straightforward comparison of their relative performance in different hand-feel characteristics. To visually display the scoring coefficients of handmade and machine-made Zhuang brocade on each index and compare the differences between them, we can use a bar chart. The following is a bar chart based on the scoring coefficient matrix of handmade and machine-made samples.



Based on the collected data, handmade Zhuang brocade exhibits higher scoring coefficients in multiple tactile indices such as softness, elasticity, fineness, thickness, and velvet feel. Specifically, in terms of softness, the scoring coefficient for handmade Zhuang brocade is 1.00, significantly higher than the 0.72 for machine-made Zhuang brocade. This indicates that handmade Zhuang brocade is softer and can provide users with a more comfortable tactile experience. Similarly, in terms of elasticity and fineness, handmade Zhuang brocade also leads with scoring coefficients of 0.99 and 1.01, compared to 0.74 and 0.80 for machine-made Zhuang brocade. This suggests that handmade Zhuang brocade not only has better elasticity but also a finer texture, capable of delivering a more superior tactile sensation.

In terms of thickness and velvet feel, handmade Zhuang brocade demonstrates its unique advantages. The scoring coefficient for thickness is 1.00, higher than the 0.92 for machine-made Zhuang brocade, indicating that handmade Zhuang brocade maintains its fabric thickness while ensuring softness and comfort. In terms of velvet feel, handmade

Zhuang brocade surpasses machine-made Zhuang brocade with a scoring coefficient of 1.00 compared to 0.60, indicating that the surface of handmade Zhuang brocade has a fuller nap, providing users with a warmer tactile sensation.

In comparison, machine-made Zhuang brocade has a slightly higher scoring coefficient of 1.00 in the smoothness index, compared to 0.84 for handmade Zhuang brocade. This may be due to the more uniform surface treatment of the fabric during the mechanized production process, resulting in a smoother surface. However, in other tactile indices, machine-made Zhuang brocade fails to surpass handmade Zhuang brocade.

Discussion

The research findings indicate that in the tactile evaluation of Longzhou Zhuang brocade, handicrafts significantly outperform machine-made products in multiple aspects such as softness, elasticity, fineness, thickness, and velvet feel. This is primarily attributed to the greater attention to detail and the exquisite skills of the artisans during the production process of handicrafts. While machine-made products exhibit some advantages in smoothness, they are relatively inferior in other tactile indices.

This study has found that handmade Zhuang brocade is significantly better than machine-made Zhuang brocade in terms of softness, elasticity, fineness, thickness, and velvet feel. This conclusion is highly consistent with the research conducted by Zhu & Ma (2020), further verifying the unique charm of handmade textiles in fabric tactile sensation. Although there are some differences in experimental conditions between the study by Zhu & Ma in 2020 and our study, such as the samples they used were from Binyang County while ours were from Longzhou County, and their evaluators were students majoring in textile or apparel who had no practical experience in brocade weaving, while our evaluators were experienced local weavers from Longzhou, the results of the two studies are very similar. Specifically, both the study by Zhu & Ma and our study have found some subtle differences in subjective hand feel between handmade and machine-made Zhuang brocade. The difference in thickness is not significant, but the difference in smoothness is more pronounced. Machine-made Zhuang brocade has better smoothness than handmade Zhuang brocade, while handmade Zhuang brocade performs better in softness, elasticity, and velvet feel. Although the experimental conditions of the two studies are different, the similar results suggest that our findings further confirm the conclusions of Zhu & Ma's study.

Machine-made Zhuang brocade is significantly better than handmade Zhuang brocade in terms of smoothness. This may be due to the more uniform surface treatment of the fabric during mechanized production, which makes its surface smoother, which is consistent with existing literature on the impact of mechanized production on fabric touch, such as Xiong et al., 2021. It is worth noting that Wang & Zhao (2022) proposed an interesting perspective: with the advancement of technology, new weaving equipment can achieve more complex weaving effects through precise programming. In the future, while maintaining production efficiency, machine-made Zhuang brocade may also improve its touch and artistic quality. This suggests that when discussing the comparison between machine-made and handmade weaving, we should also pay attention to the impact of technological advancement on weaving methods.

The main reason for the difference in tactile sensation between handmade and machine-made Zhuang brocade lies in the different raw materials and processes used in production. According to Zhu (2012) handmade brocade uses real silk velvet as the weft yarn

and cotton thread as the ground yarn, with high-grade, thick, and sturdy material texture. In contrast, to reduce costs, machine-made Zhuang brocade often uses coarse cotton yarn as the weft yarn and ground yarn, resulting in overall hand feel and gloss that are far less than handmade Zhuang brocade. In terms of process, handmade Zhuang brocade uses a bamboo cage loom with a complex structure, mostly featuring three or four-shaft organizational structures. The patterns are dense, the plain weave ground tissue is tightly wrapped, the patterns have a strong three-dimensional effect, and the hand feel is sturdy. On the other hand, machine-made Zhuang brocade uses industrial shuttle looms for mechanized production, mostly adopting a two-shaft organizational structure. The patterns are relatively sparse, and the plain weave ground tissue is exposed, making it appear simpler and rougher. Shen (2019) further confirms and extends this view.

Studying the tactile differences between machine-made and handmade Zhuang brocade not only helps to deepen understanding of the characteristics and advantages of these two weaving methods but also provides a scientific basis for the inheritance and development of Zhuang brocade culture. For consumers, understanding the tactile differences between the two weaving methods can assist them in making more reasonable choices based on their own needs and budgets (Kotler & Keller, 2016). For producers, recognizing the tactile advantages of handmade weaving can guide them in optimizing production strategies, enhancing product quality, and improving market competitiveness (Monroe, 1973). At the same time, governments and cultural institutions should also increase support for Zhuang brocade culture and promote the sustained prosperity and cultural inheritance of the Zhuang brocade industry through measures such as establishing special funds and training artisans (Yue & Huo, 2024).

After discussion, it is believed that in terms of the method for tactile evaluation experiments, this study drew on the experimental approach of Zhu & Ma (2020) and similarly adopted a subjective evaluation method to research and compare the tactile style of Zhuang brocade. However, Qi et al. (2021) used a mixed subjective and objective experimental method in their research. They not only conducted subjective tactile evaluations but also used the CHES-FY system to measure the physical indicators of fabric samples and calculated the fabric's comprehensive tactile index. They further used the fabric's comprehensive tactile index as the stimulus variable to fit psychological measurement functions for the accuracy of fabric tactile judgments under different modalities. Ultimately, they concluded that during subjective testing, human vision can influence judgments to some extent. Therefore, based on the single subjective tactile evaluation method used in this study, it is necessary to add measurements of physical indicators using experimental equipment to obtain more accurate experimental data.

The innovation of this study lies in its use of subjective evaluation methods for the first time to compare the tactile sensations of handcrafted and machine-made Longzhou Zhuang brocade products. This approach provides a multi-dimensional fabric tactile evaluation system for future research. By selecting specific tactile evaluation indicators such as softness, thickness, velvet feel, etc., the study conducts a comprehensive and detailed analysis of fabric tactile sensations. This multi-dimensional evaluation system provides a scientific basis for the comprehensive evaluation of fabrics.

However, this study also has several limitations. Firstly, the experiments are primarily based on subjective tactile evaluations by individuals. While this method can directly reflect the true feelings of consumers, subjective evaluations may be influenced by

various factors such as individual differences and psychological states. Secondly, the sample size of our study is relatively small, which may not fully represent the true feelings and preferences of all consumers. Additionally, this study focuses mainly on tactile aspects and does not comprehensively consider other factors that may affect consumer preferences, such as visual aesthetics and cultural connotations. Therefore, future research can incorporate more dimensions into consideration to more comprehensively assess the overall value of Zhuang brocade.

Recommendations

1. Theoretical recommendation

To improve the experimental design, it is recommended that future research incorporate multi-modal perception by introducing visual modal evaluation. At the same time, the sample size and diversity should be expanded to cover evaluators with different backgrounds and occupations, as well as a wider range of Zhuang brocade samples. Evaluation indicators should be refined, with additional dimensions such as breathability and durability included. Objective evaluation methods should be combined with subjective evaluations to enhance scientific rigor and accuracy. Advanced data analysis tools should be utilized to deeply mine the data, providing more comprehensive and scientific guidance for the inheritance and development of Zhuang brocade.

Furthermore, the analysis can be enriched by integrating professional knowledge and theories from clothing and textile fields, such as fiber arrangement and interweaving density, weaving tension, and surface treatment. This will help analyze the tactile superiority of handmade Zhuang brocade and the technical reasons behind it.

2. Policy recommendations

Government and cultural institutions play a crucial role in promoting the development of Longzhou Zhuang brocade. The government should increase support for cultural and creative industries to facilitate their rapid development. Specifically, for the Longzhou Zhuang brocade industry, the government can establish special funds to support training and skill upgrading projects for artisans, thereby promoting its inheritance and development. This will not only enhance the skill level of artisans but also contribute to the preservation and transmission of Zhuang brocade culture.

3. Practical recommendations

To consumers, there is not much difference in tactile sensation between handmade and machine-made brocade. When purchasing, if you pursue unique tactile experiences and cultural collection value, handmade Zhuang brocade is recommended. If you have a limited budget or are more price-sensitive, machine-made Zhuang brocade is a more economical choice.

To producers, it is important to prioritize the income of the weavers. Increasing product added value through improving product quality, innovative design, and expanding sales channels, and thereby enhancing the income levels of the weavers, is key to ensuring the sustainable development of the Zhuang brocade industry. According to stakeholder theory, paying attention to and satisfying the needs and expectations of key stakeholders is an important factor in achieving long-term organizational success (Yue, Y., & Huo, G., 2024).

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