The Sensual Intention of Wardrobe Furniture Materials Based on Women's Visual and Tactile Experience Evaluation

Jingyu Sun, and Wei Wang *

With the rise of the 'her economy', the influence of women's consumer demand on furniture design is becoming increasingly important. The purpose of this study was to explore the relationship between female consumers' visual and tactile perceptions of different wardrobe furniture materials and their psychological and sensory cognition. Based on the theory of Kansei engineering, a questionnaire was designed using a semantic differential scale and a seven-point Likert scale. Female participants were invited to rate 8 sets of perceptual vocabulary for 13 representative wardrobe furniture material samples through visual and tactile perception. SPSS 27 software was used to conduct reliability and validity tests, cluster analysis, and factor analysis on the experimental data. Cluster analysis categorized the materials into three types: natural flexible materials, patterned solid wood materials, and modern materials. Factor analysis identified two key dimensions: tactile perception and visual perception. These dimensions were used to analyze the differences in sensory cognition among the three material types in female consumers. This experiment provided theoretical support for the study of female consumers' perceptual perception of wardrobe furniture materials, and at the same time provided rational references for designers to optimise the choice of materials in wardrobe furniture design based on the emotional needs of female users.

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Keywords: Kansei engineering; Wardrobe materials; Visual-tactile perception evaluation; Cluster analysis; Factor analysis

*Contact information: College of Furnishings and Industrial Design, Nanjing Forestry University, Nanjing 210037, China; *Corresponding author: wangwei1219@njfu.edu.cn*

INTRODUCTION

With the acceleration of global gender equality, women's socio-economic status has undergone structural changes, and the increasing power of women's consumer discourse has made the 'Her economy' the core force driving the change of the consumer market (Wu 2024). Women's participation in national economic activities and economic growth shows a significant positive correlation. As a continuously expanding consumer market, behind the 'Her economy' is the enhancement of women's spiritual aspirations and the awakening of consumer awareness, and this trend of change has also profoundly affected the furniture market.

As an important part of the home space, the wardrobe is a piece of furniture with a central storage role in the bedroom, with a large footprint and high visual requirements (Jihee *et al.* 2022). The material is the material basis of the furniture. The choice of material in the furniture affects the appearance, durability, and comfort, and it gives the furniture a

certain emotional value and aesthetic experience. When purchasing wardrobes, consumers establish visual and tactile feedback in the brain by observing and touching. The prospective buyer senses the colour, texture, and feel of the wardrobe material, which generates subjective perceptual intention and emotional resonance with the wardrobe. As one of the main decision makers in household purchasing, women tend to show higher sensitivity to the perceptual understanding of materials, which has a significant impact on their purchasing behaviour and satisfaction. Consumer preference is one of the most important factors in the success of a product, so the choice of material for the wardrobe should also be able to satisfy the needs of the consumer (Janari and Rakhmawati 2016). Kansei engineering, as a method of considering design problems from the perspective of people's sensual perception, helps to solve the emotional problems of gender, personalization, and art in the process of furniture design to meet the sensual needs of female consumers for wardrobes (Chen 2023).

The process of perception is a cognitive process in which the human perceptual organ, the brain, receives, integrates, and processes information from the outside world. Sensation is a perceptual choice made by a person in relation to an object, while perception leads the subject to make a rational choice after processing the information through the brain (O'Callaghan 2020). In the choice of furniture, consumers can feel a unique emotional experience from the surface of various furniture materials through the dual perception of sight and touch (Zuo *et al.* 2016). Park *et al.* (2021) invited 36 participants to explore the effect of haptic feedback on 2D image preference in a touchscreen device through frictional contact between the finger and the surface of an object combined with the visual perception of a 2D image, and the conclusions suggest that haptic feedback plays a crucial role in users' preferences. Skedung *et al.* (2020) combined psychophysical and material science approaches to explore the understanding of tactile perception by the physical properties of the furniture surface. The correlation between the physical properties of furniture surfaces and understanding tactile perception was found to be related to the roughness, friction, and thermal properties of the material surfaces. Nordvik *et al.* (2009) used a Kansei engineering approach, employing digital image simulation techniques to analyse the visual characteristics of wooden floors and people's responses to the computerised indoor wood products. They did this through the demonstration of the visualisation of different wooden floors in the same room in conjunction with a consumer rating scale of descriptive vocabulary. Visualisation of perceptual responses can effectively measure people's preferences for interior wood design.

Consumers' perception of furniture is not only dependent on the inherent properties of the material itself, but is also significantly influenced by the surface processing techniques used. As a widely used processing method in furniture board manufacturing, coatings can alter the gloss, color, and texture of materials through their composition and application methods, making them a key variable in influencing user perception. Bhatta *et al.* (2017) explored the correlation between sensory and emotional aspects of touch by asking subjects to make perceptual assessments of materials after touching different wood surfaces with only lateral finger movements and found that naturally smooth wood surfaces were more positive than coated surfaces in terms of emotional feedback, confirming the importance of preserving the natural texture of wood processing to optimise the tactile experience and reduce negative perceptions (Bhatta *et al.* 2017). Qian Wan *et al.* (Wan 2021) conducted cutting and coating processes on three different colored woods to create two texture types and three different gloss levels: unvarnished, wax-based paint, and light-colored paint. The study explored users' visual perception of different colors, textures, and

gloss levels on wood surfaces, thereby clarifying the influence of visual sensory characteristics of wooden materials on furniture design. The experimental results showed that, compared to light-colored wood and semi-gloss wood, participants preferred dark-colored wood as well as matte and glossy wood.

Through the combination of Kansei engineering methods and visual-tactile evaluation, it is possible to explore the user's perception and emotional response to products made of various materials. Nan Li and Wei Wang analysed the physical quantities of the surface materials of children's medical products and established a relevant evaluation model by combining the children's visual-tactile experience of different materials and concluded that children's acceptance level of medical products can be improved by decreasing the roughness and glossiness of the materials (Li and Wang 2024). Sousa *et al.* (2022) used Kansei engineering theory and physical parameters of texture to explore the perceptual imagery of the surface texture of automotive plastic interior components from the physiological and psychological dimensions, and to influence the design of automotive interior components. Based on the method of semantic differential, Dong Jin and Tian Li (2023) established a subject-object comprehensive evaluation model by analysing the association between the physical properties of ageing cabinet materials and the subjective emotional factors of the elderly's sense of sight and touch, and investigated the perceptual differences of the surface roughness, cooling rate, glossiness, and colour value of the cabinet materials. Low roughness, slow cooling rate, high gloss, and high brightness red material can significantly improve the comfort of the elderly when using cabinets, and at the same time provide a theoretical basis and practical guidance for the scientific screening and design optimization of ageing-friendly cabinet materials (Jin and Li 2023). Zhou *et al.* (2023) created a questionnaire for the study of wooden door users based on the theory of lifestyles and the theory of consumer behaviour. They used cluster analysis, factor analysis, and other analytical methods to analyze the collected data. The data collected were analysed by cluster analysis, factor analysis, cross analysis, and other analytical methods, which led to the segmentation of wooden door users with different consumption preferences, providing inspiration for wooden door enterprises in product design and further research on wooden doors.

In summary, based on Kansei engineering, perceptual intention research transforms consumers' subjective perceptual intentions into quantifiable design parameters. The data are analyzed to form a correspondence between design elements and users' perceptual intentions, thereby providing a rational and scientific basis for product design and development (Du *et al.* 2024). Studies published up to this point mainly show that perceptual research on furniture materials mostly has focused on single senses, such as independent analyses of visual gloss or tactile roughness, while perceptual research on multi-sensory synergy of vision combined with touch is limited. In addition, despite significant gender differences in emotional perception between male and female consumers, existing design theories rarely incorporate gendered perceptual differences into material evaluation systems. This study starts from women's sensory experiences and emotional needs, using sensory intention research to analyze the correspondence between wardrobe material elements and women users' sensory imagery. It provides new ideas for accurately optimizing the selection of wardrobe furniture materials and improving women users' emotional acceptance of wardrobe furniture products, thereby providing more targeted theoretical support and methodological pathways for women-oriented furniture design.

EXPERIMENTAL

Experimental Research Process

The process of experimental research can be roughly divided into 3 stages: pre-investigation, experimental process, and conclusion analysis. In the pre-investigation stage, the authors collected and screened perceptual vocabulary and material samples. Then, questionnaires were designed in combination using the semantic differential method (Takahashi *et al.* 2016) and female subjects were invited to conduct the Visual-tactile experiments. Finally, the data were analysed through SPSS software to draw relevant conclusions.

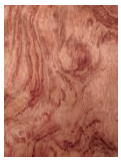
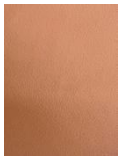
Test Subject

The experimental subjects of this study were female consumers of wardrobe products, potential female users with purchase intention, furniture designers, furniture design teachers, and student groups. A total of 50 subjects were invited to participate in this experiment. The statistical analysis showed that the age distribution of female subjects in the experiment ranged from 18 to 45 years old.

Test Samples

Through the field research of furniture outlets of major domestic e-commerce platforms, offline furniture shops and the collection of various wardrobe furniture research literature, the authors identified the most common material categories used in wardrobe furniture. Using a combination of the KJ method (Scupin 1997) and a team of three professional researchers and six design graduate students, the samples were evaluated and 13 representative material samples were selected, including 6 natural materials, 3 fabric materials, and 4 industrial materials.

Table 1. Sample Study of Wardrobe Materials

Sample Number	M1	M2	M3	M4	M5	M6	M7
Material Pattern							
Sample Name	Maple	Oaken	Black Walnut	Scented Wood	Bamboo	Rattan	Rough Textured Leather
Sample Number	M8	M9	M10	M11	M12	M13	
Material Pattern							
Sample Name	Fine Textured Leather	Polyester Cotton Fabric	Matte Plastic	Glossy plastic	Rock Plate	Aluminum Alloy	

However, the limitations of the sample inventory in terms of geographical variability and insufficient coverage of emerging materials should be emphasised, and only materials commonly found in the market were summarised and analysed. Sample drawings and numbers for these materials are shown in Table 1.

Questionnaire Design and Survey

A total of 50 pairs of semantic words of sensual imagery related to wardrobe materials were collected from various channels such as related papers and literature and furniture websites. Preliminary screening was carried out for these 50 pairs of semantic words for sensual imagery, excluding words with similar meanings or unclear directionality. To further enhance the objectivity and validity of these sensual semantic words, individuals with experience in furniture design and scholars were invited to examine material samples through touch and observation. Combining with the KJ method for joint discussion and deliberation, 8 pairs of representative semantic words for sensual imagery were finally sorted out: 'cluttered - ordered' 'firm - gentle', 'complicated - simple', 'dark - bright', 'bulky - light', 'cold - warm', 'hard - soft', and 'rough - delicate'.

This perceptual experiment used on-site touching of materials combined with the method of semantic differential (SD method) and a seven-level Likert scale (Emerson 2017). Test subjects were provided with samples of different wardrobe materials, and while touching the materials with the palms of their hands and observing the materials with their naked eyes, they rated these thirteen samples and eight sets of perceptual affective-semantic words using a subjective appraisal with the scores of -3, -2, -1, 0, 1, 2, and 3. The smaller the score the closer to the description of the left word, and the larger the score the closer to the description of the right word. Because the female subjects of this questionnaire research were all Chinese, Chinese was used as the research language throughout the questionnaire and research process to ensure the smooth progress of the research. The content of the questionnaire on the evaluation of visual and tactile perception of wardrobe materials is shown in Table 2.

Table 2. Wardrobe Material Visual-Tactile Perception Evaluation Questionnaire

Perceptual Vocabulary	-3	-2	-1	0	1	2	3	Perceptual Vocabulary
Cluttered	○	○	○	○	○	○	○	Ordered
Firm	○	○	○	○	○	○	○	Gentle
Complicated	○	○	○	○	○	○	○	Simple
Dark	○	○	○	○	○	○	○	Bright
Bulky	○	○	○	○	○	○	○	Light
Cold	○	○	○	○	○	○	○	Warm
Hard	○	○	○	○	○	○	○	Soft
Rough	○	○	○	○	○	○	○	Delicate

RESULTS AND DISCUSSION

Reliability Analysis

A total of 50 questionnaire samples were recovered during the data collection phase of this experiment, and after excluding 5 invalid questionnaires—which had the following issues: all options were identical throughout the survey, the selection of options showed a

pattern, and the completion time was significantly shorter than the expected normal time—45 valid questionnaires were ultimately retained, with a validity rate of 90%. Because the subjective imagery of the material varied among individuals during the experiment, the mean of the evaluation data was calculated to reduce the variability (Tu and Wang 2024). Table 3 shows the vocabulary values for each sample of the mean perceptual image.

Table 3. Mean Scores of Visual-Tactile Evaluation of Wardrobe Materials

Sample Number	Cluttered-Ordered	Firm-Gentle	Complicated-Simple	Dark-Bright	Bulky-Light	Cold-Warm	Hard-Soft	Rough-Delicate
M1	0.95	1.41	1.50	2.00	2.00	1.55	0.61	0.82
M2	1.59	0.11	0.34	0.61	0.05	1.34	-0.16	-0.18
M3	-0.73	-1.00	-0.34	-1.68	-1.02	-0.48	-1.05	0.27
M4	-1.59	0.14	-1.20	-0.02	-0.55	1.23	-0.02	0.66
M5	2.05	0.41	1.84	2.00	1.59	1.09	0.16	0.82
M6	1.59	1.07	-1.16	2.09	1.75	1.73	1.11	-0.66
M7	1.20	1.50	1.25	0.82	1.00	0.27	1.95	1.07
M8	2.02	1.89	1.70	0.75	0.91	1.59	1.86	1.86
M9	1.64	2.02	1.45	1.09	1.66	1.36	1.89	0.16
M10	2.30	-0.25	2.39	1.00	1.25	-0.89	-0.30	1.68
M11	2.30	-0.27	2.32	1.55	1.14	-0.89	-1.30	2.34
M12	-0.84	-1.55	1.02	1.18	-0.84	-1.86	-1.95	1.75
M13	1.43	-1.89	1.84	0.98	-0.32	-2.20	-2.18	1.36

Reliability analysis of the questionnaire data was carried out after obtaining the means of subjective ratings. Cronbach's alpha (Sun *et al.* 2007) is usually used as a valid tool to assess the consistency of the scale data, with the aim of ensuring the accuracy and reliability of the data and reflecting the degree of truthfulness of the characteristics assessed. Reliability statistics of the questionnaire data were conducted using SPSS27 software. The results of the study show that the Cronbach's alpha was 0.792, which is close to 0.8. This indicates that the data collected by this questionnaire had a good level of reliability, authenticity and dependability, capable of providing a reliable basis for the subsequent data analysis and conclusions of the study.

Cluster Analysis

Cluster analysis is a method of dimensionality reduction analysis measuring the similarity between different data samples, where several sets of data are classified into different levels of groups in the group based on the characteristics of the data (Müller 2024). Thirteen samples of wardrobe materials were analysed using clustering method. The results after cluster analysis are shown in Fig. 1.

The wardrobe material samples are represented by the vertical axis and the relative distance between the samples is represented by the horizontal axis. A vertical line was plotted from quantitative value 15 down the horizontal axis. The wardrobe material samples were divided into three groups because the vertical line crossed the horizontal line at three different locations.

The first group consisted of M10: Matte Plastic, M11: Glossy Plastic, M12: Rock Plate, and M13:Aluminum Alloy. These materials have the characteristics of modern industrialisation, so they are named as 'modern material class'; the second category includes M1: Maple, M2: Oaken, M5:Bamboo, M6: Rattan, M7: Rough Textured Leather, M8: Fine Textured Leather, and M9: Polyester Cotton Fabrics. Natural materials and soft

package materials both appeared under this classification, so the common characteristics of the two types of materials were sought, and this type of material was named 'natural soft material category'; the third category is M3 Black Walnut and M4 Scented Wood, these two types of wood are characterised by a special wood grain texture as well as more striking colours, which will be named as 'patterned solid wood quality' category.

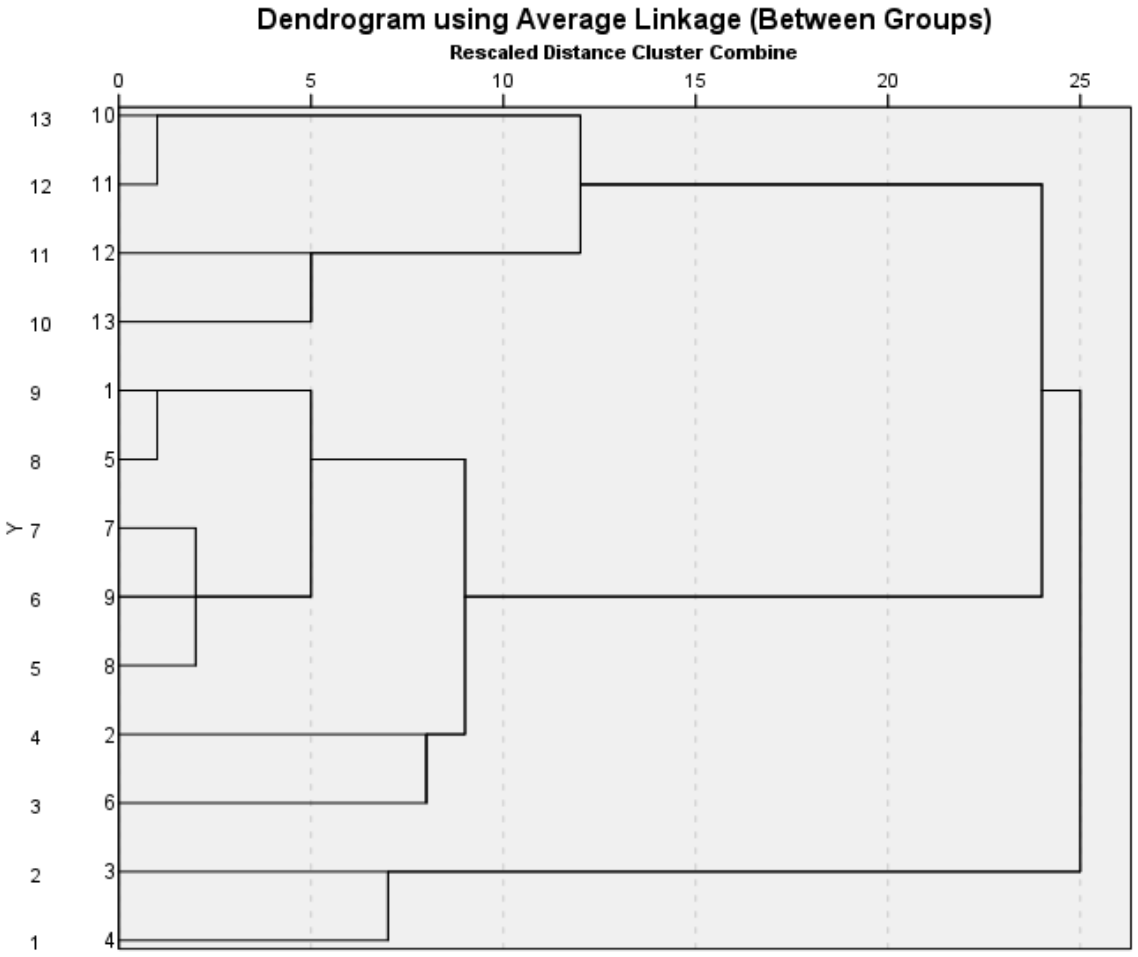


Fig. 1. Dendrogram using average linkage (between groups)

Factor Analysis

Factor analysis is a multivariate statistical method that focuses on identifying representative factors among the variables and grouping variables of the same nature to explain correlations or covariances among the data (Shrestha 2021). The Bartlett's test of sphericity and the KMO value were used to determine the suitability of the data for factor analysis. When the KMO value is greater than 0.6 and the significance of the test of sphericity is 0, the data can usually be used for factor analysis. The questionnaire data were subjected to KMO and Bartlett's test of sphericity using SPSS 27 software. According to the test results, the perceived image data of wardrobe materials had a KMO value of 0.619, a chi-square value of 85.193, a degree of freedom value of 28, and a significance level value of 0, which indicates that the questionnaire data can be used for factor analysis.

Table 4. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.619	
Bartlett test of sphericity	Approx. Chi-Square	85.193
	df	28
	Sig.	0.000

An analysis of the 8 groups of perceptual vocabulary was carried out by principal component analysis, and the results are shown in Table 5. Extracting the common factors whose eigenvalues of the factors were greater than 1, 2 common factors were obtained, and the sum of the variance contribution rates of these 2 common factors was 80.7%, explaining 80.7% of the total variance of the variables in the 8 groups of perceptual vocabulary. The eigenvalues from the 3rd factor onwards were less than 1, so the first 2 factors were extracted as common factors.

Table 5. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.858	48.221	48.221	3.858	48.221	48.221	3.506	48.830	43.830
2	2.602	32.524	80.744	2.602	32.524	80.744	2.953	36.914	80.744
3	0.760	9.501	90.246						
4	0.436	5.454	95.700						
5	0.142	1.780	97.480						
6	0.111	1.387	98.867						
7	0.080	1.002	99.868						
8	0.011	0.132	100.00						
* Extraction method: Principal component analysis									

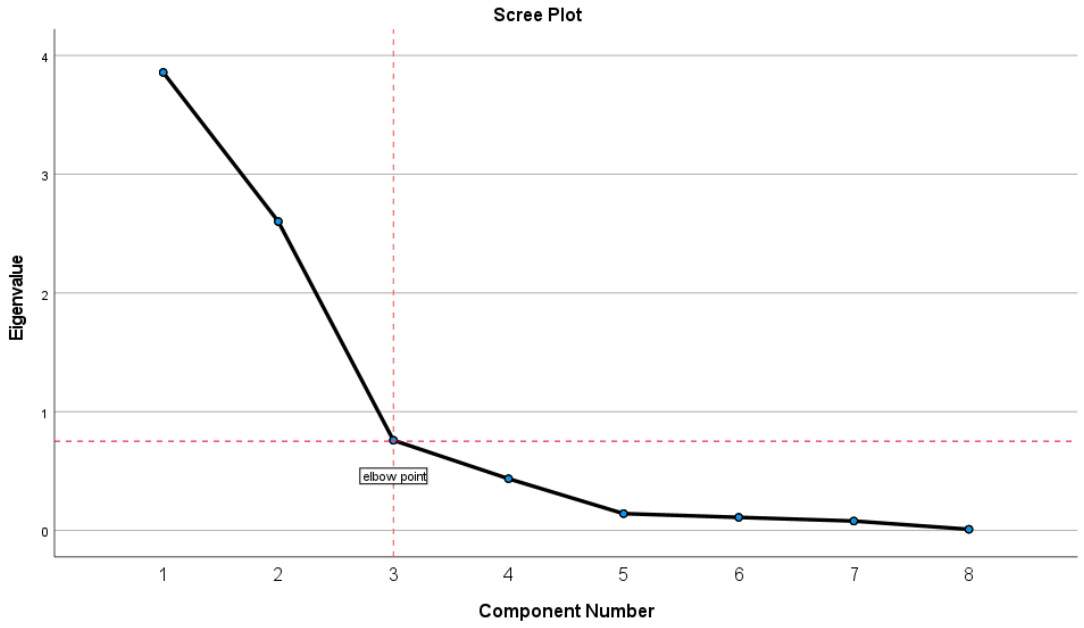


Fig. 2. Scree plot

As shown in Fig. 2, the gravel plot of principal component analysis shows the data in the table more clearly. The eigenvalues of the first two principal components were significantly higher than those of the subsequent components, and from the third principal component onwards, the eigenvalues dropped sharply and level off until they approached 0. Therefore, the turning point occurred between the second and third principal components, with the third principal component being regarded as the elbow point. This indicates that the first two principal components have been effective in explaining the main variance information in the original data, and that the extraction of the first two components as the main factors is appropriate.

As shown in the factor component matrix in Table 6. Compared with the pre-rotation component matrices, the post-rotation component matrices show the correlation relationship between the components and the variables of the 2 factors after rotation more clearly.

The perceptual-semantic analyses of the 2 rotated public factors were analysed and named: the first factor was named tactile perception factor, which was cold-warm, hard-soft, firm-gentle, and rough-delicate; and the main perceptual-semantic name of the second factor was visual perception factor, which was Complicated-Simple, cluttered-ordered, bulky-light, and dull-bright; and the main perceptual-semantic name of the second factor was visual perception factor, which was complex-simple, cluttered-organised, bulky-light, and dark-bright.

Table 6. Component Matrix a and Rotated Component Matrix a

Component Matrix a			Rotated Component Matrix a		
	Component			Component	
	1	2		1	2
Firm-Gentle	0.925	-0.200	Cold-Warm	0.950	
Bulky-Light	0.903	0.315	Hard-Soft	0.893	0.212
Hard-Soft	0.870	-0.292	Firm-Gentle	0.891	0.320
Cold-Warm	0.793	-0.524	Rough-Delicate	-0.655	0.503
Dark-Bright	0.574	0.508	Complicated-Simple	-0.377	0.854
Complicated-Simple	0.131	0.924	Cluttered-Ordered	0.184	0.853
Rough-Delicate	-0.290	0.773	Bulky-Light	0.600	0.745
Cluttered-Ordered	0.607	0.626	Dark-Bright	0.219	0.735

Extraction method: Principal component analysis

Sensory Image Analysis

Figure 3 shows the average values of wardrobe materials under the tactile perception factor, sorted according to the clustering spectrum diagram. The first category of modern material series shows more negative values in the illustration, reflecting a 'cold and hard' feeling in the tactile sensibility dimension, and its surface has been polished and processed, showing a simple and sharp industrial aesthetics. This quality is in line with what is usually associated with industrial style, *i.e.* emphasising the unity of functionality and simplicity, and conveying a calm and rational aesthetic. In the second category of natural flexible materials compared to solid wood and bamboo materials under the same category, M6 Rattan has a certain degree of elasticity, M7 and M8 belong to the softness of the leather material, M9 Polyester Cotton Fabrics are more skin-friendly, therefore, in the 'hard - soft' sensibility of the intention of the phrases, their average value is relatively

high, significantly higher than M1 Maple, M2 Oaken, M5 Bamboo, and other materials to meet the pursuit of warmth and comfort.

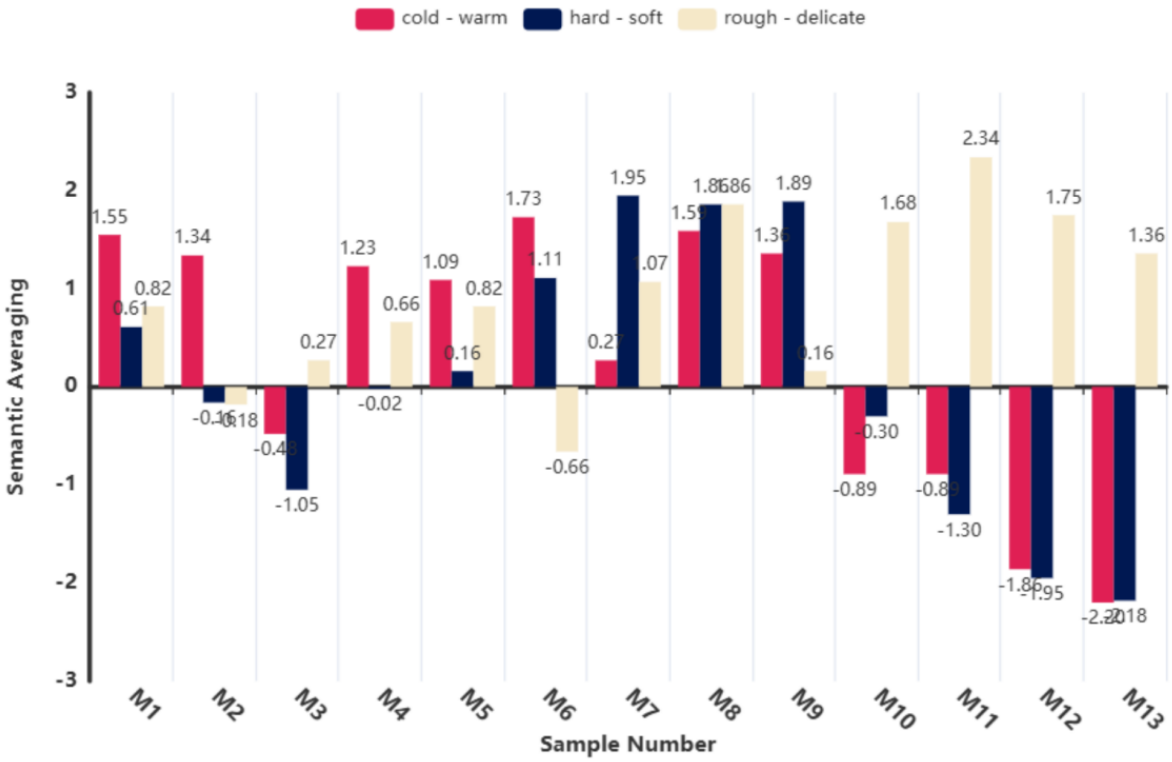


Fig. 3. Semantic averaging of touch sensibility

Figure 4 demonstrates the average values of wardrobe materials for the visual perception factor. Compared to the tactile perception factor, the third grouping of patterned solid wood-like materials has more significant values. Compared to the first and second groupings, the overall mean values of figured solid wood materials are negative. M3 Black Walnut and M4 Scented Wood have special wood grains and eye-catching colours, with darker shades and complex and varied textures. These types of dark wood grain characteristics not only increase the visual weight of the wood, but they also give it a natural noble and stable temperament. In the first group of modern materials, M12 Rock Plate and M13 Aluminum Alloy have a bulkier visual impression than M10 and M11 Plastic Materials.

The visual feeling of plastic material group is light, orderly, and simple, while M13 material has the texture of marble so it seems to be visually messy. These visual differences make a diverse perceptual experience within the modern material group. In the second material group, M6 Rattan shows a complex and orderly beauty on the visual level due to its weaving process. Its regular weaving texture not only increases the visual sense of hierarchy but also gives a natural rhythmic beauty. Other solid wood textures, such as M1 Maple, M2 Oaken, and M5 Bamboo, have relatively bright colours and lighter textures. This characteristic makes them visually present a sense of simplicity and order, in contrast to rattan weave.

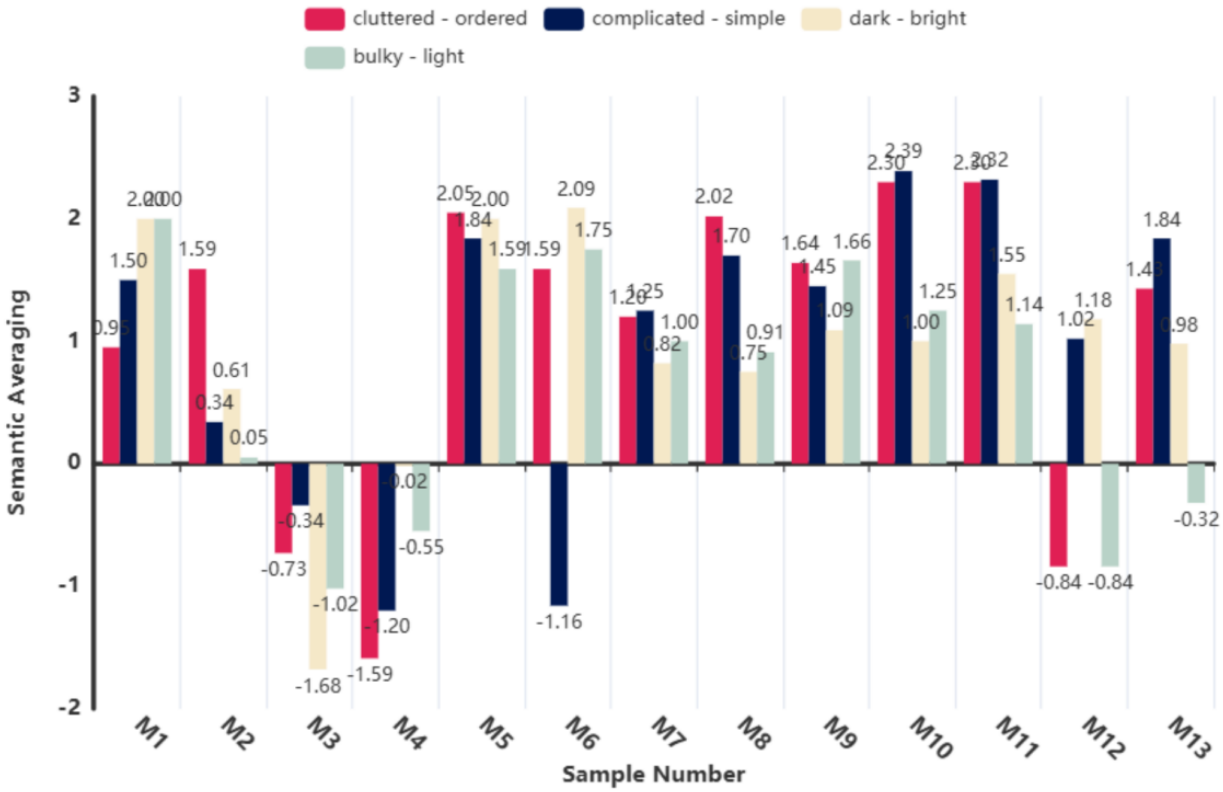


Fig. 4. Semantic averaging of visual perception

CONCLUSIONS

This study explored in depth the differences in female consumers' perceptions of different materials in wardrobes through a Kansei-engineering approach, combined with visual-tactile experiences. Through cluster analysis, factor analysis, and reliability verification of the questionnaire data, the following main conclusions were drawn:

1. The 13 materials were divided into three categories through cluster analysis, which were modern materials, natural flexible materials, and patterned solid wood materials. Then, two key dimensions, namely tactile perception factor and visual perception factor, were extracted through factor analysis. This analytical method provides designers with a decision-making framework: when selecting materials, designers can first map users' emotional needs to sensory perception dimensions, then match them with corresponding material categories to ensure that material characteristics are consistent with female users' expectations.
2. The three types of materials show significant differences in tactile and visual perception factors, providing a basis for the design positioning of wardrobe furniture: Natural and flexible materials include maple, oaken, bamboo, rattan, leather, and polyester-cotton fabrics, whose natural textures, warm tones, and soft touch convey the feeling of nature and healing. The natural attributes of this type of material can stimulate the emotional resonance of female consumers both visually and tactilely and are suitable for wardrobe

design in natural ecological style, which can create a warm and comfortable use for female consumers who pay attention to the quality of life and the harmony of nature. The unique textures of M3 Black Walnut and M4 Scented Wood offer high visual appeal and a sense of solidity, yet retain the natural warmth of wood to the touch, creating a contrast between a visually stable appearance and a soft feel. This makes them ideal for high-end wooden wardrobe designs. The modern material category is represented by M10 Matte Plastic, M11 Glossy Plastic, M12 Rock Plate, and M13 Aluminum Alloy material, which together present the characteristics of coldness, sense of order, and industrialisation, and are cold, hard, and smooth in the sense of touch, while simplicity and high gloss are the prominent features in the sense of vision. This kind of material is suitable for minimalist wardrobe design, providing choices for female consumers in pursuit of modern simplicity.

3. In the process of design practice, designers should take into account the two key dimensions of female consumers' perceptual perception of materials - tactile and visual, also, the user's experience needs and emotional resonance. The use of natural materials can be retained by retaining the details of the wood grain texture to enhance the real touch feeling of the material and to let users feel the natural texture; industrial materials can be processed through the matte finish and other processes to reduce the bulky, cold and hard sense of the wardrobe. In the combination of materials, it is possible to match pairs of two sensibility intention relative materials. A modern material and local soft package, natural flexible material matching can neutralise the cold and hard feeling of the modern material. Meanwhile, the combination of patterned wood and modern materials can simulate the collision of tradition and modernity, giving the wardrobe a richer cultural connotation, to meet the personalised pursuit of female consumers. Through comprehensive analysis of materials, the approach used in this work provides quantitative strategies for wardrobe furniture design centered on female users, endowing furniture with richer cultural connotations and satisfying female consumers' pursuit of individuality.

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