The Key Role of Emotional Perception in Product Design

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Abstract: The purpose of this study is to clarify the intrinsic mechanism of emotional perception in guiding product design and fill the gap in the existing research on the systematic integration of emotional perception theory into practical product design. A mixed research method combining bibliometric analysis, case study and user experiment was adopted. First, a bibliometric analysis of international and domestic literature on emotional perception and product design was carried out to sort out the research context and frontier hotspots; then, 12 typical products in fields such as intelligent home appliances and wearable devices were selected for in-depth case study to extract the application modes of emotional perception; finally, a user experiment with 80 subjects was designed to verify the influence of different emotional perception design elements on user experience. The results show that emotional perception plays a key role in three dimensions: user demand insight, design scheme optimization and user experience enhancement, and a mechanism model of emotional perception acting on product design is constructed. This study provides theoretical support and practical guidance for improving the emotional value of products and enhancing market competitiveness.

Keywords: Emotional Perception; Product Design; User Experience; Mechanism Model; Design Optimization

1. Introduction

1.1 Research Background and Significance

The global manufacturing industry is undergoing a transformation driven by intelligent upgrading, and product design has shifted from a traditional function-oriented paradigm to an experience-oriented one. With the improvement of residents' consumption capacity and the change of consumption concepts, modern consumers pay equal attention to emotional resonance and psychological satisfaction while demanding product functionality and durability. The widespread popularity of intelligent products such as smart home appliances, wearable health devices and human-computer interaction terminals has further highlighted the decisive role of emotional factors in product market competitiveness. Emotional perception, as a core link connecting users' psychological needs and product design elements, directly determines the matching degree between products and user expectations. Many current product design practices still lack systematic guidance of emotional perception theory, leading to problems such as inaccurate grasp of user emotional needs, inadequate emotional expression of design schemes and weak user stickiness. Exploring the key role of emotional perception in product design and clarifying its internal action mechanism is of important theoretical and practical significance. Theoretically, constructing an interaction model between emotional perception and product design enriches the theoretical system of emotional design and provides a new research perspective for the cross-integration of cognitive psychology and design science. Practically, it helps enterprises break through the homogenization competition dilemma, improve product emotional value, enhance user loyalty and achieve differentiated development in the fierce market competition.

### 1.2 Review of Domestic and Foreign Research Status

Foreign research on emotional perception and product design has a relatively early start, with scholars conducting in-depth explorations from multiple perspectives such as emotional psychology, design aesthetics and user experience. Some scholars proposed the concept of emotional design, dividing product design into visceral, behavioral and reflective levels, and emphasizing that emotional perception runs through the entire design process. Relevant studies have established quantitative relationships between individual design elements

(such as product form, color and texture) and emotional responses through experimental methods. In recent years, with the rapid development of artificial intelligence technology, foreign research has gradually tended to combine machine learning algorithms with emotional perception, realizing intelligent recognition and prediction of user emotional needs through data mining of user behavior and physiological signals. Limitations exist in foreign research: most studies focus on theoretical construction and single-element analysis, with insufficient integration of research results with specific regional market characteristics and user group differences, which restricts the universality of practical application. Domestic research on emotional perception in product design has developed rapidly in recent years, with scholars focusing on the integration of traditional culture and emotional design. Relevant studies have explored the expression ways of emotional perception in product design based on the aesthetic psychology of domestic users and carried out case studies on emotional design of specific products such as household appliances and cultural and creative products. Domestic research still has obvious deficiencies: theoretical research mostly relies on the introduction and transplantation of foreign theories, lacking localized innovation and systematic construction; research methods are relatively single, focusing on qualitative analysis such as case studies, with insufficient quantitative research on the action mechanism of emotional perception; there is a disconnection between theoretical research and practical application, and research results are difficult to form effective guidance for design practice. Existing research has laid a preliminary theoretical foundation for the combination of emotional perception and product design, but there is still a lack of in-depth exploration on the key role dimensions and internal mechanism of emotional perception in product design, and systematic research on integrating emotional perception into the whole process of product design is insufficient. This study aims to fill these research gaps.

1.3 Research Content and Technical Route

The core research content of this study includes four aspects: sorting out the core connotation of emotional perception theory and the emotional value dimensions of product design to clarify the theoretical basis; exploring the key role dimensions of emotional perception in product design, including accurate insight into user needs, optimization of design schemes and enhancement of user experience; designing empirical research to verify the action mechanism of emotional perception in product design; putting forward targeted practical design strategies based on research results.
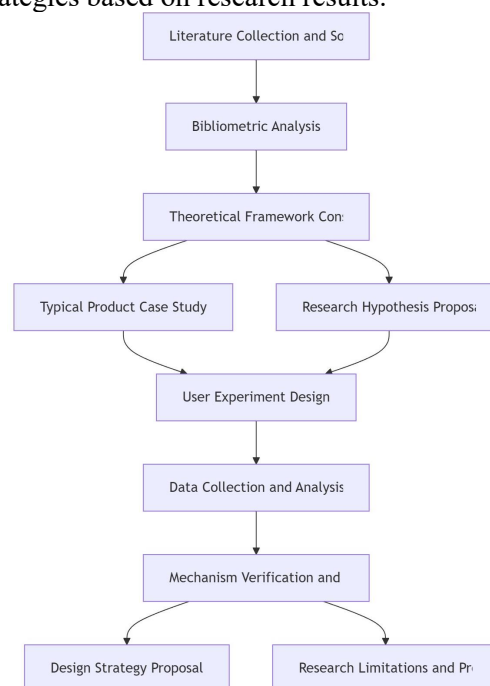
Figure 1. Technical Route Diagram of the Study

A mixed research method combining bibliometric analysis, case study and user experiment was adopted to ensure the comprehensiveness and reliability of research results. The specific technical route is as follows: collecting and sorting out domestic and foreign literature related to emotional perception and product design, conducting bibliometric analysis to clarify the research context and frontier hotspots; constructing a theoretical framework of the key role of emotional perception in product design based on theoretical analysis; selecting typical products for in-depth case study to extract the application modes of emotional perception in product design; proposing research hypotheses based on the theoretical framework, designing user experiments to collect relevant data; using statistical software to analyze experimental data, verifying research hypotheses and clarifying the action mechanism; summarizing research results, putting forward design strategies and prospects for future research.

2. Relevant Theoretical Basis

2.1 Core Connotation of Emotional Perception Theory

Emotional perception refers to the psychological process in which individuals receive external stimulus information (such as product form, color, sound, texture) through sensory organs and generate corresponding emotional experiences and psychological responses after cognitive processing by the brain. It is a comprehensive reflection of individuals' understanding and evaluation of external things, with distinct subjectivity, interactivity and situationality. Subjectivity manifests in differences in emotional perceptions of the same external stimulus among different individuals due to variations in life experience, cognitive level and personality traits. Interactivity is reflected in the fact that emotional perception is not a one-way information reception process but an interactive process between individuals and external things; individuals will adjust their perception and evaluation criteria according to interaction feedback. Situationality means that individuals' emotional perceptions are affected by specific environments and contexts, and the same stimulus may trigger different emotional responses in different scenarios. From the perspective of cognitive psychology, emotional perception includes two closely linked stages: sensory perception and emotional evaluation.

The sensory perception stage is mainly responsible for receiving and transmitting external stimulus information, converting physical signals such as light, sound and touch into neural signals that can be recognized by the brain. The emotional evaluation stage involves the brain processing and evaluating the received information, integrating with existing cognitive schemas, and generating emotional experiences such as pleasure, satisfaction, anxiety or dissatisfaction. The core of emotional perception theory lies in clarifying the intrinsic logical relationship between external stimuli, cognitive processing and emotional responses, which provides a solid theoretical basis for exploring the influence of product design elements on users' emotional experiences.

2.2 Emotional Value Dimensions of Product Design

The emotional value of product design refers to the psychological satisfaction and emotional experience brought to users through product design elements, which is an important component of product comprehensive value. Based on in-depth analysis of relevant theories and practical cases, this study divides the emotional value dimensions of product design into four categories: aesthetic value, interactive value, cultural value and functional emotional value. Each dimension has its unique core connotation and corresponding design elements, as shown in Table 1.

Table 1. Emotional Value Dimensions of Product Design and Corresponding Design Elements

Emotional Value Dimension	Core Connotation	Corresponding Design Elements
Aesthetic Value	Visual and tactile pleasure brought by the formal beauty of products, stimulating users' positive aesthetic emotions	Product shape, color matching, material texture, surface processing technology
Interactive Value	Sense of control and participation generated in the user-product interaction process, enhancing the fun of use	Operation interface layout, interaction logic, feedback mode, operation difficulty
Cultural Value	Cultural identity and emotional resonance triggered by the cultural connotation and symbolic meaning of products	Cultural symbols, traditional patterns, regional characteristic elements, brand story implication
Functional Emotional Value	Emotional experience brought by the reliable realization of product functions and humanized design	Function reliability, humanized setting, efficiency improvement effect, safety guarantee measure

2.3 Correlation Mechanism between Emotional Perception and Product Design

The correlation between emotional perception and product design is reflected in mutual promotion and restriction. Product design elements serve as the main source of users' emotional perception; different design elements stimulate users' sensory organs and generate corresponding emotional perceptions after cognitive processing. Warm colors tend to arouse positive emotions such as enthusiasm and warmth, while cool colors are more likely to bring a sense of calm and tranquility. Simple and

smooth product shapes reduce users' cognitive load and bring a sense of ease, while complex and irregular shapes may cause confusion and anxiety. Users' emotional perception feedback guides the optimization of product design. By capturing and analyzing users' emotional responses to products, designers can identify deficiencies in design schemes, adjust design elements, and improve the matching degree between products and users' emotional needs. The correlation mechanism between the two can be summarized as a closed-loop system of "design element input - emotional perception generation - perception feedback - design optimization". In this system, emotional perception acts as a core intermediary variable, connecting design element input with user experience output. The effective operation of this system enables the continuous improvement of product emotional value. The correlation between emotional perception and product design is also affected by user characteristics, usage scenarios and other factors. Different user groups have distinct emotional perception preferences, and the same product design may produce different emotional effects in different usage scenarios. Designers must fully consider these influencing factors to ensure the accuracy and effectiveness of emotional perception guidance in product design.

3. Analysis of Key Role Dimensions of Emotional Perception in Product Design

3.1 Accurate Insight into User Needs Based on Emotional Perception

User needs consist of explicit functional needs and implicit emotional needs. Explicit functional needs are easily identified through direct inquiry, while implicit emotional needs are usually hidden in users' words, deeds and emotional responses, making them difficult to accurately capture through traditional demand research methods. Emotional perception provides an effective path for accurately insighting into implicit emotional needs. By analyzing users' emotional responses to existing products, design prototypes or specific scenarios, designers can dig out potential emotional needs behind user behaviors. In the user demand research process, emotional perception can establish a mapping relationship between user emotional states and demand points. Observing users' emotional expressions, body language and voice intonation

during product use, combined with psychological measurement tools, enables judging users' satisfaction, dissatisfaction and expectations for products, thereby extracting key emotional needs. Research on intelligent wearable devices shows that users have not only functional needs such as health data monitoring but also implicit emotional needs such as privacy protection, wearing comfort and fashion expression. Statistics on user needs for intelligent wearable devices are shown in Table 2. The data in Table 2 indicate that emotional needs such as wearing comfort and fashionable appearance account for a high proportion in the overall demand, verifying the importance of emotional perception in user demand insight. Compared with traditional demand research methods, demand insight based on emotional perception is more accurate and in-depth, helping designers grasp users' real needs and lay a foundation for formulating targeted design schemes.

Table 2. Statistics of User Needs for Intelligent Wearable Devices

Demand Type	Specific Demand Content	Proportion of Users with Corresponding Needs (%)
Functional Needs	Health data monitoring (heart rate, sleep, etc.)	89.2
	Motion data recording	76.5
	Intelligent reminder (call, message, etc.)	82.1
Emotional Needs	Wearing comfort	85.7
	Fashionable appearance	78.3
	Privacy protection of data	72.4

3.2 Optimization of Product Design Schemes Guided by Emotional Perception

Emotional perception plays a guiding role in the optimization of product design schemes, helping designers reasonably adjust design elements and improve the emotional expression ability of products. In the design scheme optimization process, users' emotional perception feedback serves as an important evaluation index, focusing on optimizing design elements that have a significant impact on emotional perception. In product form design, adjusting shapes based on users' emotional perceptions makes products more in line with aesthetic preferences. Products for children adopt rounded and lovely shapes to arouse a sense of closeness and security, while professional office equipment uses simple and rigorous shapes to

convey professionalism and reliability. In color design, optimizing color matching schemes according to the emotional connotation of different colors and users' emotional perception needs. Medical products use soft colors such as white and light blue to convey cleanliness and trust, while sports products adopt bright colors to stimulate sports enthusiasm. In interaction design, optimizing interaction logic and feedback modes based on users' emotional perceptions of interaction processes improves the smoothness and fun of interaction. Intelligent home control interfaces simplify interaction processes and adopt intuitive feedback modes such as voice and animation to reduce operation pressure and bring a sense of ease. Design scheme optimization guided by emotional perception is a continuous iterative process. Continuous collection of users' emotional perception feedback enables adjustment and improvement of design schemes until the optimal emotional effect is achieved. This optimization method effectively avoids design blindness and improves design efficiency and quality.

3.3 Enhancement of Product User Experience Driven by Emotional Perception

User experience is a comprehensive evaluation of the entire product use process, including functional experience, emotional experience and psychological experience. Emotional perception serves as the core driving force for enhancing product user experience, improving user satisfaction and loyalty by optimizing emotional experience. The path of emotional perception driving user experience improvement includes three aspects. Identifying design elements that may cause negative emotions through emotional perception research and optimizing them reduces users' negative emotional experiences during product use. Designing elements that arouse positive emotions enhances users' positive emotional experiences and establishes emotional resonance between users and products. Segmenting user groups based on emotional perception characteristics provides personalized design schemes to meet personalized emotional needs. Research on smart speakers shows that users' negative emotions mainly come from inaccurate voice recognition and complex operations, while positive emotions are brought by warm voice feedback and interesting interaction functions. Optimizing voice

recognition algorithms, simplifying operation processes and adding personalized voice interaction modes significantly improves user satisfaction and loyalty. These results confirm that emotional perception effectively drives the improvement of product user experience and enhances product core competitiveness.

4. Empirical Research: Application Verification of Emotional Perception in Product Design

4.1 Research Hypotheses and Experimental Design

Based on theoretical analysis, this study proposes the following research hypotheses: H1: Emotional perception has a significant positive impact on the accurate insight of user needs; H2: Emotional perception has a significant positive impact on the optimization of product design schemes; H3: Emotional perception has a significant positive impact on the enhancement of product user experience; H4: The optimization of product design schemes plays an intermediary role between emotional perception and the enhancement of user experience. To verify these hypotheses, this study takes intelligent water cups as the research object and designs a between-subjects experiment. The independent variable is the emotional perception design level of intelligent water cups (divided into high, medium and low levels), the dependent variables are user need insight accuracy, design scheme satisfaction and user experience score, and the intermediary variable is the optimization degree of design schemes. Eighty subjects are randomly divided into three experimental groups and one control group, with 20 subjects in each group. The experimental groups use intelligent water cup prototypes with different emotional perception design levels, while the control group uses ordinary intelligent water cups without emotional perception design. The experimental process includes four stages: pre-experiment questionnaire (collecting subject characteristics), product use experience (using assigned water cups in simulated daily scenarios), emotional perception measurement (collecting emotional data through psychological scales and physiological sensors), and post-experiment questionnaire (collecting data on need insight accuracy, design satisfaction and user experience). The experimental period is seven days, with detailed recording of data in

each stage.

4.2 Experimental Data Collection and Analysis Methods

Experimental data include three types: demographic characteristic data, emotional perception data and evaluation index data. Demographic characteristic data are collected through pre-experiment questionnaires to ensure subject representativeness. Emotional perception data are collected through a combination of subjective evaluation and objective measurement. Subjective emotional perception data are collected using the Positive and Negative Affect Schedule (PANAS), and objective emotional perception data are collected using physiological sensors to measure skin conductance response (SCR) and heart rate variability (HRV). Evaluation index data are collected through post-experiment questionnaires. User need insight accuracy is measured by the consistency between needs described by subjects and core emotional needs defined in the study. Design scheme satisfaction is measured by a 7-point Likert scale. User experience score is a comprehensive score of functional experience, emotional experience and interaction experience. After data collection, SPSS 26.0 and AMOS 24.0 software are used for data analysis. Specific analysis methods include descriptive statistical analysis to understand basic data characteristics, reliability and validity analysis to test the reliability and validity of measurement tools, correlation analysis to test the correlation between variables, regression analysis to test the impact of independent variables on dependent variables, and intermediary effect analysis to test the intermediary role of design scheme optimization degree.

4.3 Experimental Results and Mechanism Verification

Descriptive statistical analysis shows that subjects cover different genders, ages and occupations, with uniform data distribution and good representativeness. Reliability and validity analysis indicates that the Cronbach's α coefficient of each scale is greater than 0.8, and the cumulative variance contribution rate of exploratory factor analysis is greater than 60%, confirming good reliability and validity of measurement tools. Correlation analysis results show that emotional perception has a significant positive correlation with user need insight accuracy, design scheme satisfaction and user experience score, providing a preliminary basis for hypothesis verification. Regression analysis results are shown in Table 3.

Table 3. Regression Analysis Results of Variables

Dependent Variable	Independent Variable	β Value	t Value	p Value	R²
User Need Insight Accuracy	Emotional Perception	0.65	8.23	< 0.01	0.42
Design Scheme Satisfaction	Emotional Perception	0.69	9.15	< 0.01	0.50
User Experience Score	Emotional Perception	0.73	10.32	< 0.01	0.54
User Experience Score	Emotional Perception + Design Scheme Optimization Degree	0.50 (Emotional Perception); 0.46 (Design Scheme Optimization Degree)	6.85; 5.92	< 0.01; < 0.01	0.68

Emotional perception has a significant positive impact on user need insight accuracy, design scheme satisfaction and user experience score, verifying hypotheses H1, H2 and H3. Intermediary effect analysis shows that the optimization degree of design schemes plays a partial intermediary role between emotional perception and user experience enhancement, with an intermediary effect value of 0.23 and an accounting rate of 31.5%, verifying hypothesis H4. Based on experimental results, this study constructs the action mechanism model of emotional perception in product design, as shown in Figure 2. The model shows that emotional perception directly promotes the accurate insight of user needs, optimization of design schemes and enhancement of user experience, and indirectly promotes user experience enhancement through design scheme optimization. This mechanism model clarifies the internal logic of emotional perception acting on product design, providing a theoretical framework for the application of emotional perception in product design practice.
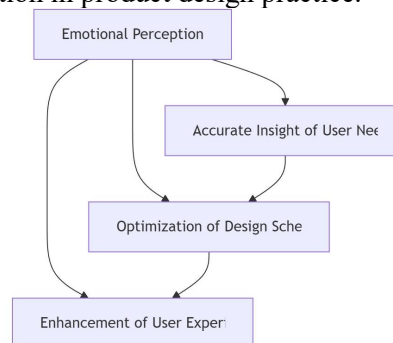
Figure 2. Action Mechanism Model of Emotional Perception in Product Design

5. Conclusion

5.1 Main Research Conclusions
This study explores the key role of emotional perception in product design through theoretical analysis and empirical research, drawing the following main conclusions. The emotional value dimensions of product design include aesthetic value, interactive value, cultural value and functional emotional value, with each dimension corresponding to specific design elements. This classification provides a clear framework for product emotional design analysis. Emotional perception plays a key role in product design in three dimensions: accurate insight into user needs, optimization of design schemes and enhancement of user experience. Emotional perception helps designers dig out users' implicit emotional needs, guide the reasonable adjustment of design elements and improve users' overall experience. The optimization of product design schemes plays a partial intermediary role between emotional perception and user experience enhancement. Emotional perception not only directly promotes user experience enhancement but also indirectly promotes it through design scheme optimization. The constructed action mechanism model of emotional perception in product design clarifies the internal logic of emotional perception acting on product design, providing a systematic theoretical explanation for the application of emotional perception in product design practice. Research results enrich the theoretical system of emotional design and provide practical guidance for enterprises to carry out emotional design practice.

5.2 Research Limitations and Future Prospects
This study has certain limitations. The empirical research object is limited to intelligent water cups, so the research results may have generalization limitations. Future research can expand the research object to more types of products to improve the universality of results. The experimental sample size is relatively small, and the representativeness of samples needs further improvement. Future research can increase the sample size and expand the scope of subjects to enhance the reliability of results. This study mainly focuses on the positive impact of emotional perception on product design, with insufficient research on the negative impact of emotional perception and corresponding avoidance strategies. Future research can explore negative emotional perception in product design and propose targeted avoidance and guidance strategies. With the development of artificial intelligence and big data technologies, future research can combine these advanced technologies to realize intelligent capture and analysis of user emotional perception, exploring the intelligent application path of emotional perception in product design and promoting the continuous innovation and development of product emotional design.

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