Research on the Design of Children's Sports Toys Based on Kansei Engineering and SPSS Computer Data Analysis Technology

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Abstract—Toys are an important and indispensable part of children's life during their growth stage. The toy design in China has great defects and does not really understand the needs of users, and only realizes the function-oriented toy design. This paper introduces Kansei Engineering design approach and SPSS data processing technology into the design of children's sports toys, and Kansei Engineering analysis and the main hierarchical analysis method in SPSS data analysis technology are conducted for the buyers of toys, and after selecting the design samples, a semantic differential scale is established to analyze the data to derive specific design semantics. The data analysis has led to the conclusion that the main perceptual terms that influence the design of sports toys are creative, fun, interactive, safe, and other functional characteristics. The combination of this theory and computer data processing technology can better analyze user needs and provide new ideas for the design of children's sports toys.

Keywords-Kansei Engineering; Children's toys; Kansei analysis; SPSS data analysis techniques

1 INTRODUCTION

Currently, 65% of urban children in China own between 20-50 toys, but after market research, the current toys do not really meet the needs of users, and there are great defects in product design research.

By applying perceptual engineering and SPSS data analysis technology to toy design research, the user's perceptual needs can be transformed into a more rational data analysis, which can better understand the needs of the target users and truly accomplish user-oriented product design, providing new ideas for the design of children's sports toys.

2 KANSEI ENGINEERING

2.1 Introduction to Kansei Engineering

For product design, the research content of Kansei Engineering can be summarized into the following three aspects: first, to study the relationship between buyers' perceptual needs and product design semantics from the buyers' perceptual impulses to purchase products; second, to study the relationship between buyers' perceptual needs for products and product design

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semantics by qualitative and quantitative analysis; thirdly, to establish a unified connection between the Kansei engineering system and the human-machine system[2].

2.2 Application research in product field

Kansei Engineering is very extensive in the field of product design. In large design companies, Hybrid Kansei Engineering System is mainly used. Namely, the forward and reverse inductive engineering systems are integrated to establish a Hybrid Kansei Engineering System. Designers can input the design drawings into the computer, and the computer will use each database as a reference to check whether the designer's perceptual image matches the design scheme; From the reverse perspective, consumers input words containing their perceptual images through the computer of the Kansei Engineering System, and the computer then outputs a product vision that meets consumers' perceptual needs, thus serving as a reference for consumers when they choose and purchase products.

In the 1980s, Mazda Motor Company used the research method of Kansei Engineering to develop the Miata sports car aimed at meeting the user's feeling requirements and riding needs, which has repeatedly hit sales peaks in Japan, Europe and the United States. The product is shown in the Figure 1.

Figure 1. Miata sports

Since the 1990s, Japan began to apply Kansei Engineering to various fields, and the research results of Kansei Engineering have been transformed into productivity, resulting in huge economic benefits. Sharp applied the technology of Kansei Engineering to develop and launch a new type of LCD instead of eyepiece video camera, and its market share increased from 3% to 24%. As shown in Figure 2.

Figure 2. LCD camera

3 SPSS DATA ANALYSIS TECHNIQUES

3.1 SPSS Introduction

SPSS is Statistical Product and Service Solutions. SPSS data analysis technology is to import the collected data into the computer software processing to obtain the correlation between the factors, the method can be more intuitive and accurate to show the degree of influence between the factors, as well as the influence of each factor on the final results of the size, for It provides great convenience for statistical analysis, predictive analysis and decision support.

3.2 Application of SPSS data analysis technology in the product field

The basic functions of SPSS include data management, statistical analysis, graphical analysis, and output management. It is more widely used in various industries. Principal hierarchical analysis is mostly used within the product area. The principle of principal component analysis is to use the idea of dimensionality reduction to represent more data information with fewer variables, and to use the idea of linearity to establish the relationship between fewer variables and more data information variables, so that the linear relationship can be used to represent the variable relationship between principal components and multiple variables. The step-by-step flow of the principal hierarchical analysis method using SPSS data analysis technique is shown in Figure 3.

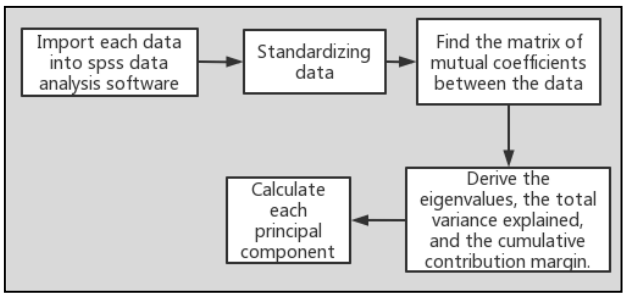

Figure 3. Main hierarchical analysis flow chart

The following Figure 4 is the design of women's bags based on SPSS data analysis technology, first through the Likert scale method to carry out questionnaire research to select the user's favorite and satisfaction of various bags, and then import the research data into the SPSS data analysis model, analyze the user's selectivity of various materials, leather bag handle selectivity, etc., and finally design the product to meet the needs of users.

Figure 4. Product design case based on SPSS analysis

3.3 The connection between SPSS data analysis techniques and Kansei Engineering

SPSS data analysis technology can provide more reliable data support for product research. In the product research stage, users' needs are usually vague and ambiguous, and it is difficult to quantify the data, while Kansei Engineering can just collect users' perceptual needs, import the collected data into SPSS software, visualize the data processing of users' perceptual needs, and provide more accurate positioning of users' needs.

The role of SPSS data analysis techniques in the field of Kansei Engineering can be summarized as follows. (1) analyzing the perceptual data obtained from experiments, calculating the total and mean values of the data; (2) grouping consumers who choose different perceptual words; (3) filtering certain perceptual words that have the greatest influence on consumers from the large number of perceptual words obtained from experiments through principal component analysis, which can be used to determine perceptual design elements and perceptual evaluation indicators.

4 RESEARCH ON THE DESIGN OF KANSEI ENGINEERING IN SPORTS TOYS

Sports toys are a large category of children's toys, mainly to provide children with the role of sports, exercise children's basic movements and skills, and enhance physical fitness.

Before product design research based on Kansei Engineering, it is necessary to do some related work. Such as establishing the target group, the target group's perceptual knowledge and perceptual needs of the product, analyzing the perceptual requirements and extracting design semantics and other preparations [4].

In view of the limitation of the age of children's toy users (children) and the particularity of the identity of buyers (parents), it is not possible to conduct research on children alone, and the different cognitive behaviors of users and buyers of sports toys have produced designs for toy manufacturers. There are certain interaction methods between toys and parents, toys and children, and children and parents, as shown in Figure 5. In the case of inconsistent users and buyers, separate research is needed to obtain different product semantic features [5].In this paper, SPSS data analysis and Kansei Engineering analysis are only conducted for toy buyers.

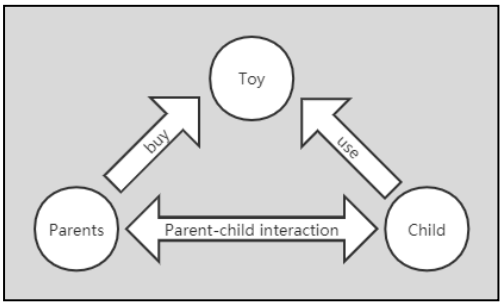

Figure 5. Interaction between the three

5 ANALYSIS OF DESIGN METHOD OF KANSEI ENGINEERING AND SPSS DATA ANALYSIS TECHNOLOGY IN TOY DESIGN

In the field of product design, the design process of Kansei Engineering is generally shown in Figure 6. The product is positioned as a sports toy among children's toys, and typical representatives are selected as design samples for different analysis in terms of function, appearance and experience. Determine the perceptual vocabulary database through vocabulary collection and screening [6].

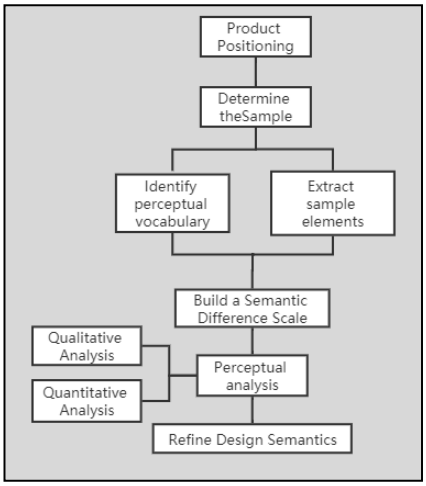

Figure 6. Kansei Engineering product design process

In the perceptual measurement link, the semantic differential method is mainly used to collect data [7]. The semantic difference method is mainly composed of several bipolar adjective groups and 5 equal evaluation levels, such as good and bad, strong and weak, large and small, as shown in Figure 7. In the current product design, the semantic differential component method is often used as an important means to effectively obtain the perceptual needs of consumers [7].

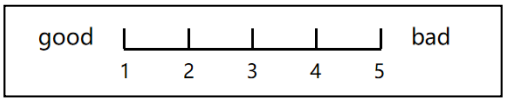

Figure 7. Example of semantic differential method

The quantified data of users' perceptual needs of the product will be imported into SPSS computer data analysis software for analysis, and it will be found that different design semantics have different effects on users' perceptual needs, and the process of combining design semantics with perceptual needs is the process of perceptual analysis [8].

In this paper, SPSS data analysis model was used to statistically analyze the perceptual measurement data, and principal component analysis was used to derive the correlation between the main user needs and design elements.

6 ANALYSIS OF BUYERS (PARENTS) AND SPORT TOYS UNDER KANSEI ENGINEERING AND SPSS DATA ANALYSIS TECHNIQUES

Sports toys mainly refer to various equipment used in sports activities, such as swings, balls, scooters, toy cars, etc. According to the different target users, the research objects here are parents of preschool children aged 3-6. The design and production process of toys must meet the needs of parents before the entire purchase process can be realized [5].

6.1 Select samples of children's sports toys

First of all, it is necessary to conduct extensive collection of sports toys for targeted screening in the later stage.

Through the classification and screening of the sample library, 9 typical samples were finally determined, and three categories were determined according to the different interaction methods. The first category is toys that children can complete the entire play process independently under parental supervision. The second category is the toys that children and parents complete the play process together, and the third category is the toys that children and peers complete the play process together [5], as shown in Table 1.

Table 1 Sample selection

the first category			
the second category			
the third category			

In order to enable target users to provide a more accurate and comprehensive perceptual vocabulary description for each toy, it is necessary to briefly introduce the toys in the sample and provide short and effective product information, as shown in Table 2.

Table 2 Basic information of samples

Product Information	
 Sample 6	Name: cartoon animal frisbee Color: colorful candy color Material: EVA plastic Applicable objects: children and adults Applicable scene: indoor, lawn, square, beach Product size: diameter 24cm, thickness 2cm, weight 90g

6.2 Establish a perceptual vocabulary

Through the collection of electronic shopping platforms, magazines, toy manuals and other various materials, the detailed information and parameters of different sports toys can be obtained. to obtain the perceptual vocabulary of users about sports toys, so as to qualitatively measure the comments of interested users on the product, and establish a perceptual vocabulary database.

After obtaining the original perceptual vocabulary, it is necessary to carry out targeted simplification and deletion, delete meaningless or irrelevant words, and summarize similar words into a group of words. The characteristic attributes of sports toys can be divided into three categories: functional attributes, human-machine attributes, and playability. As shown in Table 3. The functional attributes are durable-fragile, rich function-single function, safe-dangerous; human-machine attributes are easy-difficult, convenient-complicated; playability is fun-boring, interactive - closed, creative - rigid.

Table 3 Perceptual Vocabulary Groups

functional attributes	durable-fragile
	rich function-single function
	safe-dangerous
functional attributes	easy-difficult
	convenient-complicated
playability	fun-boring
	interactive - closed
	creative - rigid

6.3 Establishing a Semantic Difference Scale

In this experiment, the questionnaire survey method was used to obtain experimental data. The specific method was to pair nine sample pictures with eight groups of perceptual words one by one to establish a semantic difference scale, and divide the correlation between each sample and perceptual words into five Equivalent evaluation level, the five equivalent values are -3, -1, 0, 1, 3. Taking safe-dangerous as an example, -3 means very dangerous, -1 means a little dangerous, and 0 means the risk factor is low or it is impossible to compare whether it is dangerous, 1 point means relatively safe, 3 points means very safe, and so on, to complete the final semantic difference scale. As shown in Table 4.

Table 4 Semantic Difference Scale Questionnaire

Sample 1

durable	-3	-1	0	1	3	fragile
rich function	-3	-1	0	1	3	single function
safe	-3	-1	0	1	3	dangerous
easy	-3	-1	0	1	3	difficult
convenient	-3	-1	0	1	3	complicated
fun	-3	-1	0	1	3	boring
interactive	-3	-1	0	1	3	closed
creative	-3	-1	0	1	3	rigid

6.4 Import data into SPSS data analysis software

The subjects of this questionnaire survey are parents of preschool children aged 3-6 years, and 20 target users are selected for research, of which the ratio of male to female is 1:1. A total of 20 questionnaires were distributed, 20 valid questionnaires were recovered, and the recovery rate was 100%. Statistical analysis was carried out on the data of 20 questionnaires to obtain the average value of each pair of perceptual vocabulary scores in 9 samples, and each perceptual vocabulary corresponding to each sample was numerically counted using Excle software to obtain the average value. As shown in Table 5.

Table 5 Summary of Perceptual Vocabulary Scores

Sample number	1	2	3	4	5
durable	0.13	-0.52	-1.98	1.26	0.65
rich function	-2.33	-1.17	-0.32	-0.84	0.41
safe	-1.28	-2.61	-0.67	1.57	2.14
easy	1.21	0.59	-0.18	2.37	0.81
convenient	0.51	0.83	-0.56	0.46	2.12
fun	1.07	1.35	1.67	0.87	1.02
interactive	-2.12	-1.54	-0.38	0.94	0.67
creative	-2.35	-1.26	0.39	-1.25	-1.52
Sample number	6	7	8	9	
durable	2.13	1.63	0.61	-0.54	
rich function	-1.95	1.78	2.36	1.27	
safe	0.67	0.85	-1.93	-0.68	
easy	1.07	0.42	-0.39	0.35	
convenient	1.78	0.49	-1.01	-0.27	
fun	-0.23	2.03	2.69	1.15	
interactive	2.01	2.58	2.19	0.58	
creative	-1.36	1.94	2.67	0.24	

Import the average value of perceptual vocabulary into SPSS software.

Using principal component analysis, the simplified factor analysis results by reducing the dimensionality of the known data can reflect the needs of users more clearly and intuitively. Figure 8 is the KMO and spherical test chart, Figure 9 is the gravel chart, Figure 10 is the common factor variance chart, Figure 11 is the principal component analysis chart, and Figure 12 is the component matrix chart.

KMO and Bartlett test

KMO sampling suitability quantity.		.837
Bartlett sphericity test	Approximate cardinality	49.630
	freedom	28
	Significance	.007

Figure 8. KMO and spherical test plot

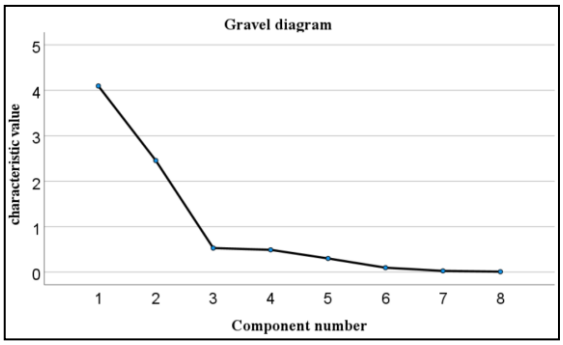

Figure 9. Gravel diagram

Common factor variance

	Initial	extract
durable	1.000	.880
rich function	1.000	.882
safe	1.000	.923
easy	1.000	.905
convenient	1.000	.875
fun	1.000	.914
interactive	1.000	.937
creative	1.000	.975

Extraction method: principal component analysis.

Figure 10. Common factor variance diagram

Total variance explained

	Initial Eigenvalue			Extraction of the sum of squares of loads		
Ingredients	Total	Percentage of variance	Cumulative %	Total	Percentage of variance	Cumulative %
1	4.096	51.200	51.200	4.096	51.200	51.200
2	2.455	30.686	81.886	2.455	30.686	81.886
3	.528	6.606	88.492			
4	.490	6.121	94.614			
5	.300	3.750	98.364			
6	.096	1.205	99.569			
7	.026	.329	99.898			
8	.008	.102	100.000			

Extraction method: principal component analysis.

Figure 11. Principal Component Analysis Diagram

Component Matrix[a]

	Ingredients	
	1	2
durable	-.382	.770
rich function	.808	.478
safe	-.482	.880
easy	-.828	.142
convenient	-.815	.265
fun	.902	-.024
interactive	.278	.927
creative	.908	.389

Extraction method: principal component analysis.

a. 2 components were extracted.

Figure 12. Composition Matrix Diagram

It can be seen from Figure 8 that the KMO value is 0.837. The closer the KMO value is to 1, the stronger the correlation between variables, the more suitable the original variables are for factor analysis, and the better the effect of factor analysis. The left side of Figure 9 is the characteristic root in the gravel diagram, and its trend changes from steep to flat. As the slope becomes slower, the information that can be explained by subsequent factors will become less, and the slope becomes flat from the factor number 3, so the number of factors that can be referenced should be less than or equal to three. The common factor variance extraction numbers of the variables involved in Figure 10 are relatively high and close to 0.9, which proves that most of the data are extracted and calculated in the data operation.

From the principal component analysis graph in Figure 11, we can know that the percentage of principal component 1 is 51.200%, the percentage of principal component 2 is 30.686%, and the percentage decreases significantly from principal omponent 3, so it can be determined that there are two principal components influencing the purchaser (parents) on sports toys. From the principal component analysis graph in Figure 12, we can know that the percentage of principal component 1 is 51.200%, the percentage of principal component 2 is 30.686%, and the percentage decreases significantly from principal component 3, so it can be determined that there are two principal components influencing the purchaser (parents) on sports toys. There are two perceptual words that are most closely related to the principal component 1, "creative" and "fun", as can be seen from the component matrix in Figure 10. The second factor is whether the toy is playable and allows children to play with it patiently. The two perceptual terms most closely related to principal component 2 are "interactive" and "safe". Interactive toys allow parents to have more communication with their children and enable parents to know more about their children. Toys with high safety allow children to reduce accidents in the process of playing sports. In summary, the factor analysis of the perceptual vocabulary of sports toys can be obtained by the main perceptual vocabulary influencing the design of sports toys with functional characteristics such as creative, fun, interactive, and safe.

7 CONCLUSIONS

The research process of product design should keep pace with the times. The design research based on perceptual Engineering and SPSS data processing technology can not only accurately grasp the perceptual needs of users, but also express the information through visual data. It

avoids the disadvantage of inaccurate demand analysis of the target group in the previous design methods and provides more options for the traditional design research process.

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