# Research on Kansei Characteristics of Electric Toothbrush Products Based on Big Data

Li Yibo*, Zhou Meiyu

East China University of Science and Technology, School of Art Design and Media, Shanghai, China

*759287204@qq.com

**Abstract.** This study takes the Kansei characteristics of electric toothbrush products based on Kansei engineering and Internet comments, aiming to explore the differences and commonalities of diverse design elements. Data sources are mainly user comments on e-commerce websites. This paper studied the label word frequency of 8 electric toothbrush products, summarized the Kansei words through co-occurrence analysis and principal component analysis, analyzed the product appearance by morphological structure method, and revealed the corresponding performance of different product elements on the Kansei characteristics through orthogonal test, and provided specific guidance for the design and improvement of electric toothbrush.

**Keywords:** kansei engineering; web comment; morphological deconstruction; factor analysis; orthogonal experiment

## 1 Introduction

According to the 51st Statistical Report on the Development of the Internet in China, as of December 2022, the number of online shopping users in China reached 845 million, accounting for 79.2% of the total netizens, so the data of online user comments contain a lot of information about user needs. The Japanese word "kansei" refers to the psychological feeling of product design features [1]. Kansei Engineering is an important quantitative method to study the emotional needs of products, with the purpose of finding the relationship between product design parameters and user opinions [2]. Starting from online reviews can effectively solve the problems of small data in traditional Kansei engineering and biased subjective sample selection, improve the efficiency of acquiring user demand information and expand the accessibility of different users, and make the experimental results more objective [3].


R. Appleby et al. (eds.), *Proceedings of the 2nd International Conference on Intelligent Design and Innovative Technology (ICIDIT 2023)*, Atlantis Highlights in Intelligent Systems 10,
https://doi.org/10.2991/978-94-6463-266-8_27

## 2 Research method

Under the market trend of emphasizing the emotional and personalized needs, whether the product design can accurately convey the emotional image has become a key factor in the product market competition. Based on Kansei engineering and factor analysis of questionnaire results, Zhang Mengmeng et al. designed an electric toothbrush that is more suitable for the emotional tendency of the elderly [4]. Xing Zhipeng et al. used KJ method and KANO model to obtain perceptual words and improved the aging toilet [5]. Although there are many scientific models and methods in the field of traditional Kansei engineering, the traditional research method has the problem of small amount of data and very subjective. So using big data to get reviews can solve these problems well. Cao Shuyuan et al. conducted emotion classification of user evaluation by training TextTNN model [3]. Li Ruizhen et al. used Pearson Chi-square test to analyze the relationship between the grouping based on industrial design elements and the number of users' favorable comments on wireless headphones [6]. The artificial intelligence platform introduced by Wang Qin et al can easily conduct sentiment analysis on the review data [7]. The research focus of the above literature is to guide the design by judging the emotional tendency from positive to negative criteria, without subdividing the emotional tendency. Therefore, the research focus of this paper is to summarize the perceptual words through network evaluation, then score the perceptual tendency of products in combination with questionnaires, and finally find the design elements that most affect the perceptual characteristics through orthogonal test and morphological deconstruction of the relationship between the perceptual features and design elements, so as to guide the design practice.

The research method of this paper includes the following steps:

**(1) Data collection: Collect user comments and evaluations related to electric toothbrush products from online platforms, e-commerce sites or social media channels.**

**(2) Data processing: The collected review data is screened and cleaned to remove duplicate, irrelevant or low-quality reviews. At the same time, preprocessing operations such as word segmentation and removal of stop words are carried out on the review text.**

**(3) Data analysis: Word frequency statistics, co-occurrence analysis and principal component analysis of label words are carried out using statistical analysis methods to understand the differences and commonalities of Kansei words of different electric toothbrush products.**

**(4) Correlation of Kansei characteristics: Design elements are obtained by morphological structure method, and Kansei characteristics are corresponding by orthogonal test.**

# 3 The experimental process

## 3.1 Get Date

In the context of big data, web crawlers are mostly used to crawl online buyer's comment data to form initial user comment data. In this paper, Octopus collector is selected to collect user comments on Jingdong shopping platform, and 8 products are selected for comment crawling from aspects such as comprehensive evaluation and product shape similarity (Table 1). Crawling its buyers' reviews of products into initial user review data, 1000 pieces of data are retained for each product.

## 3.2 Clean Data and Segmentation

Import text information into GOOSEEKER platform for word segmentation. First of all, from 9 electric toothbrush products, a total of 9000 comments were collected, after manual cleaning interference data and software screening, the remaining 8000 data. The word frequency statistics of the obtained words were carried out and sorted, and all adjectives were selected as the candidate words of perceptual words.

## 3.3 High-frequency word statistics

Text analysis and processing of valid data are carried out, word segmentation and part of speech tagging are carried out, adjectives and nouns are identified and word frequency statistics are carried out respectively, and the definition formula of high and low frequency words is based on Zipf's second law [8]:

$$\mathrm{T} = \frac{1}{2}\sqrt{1 + 8 \times I_1} \tag{1}$$

**Table 1.** Type Styles

| **Brand Name** | Usmile | Philips | Xiaomi Smart Home | Usmile |
|---|---|---|---|---|
| **Number** | 1 | 2 | 3 | 4 |
| **Sample** |  |  |  |  |
| **Brand Name** | Midea | Flyco | LEBOND | Oral-B |
| **Number** | 5 | 6 | 7 | 8 |

| Sample | | | | |
|---|---|---|---|---|
| |  |  |  |  |

According to statistics, $I_1$=165 in adjectives after word segmentation, so T≈17.67 is sorted from high to low in terms of word frequency, and the word frequency (198) of the thirtieth word is much higher than 17.67, so it can be identified as high frequency words (Table 2).

Through word co-occurrence analysis, it can be seen that the central part is mainly "good", "clean", "convenient", "good-looking" and "clean", while "fly in the face", "smooth", "frequent" and other words are not deeply related.

### 3.4 Principal Component Analysis

In order to determine emotional words more objectively, high-frequency words with similar semantics should be classified and combined, and emotional words related to product appearance and form should be retained. Finally, nine words with the highest frequency are summarized, which are clean, convenient, beautiful, comfortable, delicacy, practical, simple, generous and advanced. Design for eight electric toothbrush sample questionnaire, through the investigation to collect user of attribute perceptual demand for home treadmill, poll, conducted in the form of electronic questionnaires choose 25 used electric toothbrush. A 7-level scale was used to conduct a questionnaire survey on the selected perceptual representative words and samples. The tester scored the 8 products and calculated the average value of each representative word according to the results of the questionnaire (Table 3).

In this paper, IBM SPSS Statistics 26 was used for factor analysis. According to the macadam diagram (Figure. 1), this scheme is suitable for factor analysis. When the first two factors are extracted, the feature root value is large and the change is obvious, and the contribution to the interpretation of the original variable is great, which shows that the extraction of the first two factors has a significant effect on the original variable.

**Table 2.** High-frequency word frequency table of electric toothbrush

| words | Frequency | words | Frequency | words | Frequency |
|---|---|---|---|---|---|
| clean | 3681 | delicacy | 392 | complete | 243 |
| good | 3522 | exquisite | 357 | tight | 239 |
| neat | 1667 | suitable | 351 | cheap | 237 |
| convenient | 1414 | tangible benefits | 349 | careful | 237 |
| easy | 1397 | true | 326 | romance | 232 |
| good-looking | 1210 | alike | 309 | imparity | 224 |
| particularly | 1077 | practical | 260 | durable | 215 |
| comfortable | 606 | calculate | 254 | normal | 212 |
| pretty | 554 | succinct | 245 | In good taste | 204 |
| pleasing to the eye | 549 | comfort | 244 | easiness | 198 |

**Table 3.** Represents the average of words

| Number | clean | expediency | pretty | comfortable | delicacy | practical | simple | liberality | advanced |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.35 | 1.35 | 1.35 | 1.24 | 1.29 | 0.94 | 0.71 | 1.47 | 1.12 |
| 2 | 2.00 | 1.65 | 1.65 | 1.65 | 1.82 | 1.00 | 1.88 | 1.82 | 1.94 |
| 3 | 1.71 | 1.29 | 0.94 | 0.94 | 0.47 | 1.18 | 1.41 | 1.00 | 0.76 |
| 4 | 1.88 | 1.41 | 1.12 | 1.29 | 1.35 | 1.24 | 1.29 | 0.88 | 0.94 |
| 5 | 1.76 | 1.35 | 1.12 | 1.47 | 0.94 | 0.88 | 1.18 | 1.53 | 1.29 |
| 6 | 1.29 | 1.47 | 1.41 | 1.18 | 1.35 | 1.29 | 1.47 | 1.47 | 1.59 |
| 7 | 2.06 | 1.41 | 1.35 | 1.41 | 1.06 | 1.53 | 1.71 | 1.65 | 1.12 |
| 8 | 1.00 | 1.12 | 0.41 | 0.41 | 0.71 | 0.59 | 0.76 | 0.35 | 0.59 |

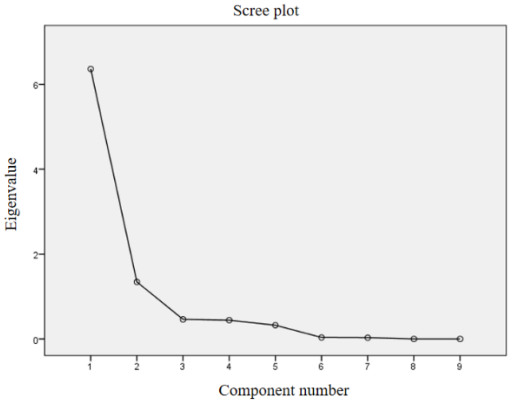


**Fig. 1.** Scree plot

According to the mutual coefficient list of principal component one (Table 4), the top three perceptual words are " convenient (X1)", "pretty (X2)" and "comfortable (X3)"; According to principal component two, the top three scores were "clean (X4) ", "practical (X5) " and "simple (X6)."

**Table 4.** List of principal component mutual coefficients of electric toothbrushes

| Keywords | Component matrix | |
|---|---|---|
| | 1 | 2 |
| **clean** | 0.727 | 0.529 |
| **convenient** | 0.968 | -0.138 |
| **pretty** | 0.957 | -0.133 |
| **comfortable** | 0.935 | -0.001 |
| **delicacy** | 0.764 | -0.050 |
| **practical** | 0.581 | 0.661 |
| **simple** | 0.787 | 0.404 |
| **liberality** | 0.898 | -0.095 |
| **advanced** | 0.871 | -0.411 |

## 4 Product design elements are associated with Kansei words

To establish the correlation mechanism between semantic perception and modeling elements of an electric toothbrush, morphological analysis should first be used to deconstruct the modeling elements of an electric toothbrush [9], which are five areas, namely brush head, button, handle cross section, handle longitudinal section and brush handle longitudinal section, and code them (Table 5).

When multiple factors exist, orthogonal experimental design can greatly reduce the number of experiments and obtain the optimal combination of different factor levels [10]. Therefore, the combination with the highest user evaluation can be obtained by associating the Kansei words in the questionnaire with deconstructed design elements. For the convenience of comparison, coding will be used (Table 6).

**Table 5.** Electric toothbrush design elements

| **Morphological regions** | | **Brush head** | **Operating interface** | **handle** | | **brush holder** |
|---|---|---|---|---|---|---|
| **Sub-factor** | | ***Brush head shape*** | ***Button*** | ***Handle cross section*** | ***Longitudinal section of handle*** | ***Longitudinal section of brush handle*** |
| **Coding** | | Y1 | Y2 | Y3 | Y4 | Y5 |
| **Factor** | **1** | ellipse | roundness | round | Narrow at the top and wide at the bottom | Straight line |
| | **2** | roundness | capsuliform | circumference | straightness | curve |
| | **3** | capsuliform | Round and capsule shape | polygon | Wide in the middle and narrow at the ends | |

**Table 6.** Design factors for product samples

| **Sample number** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| **Design feature** | 11311 | 12132 | 32122 | 12111 |
| **Sample number** | **5** | **6** | **7** | **8** |
| **Design feature** | 12122 | 11232 | 32132 | 22111 |

**Table 7.** Evaluation results of orthogonal experiment

| **Kansei characteristics** | **Average value** | **Design considerations** | | | | |
|---|---|---|---|---|---|---|
| | | ***Y1*** | ***Y2*** | ***Y3*** | ***Y4*** | ***Y5*** |
| **X1** | 1.38 | 1.45 | 1.35 | 1.37 | 1.29 | 1.29 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 1.12 | 1.36 | 1.47 | 1.32 | 1.43 |
| | | 1.35 | 1.41 | 1.35 | 1.51 | - |
| **X2** | 1.17 | 1.33 | 1.38 | 1.37 | 0.96 | 0.96 |
| | | 0.41 | 1.09 | 1.41 | 1.03 | 1.29 |
| | | 1.15 | 1.12 | 1.35 | 1.47 | - |
| **X3** | 1.20 | 1.37 | 1.21 | 1.20 | 0.98 | 0.98 |
| | | 0.41 | 1.18 | 1.18 | 1.21 | 1.33 |
| | | 1.18 | 1.29 | 1.24 | 1.41 | - |
| **X4** | 1.63 | 1.66 | 1.32 | 1.74 | 1.41 | 1.41 |
| | | 1.00 | 1.71 | 2.18 | 1.74 | 1.76 |
| | | 1.89 | 1.88 | 2.24 | 1.78 | - |
| **X5** | 1.08 | 1.07 | 1.12 | 1.07 | 0.92 | 0.92 |
| | | 0.59 | 1.04 | 3.18 | 1.03 | 1.18 |
| | | 1.36 | 1.24 | 3.24 | 1.27 | - |
| **X5** | 1.30 | 1.31 | 1.09 | 1.37 | 0.92 | 0.92 |
| | | 0.76 | 1.39 | 4.18 | 1.30 | 1.53 |
| | | 1.56 | 1.29 | 4.24 | 1.69 | - |

The cross results of Kansei characteristics and design elements show (Table 7) that the most important factors affecting "convenient" are oval brush head (1.45), round button with capsule shape (1.41), square handle cross section (1.47), wide middle and narrow handle longitudinal section (1.51), and curved handle longitudinal section (1.43). In this way, the biggest factors affecting the "pretty" are the oval brush head, the circular button, the square handle cross section, the middle width and the upper and lower narrow handle longitudinal section, and the curved brush handle longitudinal section; The biggest factors affecting "comfortable" are oval brush head, round and capsule shaped button, square handle cross section, middle wide and narrow handle longitudinal section, curved brush handle longitudinal section; The biggest factors affecting "clean" are capsule brush head, round and capsule button, square handle cross section, middle wide and narrow handle longitudinal section, curved brush handle longitudinal section; The biggest factors affecting the "practical" are the capsule-shaped brush head, the round and capsule-shaped button, the cross section of the square handle, the longitudinal section of the middle wide and narrow handle, and the longitudinal section of the curved brush handle; The biggest factors affecting "simple" are capsule brush head, capsule button, square handle cross section, middle wide and narrow handle longitudinal section, curved brush handle longitudinal section.

## 5 Summarize

Through the research methods of Kansei engineering and Internet reviews, this study deeply analyzed the Kansei words of electric toothbrush products, and obtained 6 Kansei characteristics through factor analysis. Five design elements are obtained through morphological deconstruction. Through orthogonal experiment, the most important design elements are obtained by associating Kansei characteristics. According to the emotional needs of users, designers can combine the corresponding elements to design products that are more in line with the needs of products. For example use a circular brush head, a circular button, a square handle cross section, a wide longitudinal section of the upper and lower narrow handle, and a curved brush handle longitudinal section to design a "pretty" electric toothbrush. The research results provide important theoretical basis and practical guidance for the design and improvement of electric toothbrush.

## Acknowledgment

Thank you for your careful review. Your suggestions will be very important to me. Thanks to the tutor and classmates for their help.

## References

1. Y. Matsubara, M. “Nagamachi Hybrid kansei engineering system and design support Int. J. Ind. Ergon,” vol. 19, pp. 81-92, February 1997.
2. S. Y. Cao, X. L. Geng. “Mechanical product Perceptual Evaluation Method based on Online Product Review and TextCNN,” Journal of Mechanical Design and Research, vol. 38, pp.189-194, October 2019.
3. S. B. Li, H. F. Quan, J. J. Hu, Y. M. Wu and A. S Zhang, “Product perceptual evaluation method based on online review data,” Computer Integrated Manufacturing Systems, Guiyang, vol. 24, pp. 752-762, January 2018.
4. M. M. Zhang, H. L. Zuo. “Research on design of electric toothbrush for the elderly based on Kansei Engineering,” Industrial Design, vol. 11, pp. 71-73, November 2022.
5. Z. P. Xing. “Research on Aging toilet based on KANO Model and Kansei Engineering,” Furniture & Interior Decoration, vol. 30, pp. 86-91, May 2023.
6. R. Z. Li, Y. M. Wu, J. Y. Zhi. “Research on Wireless Headset Comfort Based on Network Review Data,” Journal of Machine Design, vol. 37, pp. 134-139, September 2019.
7. Q. Wang, Y. Liu. “Based on online comment sentiment analysis and QFD product improvement design,” Journal of packaging engineering, vol. 42, pp. 169-174, December 2021.
8. Y. S. Liu, Y. L. Wang, M. X. Li. “An empirical analysis of the applicability of threshold definition method for high-frequency words in word frequency analysis,” Digital Library Forum, pp.42-49, September 2017.
9. P. Yang. “Research on perceptual image model based on product appearance deconstruction,”Harbin Institute of Technology, June 2014.
10. H. C. Yu, Y. Yin, X. Li, Y. X. Yuan, H. Wu. “The characteristics of orthogonal table in the design of orthogonal test and orthogonal analyses the significance of,” Journal of agricultural products processing, pp. 91-92 + 97, March 2020.