Research on the Design of Home Blood Glucose Meter for Young People Based on Semantic Difference Method ——The Case of Young Population Aged 14-28

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Abstract: Objective Based on the needs of young diabetic patients, this paper summarizes the emotional characteristics of young users of home blood glucose meters and creates a relaxed and interesting user experience of home blood glucose meters through design, as well as a certain difference in appearance. Methods By understanding the physiological characteristics and psychological demands of diabetic patients aged 14-40[10], we collected and screened the emotional intention words of the target users, established a semantic difference scale and obtained the semantic difference value, and statistically analyzed the obtained data by factor analysis to obtain the key intention words, to guide the design of home blood glucose meters. Conclusion From the perspective of quantitative thinking, the user's perceptual perception of the product is transformed into a specific product shape through design thinking, and the user's aesthetic preference for the home blood glucose meter is displayed through the product so that the product can better meet the emotional needs and bring some reference to the design of medical related products.

Keywords: home blood glucose meter, product appearance, semantic difference, perceptual demand

1. Introduction

1.1 Research Background

In recent years, the incidence of diabetes in China has shown a trend of youthfulness[11], The World Health Organization (2017) defines "youth" as the population aged 14-40, while in psychology, youth mainly refers to the population aged 14-28. From the perspective of consumer psychology, the article selects the target users as the consumer group of household blood glucose meters aged 14-28 (hereinafter referred to as "young users"). There is a significant gap between the consumption psychology of this group and that of other age groups. At present, most of the household blood glucose meters on the market are designed for the elderly, and the interaction mode overemphasizes the needs of the elderly[12], ignoring the needs of young consumer groups. There is a big gap between the consumption psychology of this group and that of the elderly. Therefore, it is hoped that based on the aesthetic preferences and emotional needs of the young home blood glucose meter users, the perceptual knowledge of the target users will be transformed into data, and the key intentional words will be obtained

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by factor analysis, to guide the design of young home blood glucose meters.

1.2 Development Status of Household Blood Glucose Meter Design

At present, most household blood glucose meters on the market are divided into photoelectric and electrode types based on their working principles. Brands with advantages in the design and development of such products at home and abroad include Yuyue, Sannuo, Omron, Abbott, etc. The technology selection of household blood glucose meters from different brands has certain differences, Overall, there is a greater focus on technological innovation (i.e. improving the accuracy of measurement results and transitioning from invasive measurement to non-invasive measurement), while in terms of product interaction, there is a greater bias towards serving the elderly population.

2. Semantic Difference

2.1 Semantic Difference Method

Product semantics, as a symbolic structure composed of various elements of product appearance, pays attention to the function and effect of semantics in the design process and its results. It conveys all kinds of information to consumers in a specific language. By analyzing and mining product semantics, people's cognitive feelings and relevance about modeling features can be obtained. The semantic difference method has been widely used in design and related research fields, specifically: respondents rate concepts or things based on their subjective feelings based on a given semantic difference scale. According to the emotional needs of target users, semantic words are extracted, and an emotional database is established by combining evaluation data and statistical analysis results. Experimental data are obtained by analyzing and evaluating product samples, which will be converted into reference sources for product modeling language design.

2.2 Principal Component Analysis

The basic principle of principal component analysis is to transform the initial indicators into comprehensive indicators, to reduce the dimension of data. The advantage of dimension reduction is that it can remove secondary information and extract the most influential principal component factors for key analysis. The characteristic of principal component analysis is that it can retain the initial data information to the maximum extent, so it is suitable for the analysis and decision-making of multi-dimensional related indicators. The user's semantic evaluation data of product appearance is input into SPSS software for principal component analysis, and then the dimension of the data is reduced by factor rotation, and the principal component semantic feature value with the largest feature value is obtained. Finally, the user's emotional cognition is quantified by comparing the absolute values of the feature value, and the emotional factors of the user's preference are investigated, so that designers can design the product appearance with the data in a targeted manner.

3. Design of Home Blood Glucose Meter for Young People on Semantic Difference

By interviewing the young users of home blood glucose meters, the test semantic system was constructed, and 63 young users aged 14-40we were re-screened out. The semantic indexes of five home blood glucose meters were scored, and the average score was obtained as the original data. The dimension of the data is reduced by SPSS software, and the principal component factor is extracted, to obtain the most critical emotional needs of the young users of the home blood glucose meter, analyze and sort out the obtained data results, and design the product appearance according to the results.

3.1 Establishment of Emotional Semantic Testing System and analysis of user aesthetic preferences

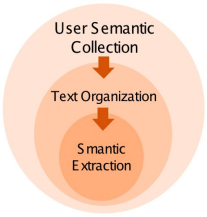

Fig1. Collection process of emotion semantic vocabulary

Table.1 Ten pairs of emotional intention words

Round-sharp	Small-heavy
Portable-fixed	Precise-fuzzy
Colorful-single	Simple-gorgeous
Hard-soft	Cold-warm
Interesting-serious	Reliable-grandiose

Through semantic extraction of interviews with target users, as shown in Figure 1.[1],ten pairs of semantically opposite emotional intention words are preliminarily collected, as shown in Table 1, and these ten pairs of words are matched with corresponding pictures to make an intention billboard so that users can more clearly understand the emotions displayed by each pair of emotional intention words and the corresponding product appearance shapes of each pair of semantic words, as shown in Figure 2.[2] Through a questionnaire survey, ten people aged 14-40 from all walks of life were asked to vote on semantic words, and finally, ten pairs of emotional semantic words with the highest number of votes were selected, namely, round-sharp, small-heavy, portable-fixed, accurate-fuzzy, colorful-single, simple-gorgeous and hard-. From these word pairs, we can see that the emotional needs of young people with diabetes are more diverse. Combining these emotional word pairs with samples, we can establish a semantic rating scale, which is convenient to transform users' emotional needs into rational data for analysis, so that the designed output can meet the emotional needs of target users.

3.2 Evaluation Sample Screening And Principal Component Factor Acquisition

Twenty-five household blood glucose meters recognized by the market are selected as samples, and the design experts are asked to screen out the five most representative samples from the twenty-five samples, which are labeled as A1, A2, A3, A4, and A 5 respectively, as shown in Figure 3.[3]. Then, a semantic difference scale like Figure 4.[4] was established to conduct a questionnaire survey on these five blood glucose meter products. Here, a five-point scale was used to quantify the initial semantics, and a five-level scale was established for five samples and 10 pairs of perceptual words, with the perceptual values of 0, 1, 2, 3, and 4 respectively, forming a semantic difference questionnaire. Then, 63 tested users aged scored a single semantic index to understand the sensory image of the target group on the existing blood glucose meter.

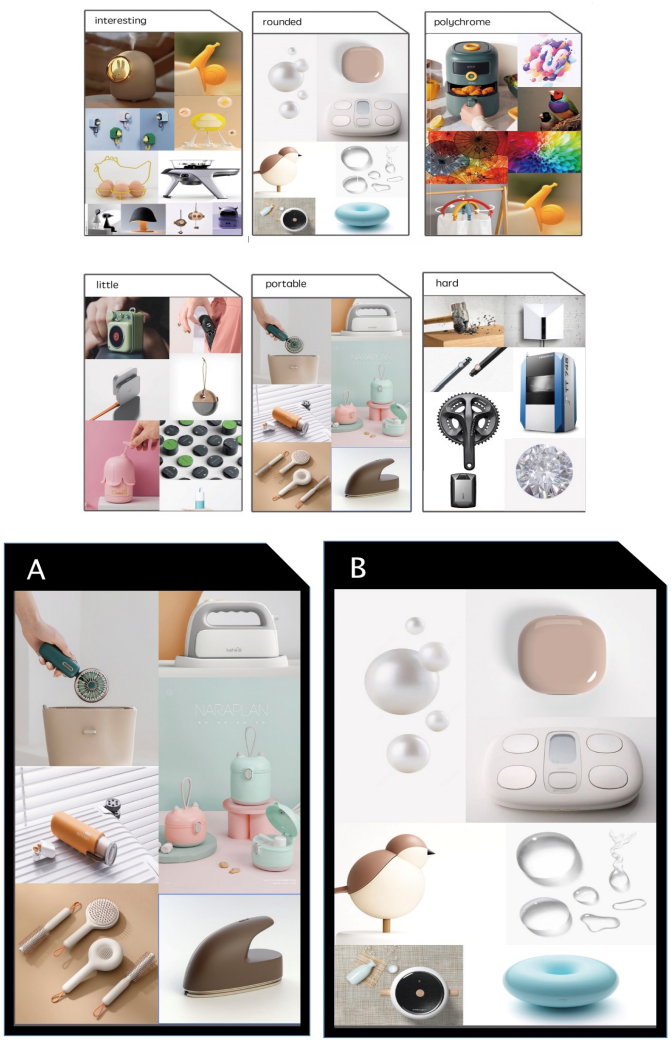

Fig.2 Board of intention test

Input the average values of the obtained data (as shown in Table 2) into SPSS software, reduce the dimensions of these average values, and conduct principal component analysis. Rotate factors to reduce the number of variables and explain the image semantic vocabulary of products with the least factors. The gravel map is shown in Figure 5.[5] .It can be seen from the gravel map that the eigenvalue of two of the ten principal components is ≥1, and the existence between the second principal component and the third principal component in the linear slope changes sharply, which slows down at the third principal component. Therefore, it is appropriate to extract two factors for rotation. The component matrix rotated by the maximum variance method shows (as shown in Table 3, variance contribution): the product appearance of the home blood glucose meter is greatly influenced by two principal components, the variance contribution value of component 1 is 57.395%, and the variance contribution value of component 2 is 30.796%[9].

The two components can explain 88.191% variance of the original variables in total, and this value can cover and explain the information of all variables.

3.3 Acquisition of Semantic Quantity and Interpretation of Sentiment Factors

As shown in Table 4, from the rotated component matrix table, it can be seen that the "small" score and the "interesting" score in component 1 are 0.967 and 0.924, which are the highest absolute values and both are positive numbers, so they are the two factors that consumers are most concerned about; The score of "gorgeous" is -991, with the highest absolute value and negative value, and the score of "colorful" is 0.966, with the second absolute value. Therefore, the emotional factors that consumers are most concerned about are "small", "interesting", "simple" and "colorful".

Based on the above analysis, we finally choose "small", "interesting", "simple" and "colorful" as the emotional characteristics of the design of young home blood glucose meters.

Fig.3 Sample of home blood glucose meter

Fig.4 Five scaling criteria of semantic scoring

3.4 Detailed Design

Based on the above analysis, especially on the relationship between perceptual images and design elements, the morphological characteristics of sample 1 and sample 3 are selected as the basis for design. By analyzing the morphological characteristics of these two samples, it can be found that "small" is mainly reflected in the sense of the volume of the product and the feeling of the materials used in the product, "interesting" is more reflected in the semantics, usage, and structure of the product, and "simple" means that the overall tone and materials of the product are relatively simple. And "colorful" is reflected in the rich decorative colors in the details of the product. The two samples selected above have four characteristics: small size, uniform style, warm material, and color decoration. In addition, the selected samples all adopt the treatment method of adding eye-catching color to the icon of the button, which can not only enrich the color of the home blood glucose meter but also achieve the effect of reminding users. Perhaps young patients with diabetes are more inclined to be simple in overall style, but add surprises in product details to improve the interest in products. However, through the observation of sample 1 and sample 3, it can be found that the appearance of these two products is slightly

Tab.2 Semantic rating of home blood glucose meter

	rounded	cleverish	portable	Accurate	Colorful	simple	hard	ice-cold	Interesting	reliable
A1	2.25	2.48	2.21	2.48	4.24	1.65	2.05	2.54	4.02	1.92
A2	1.92	2.05	2.10	2.43	2.76	2.73	3.29	3.21	3.05	2.14
A3	3.21	2.62	2.52	2.08	2.22	3.56	2.35	2.44	3.76	1.89
A4	1.46	1.46	1.56	2.29	2.67	3.02	3.27	3.08	3.00	2.35
A5	2.35	2.24	2.17	2.49	3.22	2.41	2.57	2.44	3.44	2.37

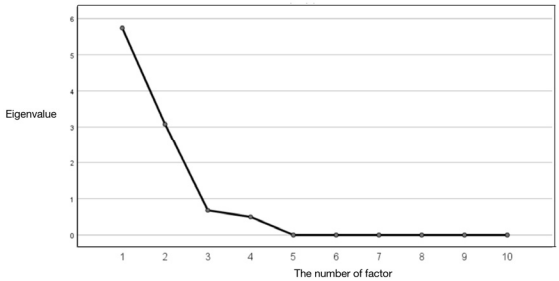

Fig.5 Screen plot (partial)

Tab.3 Variance contribution

principal constituent	eigenvalue	Contribution rate/%	Cumulative contribution value/%
1	5.739	57.395	57.395
2	3.080	30.796	88.191
3	0.681	6.809	95.001
4	0.500	4.999	100.00

Tab.4 Rotation matrix of components

	ingredient	
	1	2
rounded	0.907	-0.374
cleverish	0.967	0.041
portable	0.910	-0.160
Accurate	-0.254	0.893
Colorful	0.214	0.966
simple	-0.096	-0.991
hard	-0.914	-0.324
ice-cold	-0.846	-0.119
Interesting	0.924	0.302
reliable	-0.782	0.100

dull, lacking the vitality that young people like, and the overall shape is more traditional and the overall interest is not good. From the analysis of the samples, we can see that the following points can be emphatically considered when designing a home blood glucose meter targeting young users: First, a single color is used as the main color tone in color selection, and bright colors are avoided as far as possible. Considering the "interesting" emotional factors that the target users are interested in, some colors with high lightness and low saturation can be selected as the main color tone of the product. Some bright colors can be selected for the buttons of the product, and some colors can be decorated around the screen to dilute the depressive feeling of medical products and play a certain guiding role in the use and operation of users; In addition, in terms of product modeling, some rigid modeling should be avoided as far as possible, and chamfering can be used at the edge of the product. The overall modeling of the product can refer to the modeling of small animals, which can improve the interest in the product and reduce the user's resistance to blood sugar testing. Then, the material of the product can choose plastic with a warm touch, which is convenient for handling and modeling; Finally, according to man-machine analysis, the size of the home blood glucose meter should be in line with the habit of being grasped by most people, and the blood glucose meter should be combined with blood glucose test paper and blood collection needle as far as possible to avoid user's omission, and the operation steps should be reduced as much as possible when using it so that users can understand how to use the product when they see it.

Fig. 6 Effect diagram of home blood glucose meter

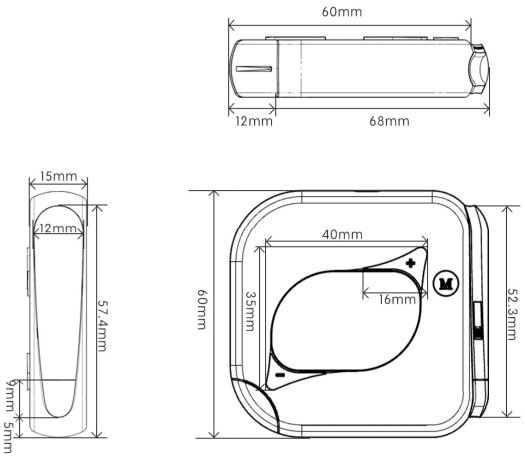

Fig. 7 The three views

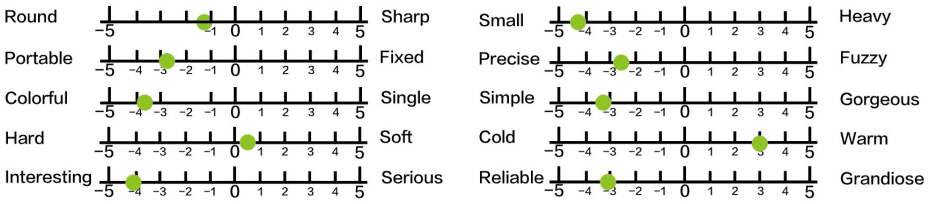

Fig. 8 Design feedback

Based on the above data and the analysis of the advantages and disadvantages of related samples, the home blood glucose meter is designed. The design result is shown in Figure 6.[6], Figure 7.[7]. Combined with the emotional needs of young people with diabetes, this home blood glucose meter has the following characteristics: First, the overall shape of the product is abstracted from rabbits, which has always given people the impression of being lively and energetic. Using rabbits as a prototype of product modeling can give users positive psychological hints, which is beneficial to their physical and mental health and can also increase interest in the product; Secondly, the appearance of the blood glucose meter is round, small, and exquisite, which meets the emotional needs of young users for home blood glucose meters, and is small and exquisite while satisfying functions and fun; Then, the rabbit home blood glucose meter is white as a whole, and the test paper slot of the blood glucose meter is orange-red, which plays a role in reminding users. The key shape is similar to the eyeliner of the rabbit, which not only adds color to the shape but also enables users to realize the role of the key when they see it, which perfectly meets the emotional needs of a "simple" and "colorful" home blood glucose meter. Finally, the home blood glucose meter combines the blood glucose meter body with the blood collection needle, and the blood collection needle serves as the "ear" of the "rabbit", which greatly reduces the hidden danger of losing the blood collection needle, enriches the shape of the blood glucose meter and makes the blood glucose meter more interesting.

3.5 Design Feedback

Taking the design effect diagram of the blood glucose meter in Figure 8.[8] .as the only legend, ten young users aged between 14 and 40 are invited to grade the decimal SD table with 5~-5 according to the ten pairs of emotional intention words in Table 1 according to their intuitive feelings about the design scheme, to verify whether the design scheme meets the emotional needs of users, and the final result is presented as the average value, as shown in Figure 8.[8] which shows that the design scheme meets the emotional preferences of young people. Good scores have been achieved in semantic features such as colorful, interesting, simple, and reliable, among which "small", "interesting" and "colorful" have the highest average absolute values, which are 4.15, 4.03, and 3.82 respectively, thus it can be seen that the home blood glucose meter abstracted from the rabbit model has been recognized by the target users.

4. Conclusion

People's feelings about a product are often emotional and complex, and the key to the design is how to show this emotional and complex perception through design thinking. In this paper, the semantic difference method is used to collect the words of young users' emotional intentions for home blood glucose meters using a questionnaire survey, and the semantic values are obtained. After weight reduction and analysis, the words of young diabetic patients' emotional intentions for home blood glucose meters are obtained. According to the words, the users' emotional needs for home blood glucose meters are quantitatively transformed into the rational thinking of designers, and finally, the design results are obtained. It is hoped that it can bring some comfort to young patients under the social background of younger diabetes, and it is also hoped that this design research from perceptual thinking to rational thinking can bring some reference to the design of medical-related products.

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