



Research on Deep Learning Precision Marketing Strategy for Electric Toothbrush

Wen Ting Huang¹, Ya Pang², Kemo Badiane³, An-Shin Shia^{4*}

¹Student, School of Business, Lingnan Normal University, Zhanjiang 524048, Guangdong, China;

²Student, School of Information Engineering, North China Institute of Science and Technology, Langfang, Hebei, China

³Associate Professor, Nanfang College - Guangzhou, 882, Wenquan Avenue, Guangzhou 510970, China.

^{4*}Associate Professor, School of Business, Lingnan Normal University, Zhanjiang 524048, Guangdong, China.

ABSTRACT: As people pay close attention to health and wellness, oral health is becoming more and more important. To better promote the sales of new Electric Toothbrushes (ET) and further meet consumers' demand for oral care, this paper uses the Deep Convolutional Neural Networks (DCNN) research method to extract the feature vectors of ET images uploaded by consumers from the comment areas of major e-commerce platforms, and adopts the image recognition technology in deep learning. The product images shared by consumers are analyzed, and the sampled feature vectors are evaluated by using Softmax Logistic Regression (or Multinomial Logistic Regression) to obtain a degree of consumers' attention to different information sources related to different types of ET so as to establish a precision marketing push model, on the one hand, to create a new design direction for manufacturers, on the other hand, to design a highly precise marketing strategy selection in order to solve the problems of poor pertinence of user groups and product function design that do not meet the needs of enterprises' sales.

Keywords: Deep Learning (DL), Precision Marketing, Deep Convolutional Neural Networks (DCNN), Electric Toothbrush (ET)

INTRODUCTION

Presently, consumers' demand for products tends to be more and more personalized in the development trend of enterprises in various industries. The production of products for the precise and accurate marketing for consumers has been the mainstream trend. Various industry sectors have long been no stranger to precision marketing, but how to use the current high-tech to improve the accuracy of marketing is still a problem that needs to be constantly explored. With the development of Deep Learning (DL), different features can be extracted directly from the original text or image data for end-to-end learning and training, which does not rely on hand-designed features and improves the robustness of the model while ensuring the accuracy of the model; effective information can be extracted by analyzing the results of the model training. Since the ultrasonic type of electric toothbrush occupies 89.8% of the current electric toothbrush market, this research is conducted on the ultrasonic type of electric toothbrush, and the electric toothbrush mentioned below refers to the ultrasonic type of electric toothbrush (ET) (Changjiang Securities, 2022). Using deep learning technology, from the perspective of consumers, image analysis and construction of new models of ET, which is gradually penetrating into the daily life of human beings, is able to analyze the differences in the degree of users' attention to the different performances and parts of ET, etc., help manufacturers further improve their products and carry out accurate marketing for different consumer groups so as to turn consumers' personalized attention into product upgrading.

To further improve the precision marketing method and system, this paper takes the commonly used ET as an example based on the DL algorithm to mark the ET images taken by consumers and use the algorithm to conduct research that aims to:

- (1) Collect and analyze, after splitting the ET parts, the relevant data of the number of times mentioned on the Internet according to the DL algorithm, which can clarify the ranking of consumers' attention to different parts and functions of ET.
- (2) Enable manufacturers and companies selling ET to better understand the needs of consumers in order to find the direction of precision marketing.
- (3) And Support companies optimize their products according to their own advantages in order to increase sales volume of ultrasonic ET.

The remainder of the paper is structured as follows. In chapter 2, we present a review of the current literature. In chapter 3, we discuss methodological approaches. Chapter 4 presents the results of the study including acquisition of data based on DL, data construction and analysis, and expert scoring method. Chapter 5 proposes selection for precision marketing direction. Finally, chapter 6 provides conclusions, implications for the study, limitations of the study and recommendations for future research.

REVIEW OF THE LITERATURE

2.1 Related Research on DL

The traditional target detection method is generally divided into three stages: firstly, some regions candidates are selected using image, then extract features from these regions, and finally a trained classifier is used for classification. There are two main problems in traditional target detection: (1)The sliding window (fixed length and width) method adopted in region selection is not targeted resulting in high time complexity and redundant windows, which affects the running speed and performance of subsequent feature extraction and classification; (2)Manually designed features are not robust to changes in target diversity, such as background complexity and morphology of target objects at different angles.

Krizhevsky, Sutskever, and Hinton (2012) proposed that DCNN or AlexNet achieve innovatively recorded image classification accuracy in the Large-Scale Visual Recognition Challenge (ILSRVC), and many applications in the field of computer vision have focused on their research on DL, according to which target detection techniques are developing rapidly. Liu, Ouyang, and Wang(2019) argued that the current emerging DL technique is a powerful method that can learn target feature representations directly from data and has led to significant breakthroughs in the field of general target detection, such as a significant increase in detection accuracy from 23% in ILSVRC2013 to 73% in ILSVRC2017; with the increasing development of DL techniques, the accuracy of target detection can rival human recognition in some aspects, and the PReLU networks proposed by He, Zhang, Ren, and Sun (2016) achieved a test error of 4.94% on the ImageNet 2012 classification dataset, a result that was the first to exceed human-level performance (5.1%). DL target detection algorithms are generally divided into two categories: (1)DL target detection algorithms based on Region Proposal, mainly represented by the R-CNN algorithm series; (2)DL target detection algorithms based on regression methods, mainly represented by YOLO algorithm and SSD algorithm (Wang, 2016).

Region Proposal is to find out the possible positions of objects in the figure in advance. Since Region Proposal uses information such as texture, edge, and color in the image, it can ensure that the selected windows (thousands or even hundreds) are relatively small. With a high recall rate, the obtained window is of higher quality than the sliding window in the traditional method and reduces the time complexity of subsequent feature extraction and classification. However, in practical applications, the recognition speed of the R-CNN algorithm series cannot meet the real-time requirements (Wang, 2016). In the regression method, YOLO is an innovation in recent years and occupies a very important position in the field of target detection. It classifies target detection as a regression problem, realizes end-to-end training and detection, and directly in multiple positions of the original image. Regression, which shows the target position border and target category, has been successfully improved and applied to many different fields due to its good speed and accuracy performance, but because there is no region proposal mechanism, it cannot locate the target very accurately, resulting in the detection accuracy of YOLO not very high(Redmon et al., 2016).

The SSD combines the regression idea in YOLO and the anchor mechanism in Faster R-CNN, and uses the multi-scale regional features of each position of the whole image for regression, which not only maintains the fast speed of YOLO, but also ensures that the window prediction is the same as Faster R-CNN. The SSD512 model performs significantly better than the Faster R-CNN in terms of PASCAL VOC and COCO, and is three times faster. The real-time SSD300 model runs at 59 FPS, which is faster than real-time YOLO, while significantly improving detection accuracy (Wei et al., 2016).

2.2 Research on Precision Marketing

At present, research on precision marketing mainly focuses on concepts, characteristics, models, operating systems, and precision marketing in the field of e-commerce. In recent years, with the rise of Big Data Technologies, the use of big data analysis capabilities to study consumer group portraits from different fields to promote precision marketing research is also increasing. Zabin and Brebach (2004) proposed the definition of precision marketing, which they believe is a marketing method that puts consumers at the center and grasps the right time, place, and lifecycle of different consumers for products, so as to use appropriate marketing methods to accurately match their needs. Based on the customer lifecycle, the three-stage precision marketing model of Attract, Retain and Leverage is proposed, which makes important thinking directions for subsequent researchers on the connection between product marketing and consumers.

After the basic meaning of precision marketing was gradually understood by the public, Liu (2007) proposed that precision marketing is an extended development of the classic marketing approach, mainly in searching for potential consumers and communicating with consumers. The future development of this direction is mainly about tools and methods of analysis, but this kind of thinking and method has not been able to play a greater value in practice. For example, Yin and Deng (2010) pointed out the limitations of database-driven precision marketing, mainly in the small initial scale, long establishment time and frequent data update iterations.

In the big data era, Han (2021) proposed four basic components of the precision marketing model, namely precise market positioning, "one-to-one" distribution and integrated sales system, personalized products and value-added consumer service system, arguing that the market and target group can be segmented and it is believed that through the analysis of Big Data Technology, the market and the target group can be segmented and personalized, so that product design, production, and consumer services can be completed. For example, Wang (2022) found that with the continuous development of Internet technology, e-commerce companies have accumulated effective information on multiple consumer groups through big data in the marketing process. By using Big Data Technology mining, it can well promote the sustainable development of enterprises. When Kong (2022) realized that machine learning can help realize the current situation of personalized marketing promotion, he introduced homomorphic encryption technology to use big data to understand customer consumption data and conduct precision marketing for various enterprise scenarios.

When online services and transactions become the mainstream ways of selling goods, El Koufi, Belangour, and Sdiq (2022) used big data analysis and machine learning technology to provide a potential customer prediction algorithm (PCPA) in order to forecast potential customers. When searching for the keywords "Precision marketing based on deep learning" on CNKI, a total of two articles can be found. The first is about to construct a correlation model between consumers' facial appearance and possible clothing preference based on DL (Wu., et al, 2019); The second is about to study the user portrait model construction algorithm that can be used for precision marketing and promotion based on DL technology to obtain various attributes and characteristics of users (Su & Xiong, 2020). We are now in the era of the rise of big data and artificial intelligence (AI). In terms of precision marketing, people continue to combine new technologies and new methods, especially under the background of big data, which has made important contributions to marketing in various fields, but for precision marketing in the field of DL under artificial intelligence, it has not yet been completely explored.

DATA AND METHODS

3.1 Faster RCNN

Faster RCNN can be divided into four parts, specifically Conv layers, Region Proposal Networks, ROI pooling and Classification. Convolution layers perform feature extraction, that is, generate feature maps corresponding to images, which can be used in Region Proposal Networks and Classification. Region Proposal Networks generate region proposals, accurate proposals can be obtained by correcting anchors. ROI pooling collects the feature maps and proposals extracted above, and sends them to the subsequent fully connected layer to judge the target category. Classification calculates the category of proposals and obtains the final accurate position of the target detection frame.

3.2 YOLOv5

YOLOv5 has four major modules, specifically the input terminal, the reference network, the neck network, and the head output terminal. The input terminal is responsible for preprocessing the input image, and at the same time, it can perform data enhancement on the image data. The reference network is used to extract general features of images. The neck network plays a role in improving the diversity and robustness of features. The head output terminal yields the result of the final target detection.

ANALYSES AND RESULTS

4.1 Acquisition of Data Based on DL

4.1.1 Datasets

The dataset was collected from the comment section of flagship stores on the Taobao platform for ultrasonic ETs from four brands: Xiaomi (Mi Home), Philips, Oral-B (Shuke), and Usmile. A total of 1,000 images were collected, and the dataset includes nine features including Toothbrush appearance, Packaging (referring to the outer packaging box for storing the ET), Storage Box (a box used for storing the ET during daily use or travel), Donation, Accessories (referring to the charging base for the ET), Toothbrush head, Toothbrush cleaning function, Toothbrush head connection, and Charging interface.

4.1.2 Target Detection

The loss function of the Faster RCNN is (I):

$$L(\{p_i\}, \{t_i\}) = \frac{1}{N_{cls}} \sum_i L_{cls}(p_i, p_i^*) + \lambda \sum_i p_i^* L_{reg}(t_i, t_i^*), \dots \dots (I)$$

where the left-hand side is the classification loss (cls loss) and the right-hand side is the regression loss (bbox regression loss), Figure 1 is obtained from both of them after 10,000 iterations respectively, where rpn loss cls and loss cls are classification losses and rpn loss box and loss box are regression losses.

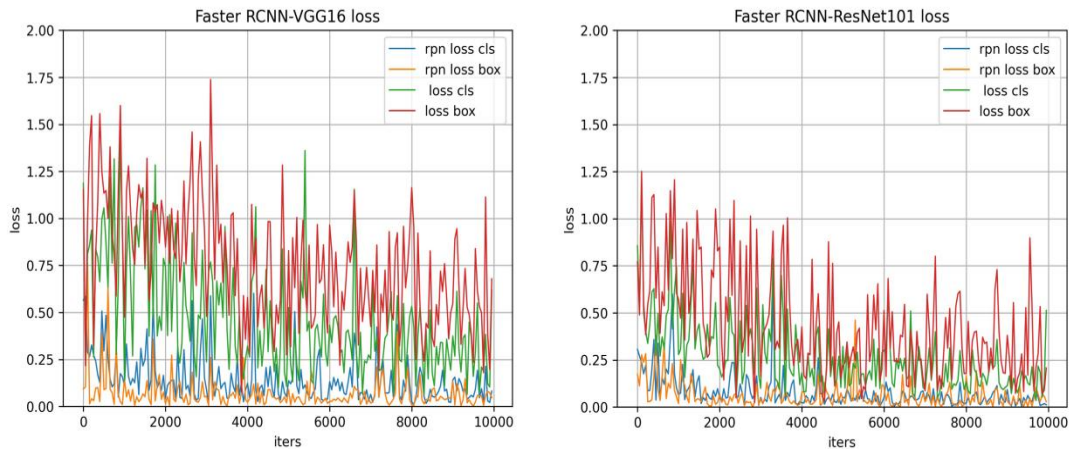


Figure 1. Faster RCNN Loss

Combining Figure 1 and Figure 2, it can be concluded that the Faster RCNN-ResNet101 performs better than the Faster RCNN-VGG16

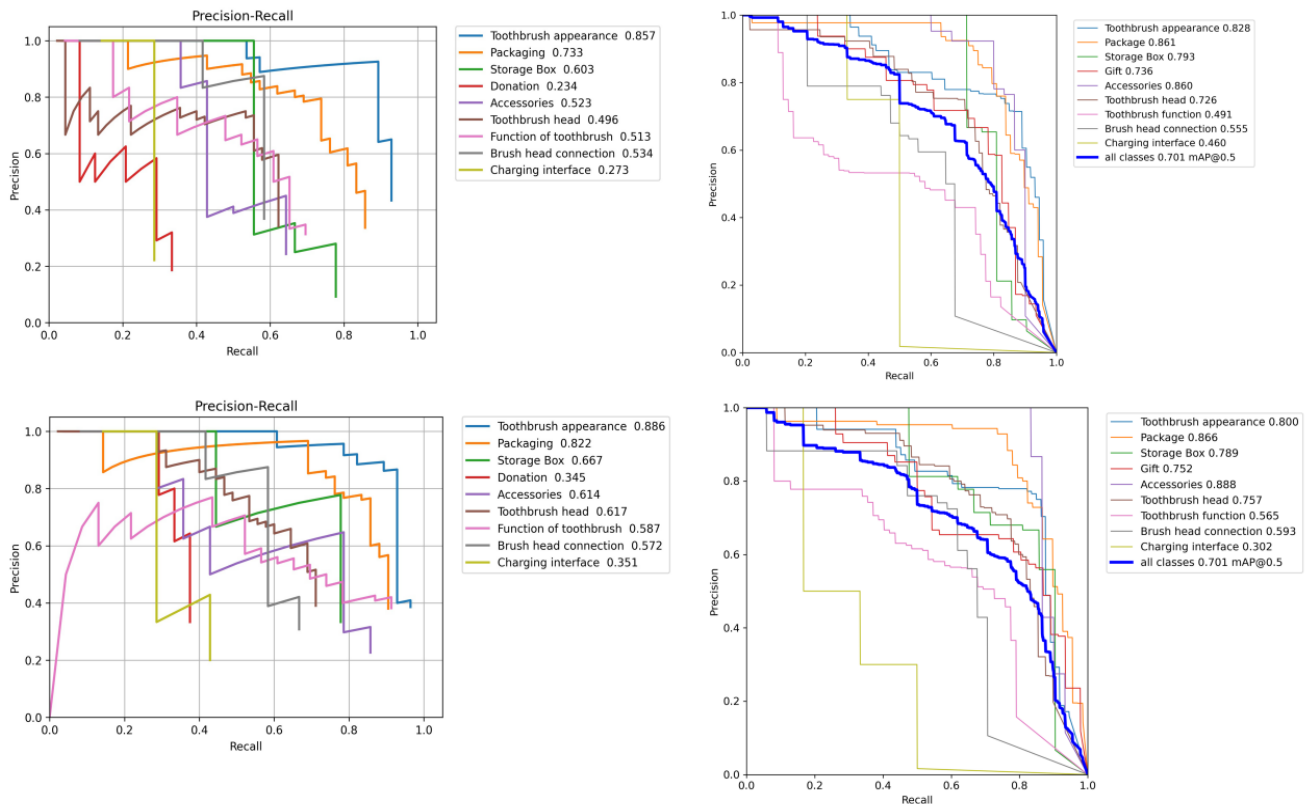


Figure 2. Top left Faster RCNN-VGG16, bottom left Faster RCNN-ResNet101, top right YOLOv5s, bottom right YOLOv5m

In Faster RCNN, VGG16 and Resnet101 were selected for 10,000 iterations each, while in the YOLOv5 series, YOLOv5s and YOLOv5m were iterated 300 times each. By comparing the Precision and Recall of each feature in Table 1 and the P-R curve in Figure 2, it was determined that YOLOv5 performs better in recognizing ET features. Although YOLOv5m shows

better recognition performance in certain features, YOLOv5s demonstrates a more balanced recognition capability and faster speed. Therefore, YOLOv5s was ultimately chosen for ET image feature detection, providing analytical data for selecting marketing directions.

Table 1. Comparison of YOLOv5s and YOLOv5m Models

Model	Faster RCNN				YOLOv5			
	VGG16		Resnet101		YOLOv5s		YOLOv5m	
Features	P	R	P	R	P	R	P	R
ET Appearance	43.7	93.5	43.3	92.9	74.6	85.0	82.4	84.0
Packaging	39.2	95.0	33.6	85.7	86.4	76.0	90.0	81.0
Storage Box	35.9	89.4	9.00	77.8	98.6	71.0	89.9	71.0
Donation	46.1	66.2	18.6	33.3	81.3	65.0	75.3	67.0
Accessories	33.4	95.4	24.3	64.2	87.9	80.0	98.8	80.0
ET Head	44.9	86.2	34.2	62.2	71.7	66.0	66.4	71.0
Function	39.1	86.1	31.3	69.6	59.5	47.0	66.3	53.0
ET Head Connection	57.0	89.1	36.8	58.3	86.8	59.0	68.8	53.0
Charging Interface	31.4	90.4	22.2	28.6	98.0	50.0	85.0	16.8
Subtotal	370.7	791.3	253.3	572.6	744.8	599	722.9	576.8
Grand Total	1987.9				2643.5			

4.2 Data Construction and Analysis

From the Taobao platform, relevant images posted by customers in the comments of ultrasonic ET stores are gathered. The images are then sent to the trained YOLOv5s network for detection to obtain the target recognition type and categories of ET images were integrated into an Excel sheet to obtain the analyzed data.

4.3 Expert Scoring Method

According to the DL technology to collect consumers' data about ultrasonic ETs on various platforms, the above weightings were finally obtained and the importance of each feature of ETs was ranked as follows (from most important to least important): The weight percentage formula in Figure 3 is as follows:

$$\frac{\text{The frequency of occurrence of this feature in the images uploaded by consumers}}{\text{The total number of occurrences for each feature}}$$

Among them, the Toothbrush cleaning function appeared 649 times, Toothbrush head 615 times, Packaging 523 times, Storage box 518 times, Toothbrush appearance 453 times, Accessories 316 times, Donation 153 times, Toothbrush head connection 110 times, and Charging interface 60 times. Based on the formula, the ranking of each feature can be obtained as follows: Toothbrush cleaning function (19%), Toothbrush head (18%), Packaging (16%), Storage box (15%), Toothbrush appearance (13%), Accessories (9%), Donation (5%), Toothbrush head connection (3%), and Charging interface (2%). The top five features have a more significant proportion, indicating their high importance. Therefore, they will be considered as the key factors for marketing strategy discussions.

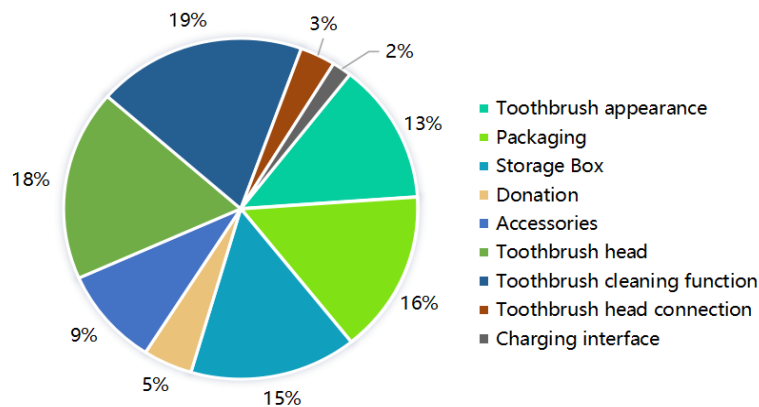


Figure 3. Weighting of Each Feature of Ultrasound-Style ET in DL (Data Collected from DL Technology Search)

SELECTION FOR PRECISION MARKETING DIRECTION

Based on the findings (Figure 3), the importance of different aspects in the minds of consumers is analyzed to determine the precise marketing direction and strategies for the product.

5.1 Product Positioning

Oral diseases are a worldwide public health problem, especially for low-income people. Due to lifestyle and consumption levels, oral diseases occur frequently, and the cost of treatment brings a great financial burden to families (Peres et al., 2019). In order to better prevent oral diseases, such as dental caries and periodontitis, toothbrushing is the best way to reduce oral bacteria. As an essential item for people to take care of their oral health in daily life, toothbrushes are widely sold worldwide. ET, as an oral care product that has emerged in recent years, should initially be positioned as a new generation of products with more cleaning power and safety than ordinary toothbrushes. Secondly, differentiated product positioning should be carried out through multiple classification methods, such as different groups of people or different effects. For example, sensual and gentle oral care that can give you meticulous and comprehensive care and attention of a mother, or accurate and efficient oral care that can serve as your professional oral health care (POHC). Product positioning needs to be targeted, and on a certain point that consumers are most concerned about, it is clear whether it needs overall mild care or care for different consumer groups with oral diseases.

5.2 Focused Marketing Strategy

As described above, it has been shown that the top five features of ET that consumers most appreciated are also the most important. According to the results of the research, the top five features (accounting for 81% of all weights) are as follows: Toothbrush cleaning function (19%), Toothbrush head (18%), Packaging (16%), Storage box (15%), and Toothbrush appearance (13%). Therefore, in actual production and marketing, manufacturers and sales companies should focus on these five elements and grasp the five key points that consumers value most.

5.2.1 Cleaning Effect

Compared with ordinary toothbrushes that are manually operated independently, ET has been shown in a large amount of research to reduce dental plaque and achieve better cleaning effect than ordinary toothbrushes. Many consumers who choose ET also regard this as the most critical factor of ultrasonic electric toothbrush. However, after reading the research of many scholars, it is found that consumers who are reluctant to choose ET are mostly based on cleanliness and safety considerations. For consumer groups, the biggest function of a toothbrush is to achieve the best cleaning effect based on safety, so the most important thing is to highlight this point when focusing on the marketing direction of ET products.

In terms of tooth cleaning and safeguarding safety, the ET is operated by the internal drive of the motor to rotate or vibrate the toothbrush head to properly brush teeth, which will be more even in strength and range than manual brushing, minimizing damage to teeth and gums caused by improper manual brushing techniques. Recent improvements to the sonic type are mainly in the frequency of vibration, so that food debris or tartar hidden in the buccal cavity is not easily detected and shaken off, resulting in better cleaning and comfort. Moreover, as most consumers brush their teeth on a daily basis according to their free time and experience, the length of time required is often not sufficient, so their teeth are not clean enough or over-cleaned.

However, in this article, we found that the current ET products also have the problem in disassembling and cleaning the toothbrush due to their high degree of precision. When designing, the factory should consider the problem to better cope with cleaning the toothbrush in addition to cleaning the teeth, instead of just changing the toothbrush head, it should be a combination of daily cleaning and regular replacement of the toothbrush head. Furthermore, relying on sonic frequencies to shake off food residues, although applicable to a large number of the general public is not suitable for patients with different types of oral disease, whose teeth are more sensitive than the general public, making their teeth unable to withstand the cleaning effort of a normal ET.

The most important function of a toothbrush for the consumer group is to achieve the most effective cleaning effect on the teeth. However, if the product itself can be kept clean on top of this, and the cleaning needs of consumers with different oral sensitivities can be taken into account, it is more conducive to the marketing of ET products. Therefore, it is very important to highlight this point when focusing on the marketing of ET products.

5.2.2 Toothbrush Head Design

Toothbrush head design occupies the second place that consumers value in the above data, highlighting its importance. As the key part of the ET that comes into direct contact with the teeth, the toothbrush head is of vital importance to consumers. Clinical studies conducted by the School of Stomatology of the Fourth Military Medical University have shown that compared to flat toothbrush heads, toothbrushes with wavy bristle surfaces are more effective in cleaning the lips and the surfaces of the proximal and intermediate teeth; and toothbrushes with parallel bristles are not as strong as those with crossed bristles in penetrating deeper into the interstices of the teeth.

As the most important part of the toothbrush head, toothbrush bristles play a unique role in cleaning teeth. Toothbrushes currently on the market mainly have three levels of bristles: soft, medium, and hard. Various experiments have shown that harder bristles are more effective at cleaning teeth than soft bristles, but at the same time they are more harmful to damage teeth. The materials and designs of the brush gradually change with the individual needs of consumers, from the traditional brush nylon (PA) to other brush filaments with more refined and novel functions, such as adding bamboo charcoal with antibacterial and odor-absorbing properties (Li, 2022a).

In the design strategy of the toothbrush head, the researchers integrated various aspects such as perceptual engineering and texture design to add a sense of imagery to the design of the toothbrush head. Secondly, for the various Electric Toothbrush heads, designers designed them based on multiple layers. For example, when designing an OR electric toothbrush, the designer started from the human rounded tooth structure morphology and designs a small and rounded toothbrush head to achieve wrapping the teeth as much as possible and consciously tends to clean the tongue side. (Li, 2022b)

Meanwhile, during the survey, the author found that today's consumers mention more about the hard and soft bristles of the toothbrush head as well as the sparse bristles. Out of the comfort demand, they are more inclined to choose the toothbrush head with more dense soft bristles, but the cleaning power is the primary purpose of ET, and the Electric Toothbrush head in the current market has sparse soft bristles and hard material compared to ordinary toothbrushes. How to ensure that the toothbrush head and toothbrush bristles have a texture design, while balancing the cleaning power and comfort level of the bristles in different materials, will become one of the directions that designers need to pay attention to in the future.

5.2.3 Packaging

From the perspective of the primacy effect, as a brand or product that consumers have never used before, the shape design of the toothbrush and its external packaging will have a significant impact on consumers' awareness. If the packaging is too simple, consumers will ignore or even avoid it, thus giving up further understanding of its role and functions.

After sorting out and summarizing the concerns and needs of consumer groups, it is found that the current matching packaging sold by ET is loved by many people. It provides consumers with a beautiful visual experience in the form of exquisite gift boxes, which is different from those sold separately in the market, mostly used in the form of plastic shell and cardboard packaging. Ordinary toothbrushes are usually packaged in plastic shells and cardboards, and ET packaging boxes have a stronger visual impact. Secondly, the interior of the packaging mostly adopts interesting patterns and shapes, and is provided with grooves that fit the toothbrush. Some even design high-end boxes with buttons, so that consumers can maintain a happy mood when opening the box to take out the toothbrush, greatly reducing the possibility of finger damage due to rough paper packaging.

However, at present, there are not many designs that can take into account the appearance and interior design of the packaging box. Most designers will only start from the appearance of the packaging, and to a certain extent ignore the disassembly of the packaging box and the presentation of the disassembled packaging box is also the key to its packaging. Besides, there are very few ET shells that can truly design packaging from the psychological characteristics of different groups. For example, when facing the visually impaired, technology-style boxes can be designed with Braille touch and voice, which can make consumers feel convenient and respected with clear interaction (Guo., Sun., & Liu, 2023). For consumer groups, the first impression of the product is very important, which can be based on age and gender, with more significant different characteristics of each group, from the perspective of first sight or first touch in order to achieve targeted marketing for different consumer groups.

5.2.4 Storage Box

Due to the different storage environments and methods, oral and external bacteria attached to the toothbrush head will also grow and change. Therefore, after the toothbrush completes its basic function of cleaning teeth, the consumer group pay more and more attention to how to place and store toothbrushes so as to reduce the degree of bacterial contamination. During the brushing process, toothbrushes are not only contaminated by microorganisms from the inside of the mouth, leading to dental caries, periodontitis, and other oral diseases, but also may be infected by non-oral bacteria, resulting in a

weakened oral immune system. More seriously, bacteria such as caries and periodontal pathogenic bacteria will continue to spread and infect other parts by attaching to the toothbrush head, and may even destroy other immune systems in the body(Wang et al., 2010).

According to the survey, consumers usually place their toothbrushes into a toothbrush cup or hang them upside down. As for ET, consumers know they can avoid cups with water stains, and relying on its bottom with a larger contact area than ordinary toothbrush, stand it upright or hang it. These methods can help store the toothbrush to a certain extent, but ignore the fact that food debris on the toothbrush may grow due to different environments. In order to solve this problem, many scholars or researchers have set up various experiments in different environments to investigate the growth of microorganisms. In addition, there are individual experiments setting up antibacterial toothbrush boxes with simple UV lamps, drying boxes, and water-absorbing balls for toothbrush storage boxes. Finally, some experiments have demonstrated that this has a certain effect on inhibiting bacterial growth(Huang, Zhang,&Wu, 2022).

Based on the above, on the one hand, ETs need to be always placed in a dry and ventilated environment. On the other hand, if the manufacturer can provide it with an anti-bacterial storage box, the sales company will have greater marketing and sales advantages compared to other toothbrushes. The details that consumers failed to notice before can further become the highlights attracting them to purchase.

5.2.5 ET Appearance

The appearance of toothbrushes is the most intuitive for consumers to face. Different shapes, materials, colors, and other aspects will bring different experiences to consumers. From a visual point of view, if the color is lighter, it will create a more energetic feeling; if it is darker, it will create a more elegant and noble feeling. As one of the most sensitive senses of human beings, the sense of touch can also produce synesthesia with other senses (such as vision).For example, artificial rubber (TPE=Thermoplastic Elastomers) or ABS (Acrylonitrile Butadiene Styrene) materials are easier to match with curves and shape designs than other materials, resulting in a soft feeling(Li, &Pei, 2021).

Moreover, before fine designing the components of ET, industrial design researchers mainly focus on the overall design texture of toothbrushes, and carried out element-oriented design for specific consumer groups. For example, Li., Huang.,and Li (2022) analyzed the CMF design of female ETs through the theory of perceptual engineering, extracted and combined the possible thinking and perceptual images of women with different identities, thus providing direction for the texture design of toothbrushes. In addition to focusing on the female groups, the researchers have also analyzed the design inspiration directions for other groups.

As the research has been continuously refined and expanded, it gradually tends to differentiate the settings according to the preferences and possible inclinations of different consumer groups. Various parts of the toothbrush, such as toothbrush head (slenderness, softness, etc.), toothbrush handle (tactile sensation, degree of indentation, etc.), and the setting of the brushing activation function and placement of the toothbrush activation function are constantly being optimized. For example, when Zhangand Zuo(2022) studied the ET of the elderly group, keywords of perceptual images were collected, and the design strategies for the toothbrush head, toothbrush neck and handle of the toothbrush were respectively carried out. Therefore, when marketing ET, it is of paramount importance to design its overall texture, material, color application and other aspects. After completing the overall design, it is necessary to carry out detailed design for each part, so that consumers with different preferences can be attracted by the product and think about using it in the future.

5.3 Discussion

As mentioned above, in the market environment where oral care is getting more and more attention from the public, the key marketing concept of ET should focus on the five major factors that consumers are most concerned about. For the overall packaging appearance and design, the common characteristics or psychology of different groups can be used to design and promote products in terms of sensibility, rationality or refinement and simplicity, which can be used as the shaping of brand image and can also be used as a standard for the classification of the enterprise's various products. For the cleaning function, this is the basic function that toothbrushes must have, and the reason why ET has emerged in recent years and the public has seen it is stronger than ordinary toothbrush in terms of cleaning ability. Therefore, in the marketing process, sellers should focus on highlighting its most powerful effect on cleaning teeth and caring for the oral cavity, and need to emphasize that while its cleaning power is stronger, its protective effect on teeth is also the top priority, thus indicating that the ET is tested using scientific experiments, it not only has strong cleaning power, but will also be automatically adjusted to the most suitable time and strength to protect dental health, so that consumers can purchase it with confidence.

CONCLUSION

The results of this study show that the organic combination of deep learning algorithms and marketing can accurately grasp the consumers' needs and preferences, and can further help enterprises improve the targeting and functional improvement while making precise marketing strategy selection for products to meet the deeper needs of consumers. For enterprises, the organic combination of deep learning algorithms and marketing is an effective way to enhance product competitiveness and achieve precise marketing effects.

6.1 Implications for the Study

6.1.1 Theoretical Implications

DL performs iterative learning in massive data, which saves a lot of manual design time compared with the past, and the basis of precision marketing is to identify and guide users' needs for products (Zhang.,Zheng., &Xu, 2022). This paper uses the DL algorithm to obtain and analyze consumers' experience and emotional tendencies after purchasing ET so as to obtain the direction of targeted and precise marketing of products, and provide some research implications for various products to identify consumer tendencies.

6.1.2 Implications for Practitioners

This paper uses DL technology to obtain the five aspects of ET that consumers are most concerned about, and thus proposes the direction of marketing strategies for the most important influencing factors, which will help manufacturers and enterprises produce ET, which has certain research significance for promoting the development of this industry.

6.2 Limitations of the Study and Recommendations for Future Research

6.2.1 Limitations of the Study

Due to the complex and huge amount of data such as text and image comments by consumer groups, this article can only capture part of the data based on random sampling, so the results of the analysis may have certain errors.

6.2.2 Recommendations for Future Research

It is suggested that follow-up studies can conduct in-depth discussions on this topic, and use the precision marketing strategy of the constructed product to conduct large-scale market practice testing to enrich the effectiveness of the research results.

REFERENCES

- [1] Changjiang Securities Company Limited (2022). *Electric Toothbrush Industry Special: New Consumption, New Track, New Brands*. Wuhan: Changjiang Securities,(2022-01-10), Jan.16. 2023, Retrieved From <https://baijiahao.baidu.com/s?id=1721534875674725470&wfr=spider&for=pc>
- [2] El Koufi, N., Belangour, A., &Sdiq, M. (2022). *Research on Precision Marketing based on Big Data Analysis and Machine Learning: Case Study of Morocco*. *International Journal of Advanced Computer Science and Applications*, 13(10). Doi: 10.14569/IJACSA.2022.0131008.
- [3] Guo, Y. P., Sun, H. H., &Liu, Y. S.(2023). *Innovative Design and Implementation of Electric Toothbrush Packaging for the Visually Impaired*. *Screen Printing*,(01):56-58.
- [4] Han, H. M.(2021). *Analysis of Precise Marketing Model in the Era of Big Data*. *Economist*,(07):263-264.
- [5] He, K., Zhang, X., Ren, S., & Sun, J. (2016). *Deep Residual Learning for Image Recognition*. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, pp. 770-778. <https://doi.org/10.48550/arXiv.1512.03385>
- [6] Huang, H. X., Zhang, X. Q.,&Wu, S. Y .(2022). *Effects of Toothbrush Storage Environment and Arrangement on Microorganisms*. *Experimental Teaching and Instrumentation*,39(Z1):80-81.
- [7] Kong, C.(2022). *Research on Enterprise Digital Precision Marketing Strategy Based on Big Data*. *Mathematical Problems in Engineering*.
- [8] Krizhevsky, A., Sutskever, I., & Hinton, G. E. (2012). *Imagenet Classification with Deep Convolutional Neural Networks*. *Advances in Neural Information Processing Systems*, 25(2) 1097-1105.
- [9] Li, G. (2022a). *Design and Development Trend of Toothbrushes*. *Oral Care Products Industry*,32(01):21-24.
- [10] Li, G. (2022b). *A Review of The Effectiveness and Safety of Pendulum Type Small Round Head Electric Toothbrushes in Home Oral Care Applications*. *Oral Care Products Industry*,32(03):45-51.
- [11] Li, K., &Pei, X. S. (2021). *Research on Factors Influencing the Satisfaction of Electric Toothbrush Experience Fromthe User Perspective*. *Light Industry Science and Technology*,37(04):139-141.

- [12] Li, Q., Huang, L. Q., & Li, M. Z. (2022). Textural Imagery Perception and Design of Female Electric Toothbrushes. *Packaging Engineering*,43(08):108-114+136.
- [13] Liu, L., Ouyang, W. L., & Wang, X. G. (2019). Deep Learning for Generic Object Detection: A Survey. *International Journal of Computer Vision*.
- [14] Liu, Z. Y. (2007). Research on Precision Marketing Methods. *Journal of Shanghai Jiaotong University*, (S1):143-151.
- [15] Peres, M. A., Macpherson, L. M., Weyant, R. J., Daly, B., Venturelli, R., Mathur, M. R., ... & Watt, R. G. (2019). Oral Diseases: A Global Public Health Challenge. *The Lancet*, 394 (10194), 249-260.
- [16] Redmon, J., Divvala, S., & Girshick, R., & Farhadi, A. (2016). You Only Look Once: Unified, Real-Time Object Detection. *IEEE*. Doi: 10.1109/CVPR.2016.91
- [17] Su, C. H., & Xiong, T. (2020). Design and Simulation of DI-Based Precision Marketing Push Algorithm. *Modern Electronic Technology*, 43(22):144-147.
- [18] Wang, B. (2016). Advances in Deep Learning-Based Target Detection Research. *Deep Learning Classroom*. March.16. 2023, Retrieved From https://mp.weixin.qq.com/s?__biz=Mzi1Nte4Ntuwoq==&Mid=502841131&Idx=1&Sn=Bb3e8e6ae2ee1f4d3f22459062b814#Rd
- [19] Wang, J. L. (2022). Research on Precision Marketing of e-Commerce Enterprises in the Context of Big Data. *Economist*, (1):274-275+279.
- [20] Wang, M. H., Yin, W., Hu, D. Y., He, S. L. & Lin, L. (2010). Bacteriological Testing of Toothbrushes Under Different Storage Conditions after Brushing. *Journal of Practical Dentistry* (06), 782-784.
- [21] Wei, L., Dragomir, A., Dumitru, E., Christian, S., Scott, R., Fu, C-Y., & Alexander, C. B. (2016). Ssd: Single Shot Multibox Detector. *European Conference on Computer Vision*. Springer, Cham.
- [22] <https://doi.org/10.48550/arXiv.1512.02325>
- [23] Wu, A-B., Ge, Chen-Chen, Sun, Lin-Hui., Zhang, Yun., & Li Gang. (2019). DI-based Face Value Estimation and E-Commerce Precision Marketing. *Industrial Engineering and Management*, 24(06):124-131. Doi:10.19495/j.cnki.1007-5429.2019.06.015.
- [24] Yin, Q. H., & Deng, R. (2010). Current Status of Precision Marketing Research. *Journal of Economic Research*, (09):158-159.
- [25] Zabin, J., & Brebach, G. (2004). *Precision Marketing: The New Rules for Attracting, Retaining, and Leveraging Profitable Customers*. John Wiley & Sons.
- [26] Zhang, J. Y., Zheng, L. L., & Xu, X. Y. (2022). The Impact of Precision Marketing on Brand Co-Creation Value in the Context of Big Data. *Business and Economic Research*, (9):60-63. Doi:10.3969/j.issn.1002-5863.2022.09.016.
- [27] Zhang, M. M., & Zuo H. L. (2022). Research on the Design of Electric Toothbrush for the Elderly based on Perceptual Engineering. *Industrial Design*, (11):71-73.