Development And Functional Analysis Of Hearing And Speech Rehabilitation Applications Based On User Experience

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With the continuous development of the field of hearing and speech rehabilitation, from the early traditional rehabilitation training to today's intelligent and digital rehabilitation applications, this process has undergone significant technological evolution. The design of hearing and speech rehabilitation applications has gradually introduced technologies such as artificial intelligence, speech recognition, and virtual reality, aiming to provide a more efficient, convenient, and personalized rehabilitation experience for patients with hearing and speech disorders. This paper first reviews the development history of hearing and speech rehabilitation applications and analyzes its main characteristics and technological innovations at different stages.

In terms of functional analysis, this paper summarizes its core functional modules, such as speech training, hearing test, pronunciation correction and feedback system, by sorting out and classifying the functions of existing rehabilitation applications. Based on the EPI (Ecological Psychology Interaction) model, this paper compares the design features of each application from six dimensions: path, feedback, presentation form, interaction form, duration and goal. At the same time, combined with the user experience perspective, the advantages and disadvantages of different applications in terms of user satisfaction and rehabilitation effects are discussed. The research results reveal the advantages and disadvantages of current applications in functional design and user experience optimization, and put forward improvement suggestions, to provide theoretical support and practical reference for future application development and optimization.

I. History Of Hearing And Speech Rehabilitation

Online speech rehabilitation is implemented for patients with various speech and hearing disorders, including aphasia, apraxia of speech, swallowing disorders, speech and cognitive disorders, neurodevelopmental disorders, voice disorders, and autism-related speech disorders. Wait (J. Macoir, 2017). Compared with conventional speech rehabilitation treatment, the Internet online form has certain requirements on patients' physiological perception, cognitive behavior, subjective initiative, and technical operation ability. In addition, patients must be able to maintain concentration on the computer/mobile phone screen for a certain period and be willing to receive online speech rehabilitation.

Online speech rehabilitation on the Internet has been in development for over 40 years. In the early

exploration stage, the speech therapist observes the patient's speech performance through a television camera, and the patient follows the voice instructions to complete the training of target segments, words, phrases, and sentences. Remote speech rehabilitation at that time was not a true "online communication" because before Internet devices were popularized in the whole society, such research could only be done through "closed-circuit television equipment" and "telephone equipment" connecting two points and sending additional personnel to the site. On-site guidance can be completed (Wenjun et al., 2022).

Around 2005, with the popularization of the World Wide Web and the widespread use of real-time video equipment, online speech rehabilitation, an efficient and convenient rehabilitation model, was widely used by medical institutions and research teams in many countries, and its status in research and clinical practice began to be gradually established. During this period, countries began to pay attention to the construction of online equipment. Patients can use personal mobile phones or personal computer terminals with professional video conferencing software (encrypted) to complete online communication. Video software can also be tailored to the needs of both doctor and patient. While promoting the above projects, various countries have also begun to formulate online speech diagnosis and treatment standards. Different from ordinary online speech communication, online speech rehabilitation needs to follow strict ethical norms and practice access systems (D.R. Denton, 2005). The international community does not regard online speech rehabilitation as a simple extension of ordinary speech rehabilitation methods. Instead, it carefully examines the characteristics of speech rehabilitation and combines the particularity of "online" to formulate detailed ethical requirements and operating specifications for the entire speech therapy process, thus fundamentally ensuring the sustainable and healthy development of online speech rehabilitation.

With technological advancement and the gradual establishment of treatment specifications, online speech rehabilitation has entered a stable development stage since 2010. During this period, speech rehabilitation associations, national health departments, and government medical organizations in many countries incorporated the implementation process of online speech rehabilitation into the scope of the national standard medical system and began to explore implementation means and effects (Wenjun et al., 2022).

In recent years, with the rise of the concept of digital therapy, digital treatment methods have also appeared in different fields of disease treatment. Compared with the traditional manual intervention model, the digital treatment model has its unique advantages (Hangzhou Branhill Children's Rehabilitation Center, 2022). For example, digital equipment can not only accurately collect patient's voice, expression, behavior, and other data, but also conduct in-depth analysis based on AI algorithms to provide more accurate feedback to patients and rehabilitation therapists; during the treatment process, digital equipment can also generate data that exceeds human capabilities. A wide range of precise stimulation, truly achieving precise intervention and treatment. At the same time, hearing and speech rehabilitation training is a therapeutic behavior based on many repetitive operations. It partially replaces manual intervention through digital means, while expanding the boundaries of manual capabilities, bringing improvements in treatment efficiency and effects to the entire speech rehabilitation industry.

II. Hearing And Speech Rehabilitation Application Function Analysis

Hearing and speech rehabilitation applications refer to tool software for communication by hearing-impaired people (deaf people). By embedding technologies such as speech recognition and speech synthesis in the application, barrier-free information communication for hearing-impaired people is achieved. At the same time, artificial intelligence technology is used for speech rehabilitation to further improve the current situation of

communication between hearing-impaired people and the outside world (Hu Ting, 2020). After sorting out the hearing and speech rehabilitation service applications on the market, they were finally divided into three categories: social, tool, and medical health.

The social category focuses on communication, display, and sharing, such as Deaflife, Voibook, etc., which can attract more hearing-impaired people to bravely show themselves and make their voices, helping the hearing-impaired to better integrate into society and improve social interaction. Circle; the tool category mainly provides users with basic speech-to-text functions, such as iFlytek Hearing application, which has relatively simple functions. The most important design point is a smooth operation to ensure the normal use of users; medical and health applications use hearing tests and focus on hearing rehabilitation training, it can help users quickly understand their hearing conditions, thereby achieving the effects of hearing protection and treatment, and promoting the development of the traditional medical industry and the emerging Internet industry. Among them, the division between social and tool products is relatively vague, and there is some cross-integration. Therefore, they are often combined into social tool products for discussion.

As an emerging product, the hearing and speech rehabilitation application is developing rapidly and provides services for hearing-impaired people from social and medical aspects. However, at the same time, the hearing and speech rehabilitation application also has modules that need to be improved in various aspects.

The hearing service applications on the market are classified and sorted as shown in Table 2.1, and the main functions and representative applications of hearing and speech rehabilitation applications are sorted out to lay the foundation for later competitive product analysis and user research. The functional overlap rate of social and tool products is high, so these two types of applications are combined for analysis. At present, the division between social tool applications and medical health applications on the market is relatively blurry. Functions are beginning to merge, with multiple and comprehensive functions. Medical health applications are relatively biased toward the medical classification of rehabilitation treatment. This research direction mainly focuses on the analysis of social tool applications.

Application type	Functional services	Represent application
Social tools	1. Create a circle of friends for hearing-impaired people 2. Sign speech teaching 3. Online rehabilitation training 4. Video voice translation 5. Text projection 6. Deaf employment services and sign speech information 7. Hearing-impaired supplies mall	Voibook application Deaflife application iFlytek application
Medical and health	1. Hearing test 2. Expert consultation 3. Mobile phone hearing aids 4. Speech rehabilitation 5. Hearing-impaired supplies mall	Hearing treasure Angel's teachings Xiaonan heard lighthouse hearing test Health application (ios)
Table 2.1 Hearing and Speech Rehabilitation Application Classification		

Drawn by the author

Currently, the existing social tool applications on the market that serve the hearing-impaired mainly include Deaflive", "VoiBook", etc. Their main functions include vertical social networking, translation, employment, rehabilitation courses, etc., which meet most of the needs of users. However, the functions, interfaces, and interaction designs of current applications are still designed around the functional needs of users, without considering the user's experience needs in the process of using the product, resulting in serious homogeneity of current hearing service applications. At the same time, hearing-impaired people's demand for experience is gradually increasing. The experience of the current hearing and speech rehabilitation application can no longer meet the increasingly rich experience needs of users, and the design of the application is in urgent need of iteration.

Secondly, current hearing and speech rehabilitation applications do not segment users in detail enough. Existing applications are pursuing large and comprehensive functions and include all functions as much as possible, resulting in a lack of segmentation and positioning and a lack of precise control of users. This further leads to the fact that the current hearing and speech rehabilitation application market has not yet reached the effect of a hundred schools of thought contending. The functions are seriously homogenized, the market share is low, and it cannot even meet the most basic needs of users.

III.   Market Competitive Product Analysis

Existing hearing and speech rehabilitation applications can be divided into social tools and medical and health categories according to service objects and functions, including real-time translation, remote translation, social services, rehabilitation consultants, sign speech teaching and other functions. According to the comprehensive ranking of hearing and speech rehabilitation applications provided by the Qimai Data website, two applications, "Voibook" and "Deaflife", were selected for comparative analysis (Qimai, 2024).

In 2015, Zhao Wanru published a paper on "Research on User Experience Elements Based on Internet Products" and proposed "EPI: Expectation (expectation: demand, first impression, prediction), Progress (process: path, feedback, presentation form, interaction) Method, duration, goal), Impact (influence: memory, mood swings, self-change, self-feeling)" user experience element model. Although the paper follows the concept of user experience and builds and verifies the model around Internet products, However, it emphasizes the inseparable integrity between psychological expectations, behavioral processes, and influences during the experience process. The purpose of its research is to try to plan and influence user experience as a complete life experience (Xiang-Yang, 2019). Therefore, this research compared the selected products according to the six secondary elements of the EPI model: path, feedback, presentation form, interaction form, duration, and goals.

Path Comparison Analysis

Interaction can be understood as methods and tools to achieve experience, and these tools and means are in all aspects, and the path is an important point among them. Paths exist in many interactions. The shopping path in the mall and the browsing route in the amusement park are all designed. How the guests walk and what attractions and counters they will see along the way. The path is like a framework that determines how they unfold and experience it. The design of the path will affect indicators such as task success rate, error rate, and efficiency. If the path is complex and unreasonable, users will get lost and spend more steps and time to complete the task and explore how to operate. This also affects the product's learnability, awareness, and control capabilities. A simple path that conforms to the user's intelligent model is of course easier for users to master and understand how to use (Zhao Wanru, 2015).

The comparative analysis of the paths of the two applications is mainly carried out in detail from the aspects

of functions conforming to habits, function hierarchical order, control guidance, entrance settings, etc. As shown in Figure 3.1, the functional framework of the two applications is first sorted out. The homepage of Voibook is a translator, which is consistent with its positioning as a tool application; the homepage of Deaflife is Sound of Life, which is a circle of friends for the hearing-impaired group, which is consistent with the functions of its main social platform. The click operations of both applications are relatively simple, mainly focusing on the second and third-level menus, and there are no deep-buried functions.
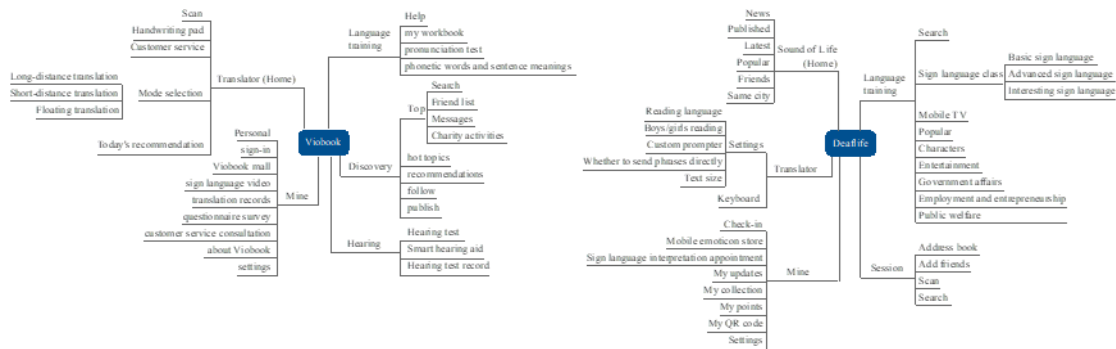

Fig 3.1 Comparison of Voibook application and Deaflife application frameworks
Drawn by the author

Taking the operation path of the short-range speech translation function as an example, the research analyze the functional paths of the two applications respectively. As shown in Figures 23.2 and 3.3, from the entrance point of view, Voibook's translation entrance is on the homepage, and the translation types are classified into three modes: long-distance translation, short-range translation, and floating translation. Swipe left or right to switch; to Deaflife The translation entrance is in the bottom navigation bar. Click to directly enter the translation interface. However, Deaflife does not distinguish the navigation icons. Translation, as the main tool, is not eye-catching in the navigation bar. Judging from the path, Voibook requires two actions of sliding and clicking to enter, while Deaflife only needs one click to enter. At the same time, Voibook has added a shortcut to the short-range translation interface to switch the current translation mode in the upper right corner. Users can reselect a new mode without exiting the current mode.

In general, both applications place basic translation functions in the main position of the application interface to facilitate users to make operational choices.

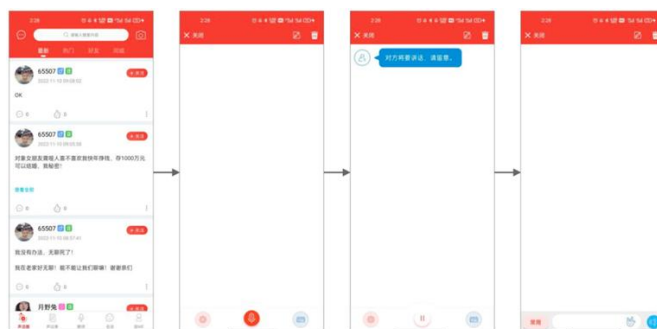**Fig 3.2 Voibook application translation function operation path**
Drawn by the author

Fig 3.3 Deaflife application translation function operation path

Drawn by the author

Feedback Comparison Analysis

The interaction between users and products in the experience needs to convey information to each other. Whether it is text, pictures, videos, or implied symbols, they are all carriers of information. In Internet products, feedback may be based on intermittent prompts, a progress bar, or a loading animation. Different scenarios require different forms of feedback. Internet products often require timely and frequent feedback to ensure smooth user use. After the user issues an instruction, the product gives feedback so that the user can know whether the operation is completed and how it is progressing. Feedback is an important channel for communication between products and users. The form and speed of feedback directly affect the user's operational flow and their understanding of the product (Zhao Wanru, 2015).

The comparative analysis of the feedback from the two applications is mainly carried out from the aspects of feedback speed, feedback form, etc. Timely feedback can reduce the anxiety generated by users during the waiting process, especially when facing a special user group of hearing-impaired people. Users' varying degrees of hearing loss make them more dependent on other sensory modalities. You will also be more dependent on the various feedback from the application. As shown in Figure 3.4, the importance of feedback effects is analyzed by comparing the default pages of the two applications. The left side is the friend interface of the Voibook application. When the friend interface is empty, Voibook application uses an illustration placeholder to remind the user that the current interface content is empty; the right side is the conversation interface of Deaflife Application. When the conversation box is zero, Deaflife has not provided any feedback for the time being. Users cannot accurately judge the reason why the interface is empty. Imperfect details will instantly reduce the user's experience.
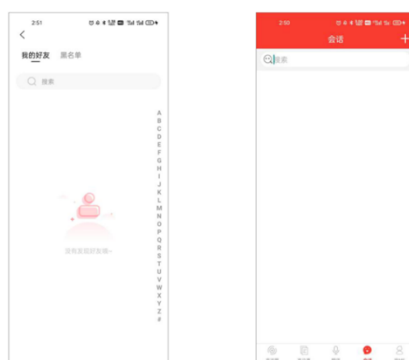

Fig 3.4 Comparison of default pages of Voibook application and Deaflife Application

Drawn by the author

Comparative analysis of presentation forms

The presentation of experience is often the aspect that users are most directly exposed to and perceive. The presentation form is related to the sensory design of the product, the arrangement, layout, and display of the content, etc., and is the most direct point of contact for users. Whether the presentation of the product is clear and easy to understand has a great impact on user use. It is related to how the experience is laid out and in what form, style, and color. Taking Internet products as an example, the presentation of the product involves a lot of vision and hearing. Visually, the product's interface, controls, icons, and animations are all objects and elements of the presentation. Presentation is the easiest way to arouse the user's feelings, stimulate the user's senses, and leave a certain impression on the user (Zhao Wanru, 2015).

As shown in Figure 3.5, the comparative analysis of the presentation forms of the two applications is mainly carried out from the aspects of audio-visual style, logo recognition, content presentation, layout, control position and form, etc.

Judging from the style of the logo, Voibook uses a deformation of the word "yin" to intuitively express the main functions of the application; Deaflife's logo uses a monkey hand-drawn by the application 's creators, which is cute and naive. In terms of the visual expression style of the interface, both applications use a white and red matching pattern to convey optimistic emotions and increase the emotional warmth of the applications. The interface layout is mainly based on visual expression, which tends to be flat and simple to understand, which can help hearing-impaired users quickly and accurately locate the required information. At the same time, the layout design of both uses the bottom tab navigation mode, which is more organized but lacks immersion, which is not conducive to an immersive experience.
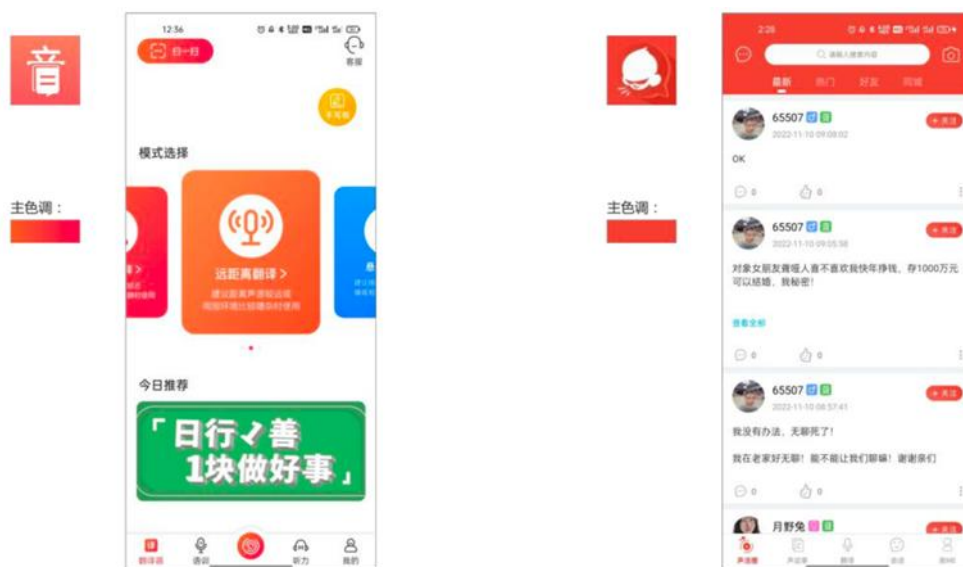

Fig 3.5 Comparison of presentation forms of Voibook application and Deaflife Application
Drawn by the author

Comparative analysis of interactive forms

The interaction method involves the comprehensive performance of other elements. In addition to the interaction mode, the interaction method also involves paths, feedback, presentation, etc. If the interaction method is too complex, the corresponding path will become longer and the number of steps will increase. It may be more

complicated for users to learn, and it will cost more to understand. The form in which feedback is presented also affects the effectiveness of the interaction. In user experience, there are various interactions between users and products and between users. Social products and tool products have different interaction modes. Social product experiences tend to be richer and more interesting. However, tool products may not have such rich interactive mechanisms, and users may simply operate the product (Zhao Wanru, 2015).

The comparative analysis of the interaction forms of the two applications is mainly carried out from the aspects of operation conformity to the scene, interaction model, recommendation accuracy, process interruption, interaction interference, content interference, mastery control, etc. Interaction is mainly divided into various forms such as user and product, user and creative team, user and user, etc. Both applications have added a circle of friends functions to meet users' interactive needs and attract potential users. However, the user group is relatively single and the interaction form is relatively simple. It is mainly the interaction between users and products, and there is a lack of content worthy of user exploration.

Duration Comparison Analysis

The time dimension in experience is often ignored by people. There is a stage from the beginning of the experience, the first impression to becoming a habit with a fixed frequency of use to familiar and unconscious use. If the duration of a single experience is too long, the user may be tired and unable to persist; if the time is too short, the user may feel bored and lack a challenge (Zhao Wanru, 2015). The comparative analysis of the duration of the two applications is mainly carried out from the aspects of task time, usage frequency, speed, usage stage, etc. At present, these two applications are mainly used in scenarios such as translation and voice conversion. The task time and duration are short, which can help users quickly complete translation operations, but it is difficult to provide users with an impactful experience in a short period. At the same time, both applications have launched social platforms for hearing-impaired people to display their lives and exchange information. However, they are not very active, are seriously homogenized with other social software, and do not fit the characteristics of users.

Goal Comparative Analysis

User behaviors generally have various purposes, and many interactive behaviors are goal-driven. "About Face" proposes that user goals are divided into three types: experience goals, ultimate goals, and life goals (Cooper et al., 2014). Life goals involve a wider range of factors, including long-term expectations, motivation, self-feeling, and other expected factors and influencing factors. The end goal represents the user's motivation for taking action when using a specific product. When a user picks up his phone and opens an application, he may have an expected result in mind, and the product can help the user accomplish these goals directly or indirectly. Research has found that if users have a strong goal to accomplish something, their tolerance and fault tolerance for the product will increase. As long as it succeeds, users can tolerate many other shortcomings in the process. If the goal is not achieved, the entire experience will be bad, satisfaction will be reduced, and the user will never use the product again. The setting of goals also affects usefulness and attractiveness. If the help and effect are very small after the user achieves the goal and does not touch the user's pain, the product may not be so attractive to users (Zhao Wanru, 2015).

The comparative analysis of the goals of the two applications is mainly carried out from the aspects of task completion, content quality, personal satisfaction, etc. At present, both applications can achieve the ultimate goal of serving users, but they cannot meet the user experience goals. As shown in Figure 3.6, taking the social circle as an example, the left side is Voibook's social circle, which attracts like-minded friends to discuss topics. The

right side is Deaflife's social circle, which has no classification of topics, only the distinction of popularity. However, the current user activity of both products is not high. The reason is that there is no segmentation of user experience goals. Different users have different experience goals, and it is necessary to explore the user experience needs more deeply.
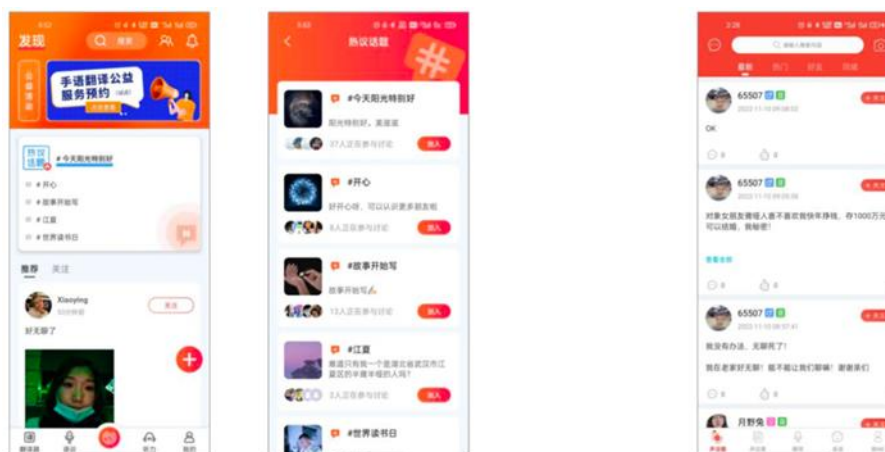

Fig 3.6 Comparison of social circles between Voibook application and Deaflife Application
Drawn by the author

IV.   Analysis Of APP Advantages And Disadvantages Based On User Experience

In terms of visual perception, the interface designs of Voibook and Deaflife applications are in line with the target group - the hearing-impaired. Deaflife's interface design is relatively regular, while Voibook's interface design is regular and flexible. In terms of interactive behavior perception, both applications start from the user's behavioral needs, reduce page jumps and operation steps, and reduce the difficulty of operation. Deaflife's main function is social software for the hearing-impaired, and it is more interesting in terms of interactive behaviors to attract users' interest. Voibook's basic functions are more powerful and can meet the different needs of users. Overall, both applications have smooth interaction logic and simple and easy-to-understand interface designs. However, they lack the exploration of users' emotional needs and immersion and only meet the users' functional needs.

As an important sensory system, the hearing system plays an important role in people's understanding of the world (Xiao Feng, 2023). The loss of the hearing sense of the hearing-impaired makes them more dependent on other senses (Feng Huirong, 2020). This research analyzes hearing-related product experience, aiming to help promote the development of hearing services and increase society's attention to the needs of the hearing-impaired. With the development of Internet technology, the development of hearing and speech rehabilitation applications has also gradually improved. However, as a new thing, hearing service applications are still in the exploratory stage, and there are still many problems that need to be solved:

User classification is blunt and general. Existing hearing and speech rehabilitation applications have a rigid and general classification of users and do not reflect the differences among user groups, resulting in the homogeneity of products. Hearing-impaired users are classified according to age groups and can be divided into hearing-impaired children, hearing-impaired teenagers, hearing-impaired college students, middle-aged and elderly hearing-impaired groups, etc (Hong Ming, 2023). Each group has different experience needs. Therefore, the premise of design is to clarify the user group and summarize their goals for the experience.

The Island Effect of the hearing-impaired Community. Hearing-impaired users mainly use the translation function of the application. This function has a short duration, making it difficult for users to enter a flow state, and therefore cannot improve the immersion of using the application. Immersion is the premise that prompts users to further experience. Immersion experience is a positive and positive psychological experience. It will make individuals feel great pleasure when participating in activities, thereby prompting individuals to perform the same activities repeatedly without getting bored (Wu Sumei, 2018). How to allow users to stay and experience as much as possible in the application requires theoretical support from experience design.

Applicable scenarios are limited. The users of the Hearing and Speech Rehabilitation application are mainly hearing-impaired people and hearing people who need hearing services, and it has not broken the "social isolation" (Wei Yingjie, 2012) of hearing-impaired people. The reason is that the functions and experience of the application are mainly designed for the hearing-impaired group, and the social platform created will not increase the communication opportunities between the hearing-impaired group and the hearing-impaired group and is not conducive to the communication and communication of the hearing-impaired group.

The page is complex and the information is messy. Affected by technology, the usage scenarios of existing hearing and speech rehabilitation applications are limited. For example, the real-time translation function that is most urgently needed by hearing-impaired users mainly relies on voice translation technology, but this technology has higher requirements for use scenarios. When users are in a noisy environment, speech recognition technology is limited, which to some extent also affects the smoothness of hearing-impaired users' ability to communicate with hearing people when they go out (Vivo, 2021).

The page is complex and the information is messy. According to the principle of sensory compensation, the hearing loss of hearing-impaired people will be visually compensated, and the visual experience mainly comes from the design of the interface (Xingying Zhang, 2023). While pursuing comprehensive functions, the application should also distinguish between the primary and secondary needs of users and classify and organize user needs. The existing hearing and speech rehabilitation application interface design is messy, and trying to list all functions on the homepage will only make it difficult for users to distinguish effective information among the numerous pieces of information. Secondly, familiar interfaces and interaction processes can help users use them skillfully, but existing hearing service applications have fallen into a trap of overly familiar interfaces. Blindly imitating other products will only make their products lose their market competitiveness.

Low usage penetration. The number of hearing-impaired people in China ranks among the top in the world, but there are very few interactive designs dedicated to serving the hearing-impaired people, which brings troubles to their daily lives of the hearing-impaired people (Xu Cheng, 2019). Secondly, the state's strategy for hearing-impaired people is more from the perspective of people's livelihood security, and the significance of the design is to provide more exclusive services for hearing-impaired people based on their psychological aspects.

After analyzing the two applications on the market, it is not difficult to see that the hearing and speech rehabilitation service applications are trying to list all functions and cover all hearing-impaired groups, but the result is the loss of user groups. It has gradually become a design trend for applications to list from large and comprehensive functions to small and refined functions to enhance user experience. This trend is also conducive to applications to seize users and the market and helps to improve user experience, thereby increasing the target group. continuous use intention and enhance user loyalty to brand products.

This paper systematically analyzes the development history, functional design and user experience advantages and disadvantages of hearing and speech rehabilitation applications, and reveals the advantages and

disadvantages of current applications in terms of technical implementation and user experience design. The research results based on the EPI model and user experience theory show that different applications have significant differences in six dimensions: path, feedback, presentation form, interaction form, duration, and goal. Although some applications have achieved good results in voice training and personalized feedback mechanisms, further improvement is still needed in the combination of user experience optimization and technological innovation.

First, the combination of perceived ease of use and perceived usefulness should be strengthened, with the core goal of improving user experience. The interface design of the application should be more in line with the user's cognitive habits and operational needs, and improve the user's learning efficiency and satisfaction by optimizing the information presentation and interaction form. At the same time, attention should be paid to guiding the optimization of the user's learning path and training process to ensure that the application can provide clear navigation and real-time feedback mechanism.

Secondly, the performance of the application in terms of perceived value should be enhanced. By introducing innovative functions and intelligent analysis technology, users can be provided with personalized rehabilitation plans and refined training guidance. Combined with data analysis and user feedback, the functional modules and training content of the application can be dynamically adjusted to better meet the personalized needs and expectations of users.

In addition, in terms of the balance between technology optimization and user experience, the mediating role of innovation in user experience should be further explored. The introduction of technology should not only stop at improving functions, but also enhance users' continued use intention by improving their emotional experience and satisfaction. Future application design should achieve true innovative value by optimizing user experience while maintaining technological advancement.

The research in this paper provides theoretical support and improvement suggestions for the design of hearing and speech rehabilitation applications, and provides practical references for the combination of future applications in technology innovation and user experience optimization.

Acknowledgment

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