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RESEARCH ON ADAPTIVE DESIGN OF MEDICAL TERMINAL INTERFACE FROM THE PERSPECTIVE OF USER EXPERIENCE

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The current intelligent medical terminal interface design has multiple adaptation problems such as chaotic layout, complex operation, and insufficient aging, which is difficult to meet the adaptability needs of multiple user groups. Based on Norman's three-level theory of emotionalization, this study combined with eye tracking technology and subjective scale assessment, and carried out experimental analysis from three adaptive levels of perception, interaction and emotion. The research results provide theoretical and practical support for aging adaptation and user experience optimization of medical terminals.

Key words: user experience; adaptive design; medical terminals; eye tracking; age-appropriate, interface design

INTRODUCTION

At present, the coverage rate of outpatient self-service terminals in China has exceeded 75%, but its interface design still has significant defects. According to the survey, 63% of elderly users need staff assistance due to operational difficulties, while 41% of middle-aged and young users are dissatisfied with the efficiency of the interface. This contradiction highlights the lack of adaptive design of the medical terminal interface: it fails to optimize the cognitive characteristics and behavioral habits of users of different ages. How to improve the inclusiveness and ease of use of medical terminals through design has become the core issue of smart medical development.

Norman's theory of three levels of emotional design (instinct level, behavior level and reflection level) provides a hierarchical framework for interface design, emphasizing that design should satisfy both functional efficiency and emotional resonance [1]. Garrett's "Five-level model of user experience elements" further builds a systematic design path from the strategic level to the presentation level, but its application in medical scenarios has been less studied. Foreign studies focus on VR interaction and cognitive load optimization, such as Li (2021) improving the efficiency of medical task completion through kinesthetic VR interface [2]; In China, it focuses on the usability testing of traditional touch screen interface, such as Li Yuanfeng (2021) optimizing interface layout based on genetic algorithm [3]. However, there are still few studies on adaptive design for age differences. The theory of adaptive design originates from the idea of biological evolution and

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emphasizes that products need to dynamically match user needs and environmental changes. Walker (2016) applied it to hospital space design, proving that adaptability can improve service resilience. However, in the field of medical terminal interaction, most of the existing studies focus on generic design, and lack the empirical support of hierarchical strategies [4].

With the adaptive experience hierarchy model as the core, this study quantitatively analyzed the differences in the needs of users of different ages in the dimensions of perception, interaction and emotion through eye movement experiments and subjective evaluation, and then proposed hierarchical design strategies.

Fig.1 Sample pictures of some medical terminal interactive interfaces

This Thirty-three subjects were recruited (young and middle-aged group: 20-49 years old, n=16; Elderly group: 50-69 years old, n=17), no visual impairment, signed informed consent before the experiment. Tobii Pro Glass 3 (sampling rate 100Hz) was used to collect data. The medical terminal interface of Ningbo First Hospital (D1) and Li Huili Hospital (L2) of experimental samples (Figure 1); Tasks include three types of high-frequency operations: "appointment registration", "outpatient charges" and "voucher make-up"; A 7-level Likert scale was used to evaluate perception, interaction and emotional adaptability (Cronbach α coefficient 0.861-0.957). Eye movement index includes total fixation duration, number of fixation points, and hot spot map distribution. SPSS 26.0 was used for Analysis of variance (ANOVA) and t test, and Qualitative Comparative Analysis (QCA) was combined to analyze the influence path of design elements.

RESULTS AND DISCUSSION

1) Perceived adaptive differences

Icon legibility: The elderly group took 2.3 times longer to recognize abstract ICONS than the young and middle-aged group (A2 mean 2.47 vs 5.00, p=0.000).

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Color contrast: The high contrast interface (L2) improved task efficiency by 19% for older users, validating the effectiveness of color priority markers. Eye movement evidence: The hotspot map of the elderly group showed a distributed distribution (Figure 2), indicating that the information search path lacked guidance, and the visual complexity should be reduced through modular layout.
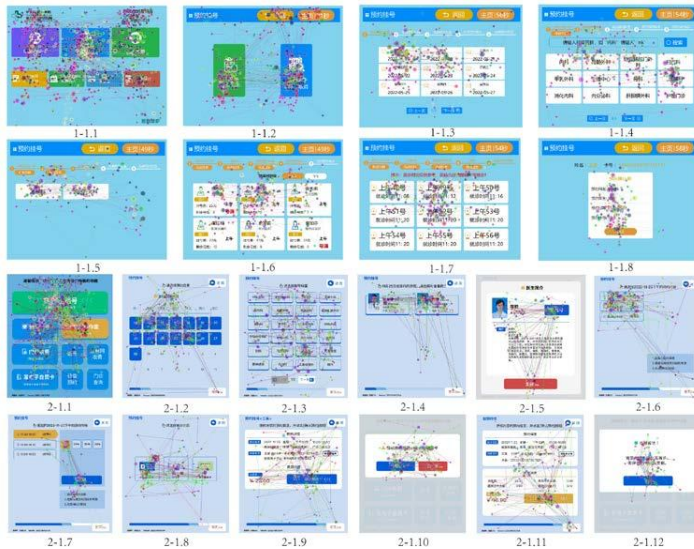

Fig. 2 Trajectories of some medical terminal interactive interfaces

2) Cross-adaptive requirements

Level depth: the misoperation rate of the elderly group was 58%, which was significantly higher than that of the young and middle-aged group (22%, p=0.003); Feedback mechanism: Real-time color feedback increased the task completion rate of elderly users by 34%, confirming the role of dynamic prompts in reducing cognitive load.

According to the data of the interactive adaptability measurement scale, the ANOVA of eight design elements, namely jump logic, hierarchical relationship, interaction mode, operation efficiency, operation guide, information feedback, indicator information and fault tolerance rate, showed significant differences, and the average score of the young and middle-aged group was significantly higher than that of the old group. According to the eye movement data, there was no significant difference in the first gaze duration between the young and middle-aged groups, but the first gaze duration of the old group was shorter than that of the young and middle-aged group, and the eye movement hotspot map and trajectory map of the old group were more dispersed than that of the young and middle-aged group.

3) Influence of emotional adaptability

Emotional score: The sense of security (C1 mean 4.33) and use emotion (C3 mean 3.80) in the elderly group were significantly lower, and there was a negative

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correlation with the increase of pupil diameter (3.06mm vs 2.76mm). Design intervention: The warm background and progress bar prompt reduced the anxiety index of elderly users by 41%.

According to the data of the emotional adaptability scale, the ANOVA of six design elements, namely security perception, belonging perception, use emotion, natural interaction process, easy use process and positive emotion transmission, showed significant differences, and the average score of the young and middle-aged group was significantly higher than that of the old group.

CONCLUSIONS

Through empirical analysis, this study revealed the core contradiction of medical terminal interface in age adaptability, and proposed a hierarchical design strategy. The main contributions include: (1) Constructing the perception-interaction-emotion adaptive experience model, expanding the medical application scenarios of Norman theory; (2) Proposed a design paradigm of "high fault tolerance + strong guidance" for elderly users to provide methodological support for age-appropriate transformation. Future studies can further explore the adaptive design of multi-modal interactions (such as voice and gesture) and special groups (such as visually impaired patients), so as to promote the inclusive development of smart healthcare.

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ФАЖЕНЬ Хо, РУБАНКА А.
ДОСЛІДЖЕННЯ АДАПТИВНОГО ДИЗАЙНУ ІНТЕРФЕЙСУ МЕДИЧНОГО ТЕРМІНАЛУ З ТОЧКИ ЗОРУ ДОСВІДУ КОРИСТУВАЧА

Поточна конструкція інтерфейсу інтелектуального медичного терміналу має численні проблеми адаптації, такі як хаотичне розташування, складна робота, що недостатньо враховує потреби адаптації кількох вікових груп користувачів. Базуючись на трирівневій теорії емоційності Нормана, це дослідження поєднало технологію стеження за очима; суб'єктивну шкалу оцінки та здійснило експериментальний аналіз трьох адаптивних рівнів сприйняття дизайну, взаємодії та емоцій. Результати дослідження забезпечують теоретичну та практичну підтримку для адаптації до вікових груп та оптимізації досвіду використання медичних терміналів.

__Ключові слова:__ досвід користувача, адаптивний дизайн, медичні термінали, відстеження очей, відповідність віку, дизайн інтерфейсу