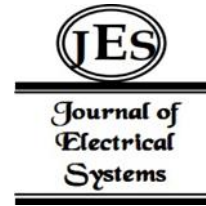


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A Study on the Design of Smartphone APPs Targeting the Behavioral Characteristics of the Elderly under the Background of Artificial Intelligence



Abstract: - As a practical technology, artificial intelligence has an important impact on the development of mobile media. Intelligent analysis and understanding of user behavior and realistic personalized service have become key factors in APP development. At the same time, China has entered the development stage of a deeply aging society, and the discussion on the "age-appropriate" design of smart phone APPs for elderly users is not sufficient. Through literature review, the physiological characteristics of the elderly are combed and analyzed. With the help of field interviews, the behavioral characteristics of the elderly are deeply studied and their characteristics are summarized. Based on this, the design and practice of smart phone "aging" APP are completed, and the theoretical model is constructed. It is hoped to provide reference for the design, development and renewal of digital products for the aged in China.

Keywords: Artificial intelligence; Elderly, Behavioral Characteristics, Urban Community, Smartphone APPs.

I. INTRODUCTION

With the development of artificial intelligence, the integration of technology and human wisdom has been further enhanced [1]. Its application in the information circulation of mobile media will greatly change the behavior pattern and cognition of user groups. In this context, it is of practical significance to discuss the behavioral characteristics of the elderly and the design and practice of smart phone APPs.

According to the data from the "Seventh National Population Census Bulletin," "China's population aged 60 and above has reached 264 million, accounting for 18.70% of the total population. Among them, the population aged 65 and above is 190.64 million, accounting for 13.50%. China has entered a stage of deep aging society" [2]. By the end of 2021, the urban resident population in China reached 914.25 million, with an urbanization rate of 64.72%. The proportion of elderly population in urban areas is 15.82%. It can be seen that Chinese society is entering a stage of deep "aging," while the urbanization process is also accelerating.

Against this background, the phenomena of "empty-nest elderly" and "migrant elderly" are becoming increasingly serious. How to improve the cultural and living quality of the elderly, enabling them to quickly integrate into new lifestyles, has become an urgent issue for all sectors of society. According to a survey conducted by the "China Youth Daily" on the elderly population, "89.0% of respondents feel that the emotional support for empty-nest elderly is severely lacking" [3]. Among them, intergenerational communication, friend interaction, participation in social activities, and other emotional socialization are the main issues. At the same time, the medium of "virtual socialization" generated by the information society also affects various aspects of elderly life communication. More elderly people hope to use "virtual socialization" media to obtain emotional satisfaction and social value.

II. ANALYSIS OF PHYSIOLOGICAL AND BEHAVIORAL CHARACTERISTICS OF THE ELDERLY

A. *Physiological Changes in the Elderly*

With age, there is a decline in the physiological status, functions of bodily tissues, organs, and systems, as well as physiological indicators reflecting these states and functions. The cognitive, behavioral, and needs of the elderly also change accordingly. When people grow up to older adults, they meet physical declines such as blurred vision, tremor in hands, and arms, slowness of movement, or postural of a humpback. [4]. As shown in Table 1.

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Table 1: Analysis of Physiological Characteristics of the Elderly and Design Requirements

Physiological Changes	Specific Description	APP Design Requirements
Vision	Hearing impairment is one of the most common issues that older adults' experience [5]. Central visual function declines, lens gradually flattens, refractive power changes, corneal sensitivity decreases, sensitivity to weak and strong light decreases, color discrimination decreases, image visual acuity decreases, etc.	Text size, layout structure, and color application should conform to the visual physiology of the elderly.
Hearing	Hearing begins to decline, secretion and cleaning functions of the external auditory canal weaken, inner ear function declines accordingly, auditory nerve cells decrease or undergo apoptosis. Men's hearing decline mainly focuses on frequencies between 3000 and 6000 Hz, while women mainly focus on frequencies between 550 and 1000 Hz.	Prompt tones should have increased base volume, and sharp prompt tones should be avoided.
Touch	Manifests as skin wrinkles, decreased tactile sensitivity, dulled pain perception, decreased sensitivity in operating, etc.	Functional design should be concise, distances between elements should be increased to facilitate accurate issuance of operating instructions by the elderly, while avoiding fine operations and complex gesture movements to reduce the difficulty of operation for the elderly.
Cognitive Ability	Manifests as declining memory, inability to remember large amounts of information in a short period, easy forgetfulness, attention distraction, declining learning ability requiring constant repetition and sufficient time, slow pace, and a preference for learning things of personal interest.	Hierarchical information design and simple logic, strong correlation in functional architecture, addition of readable text explanations, accurate and clear information classification, reduction of the amount of information requiring comprehension.

It can be seen that changes occur in the physiological functions of the elderly, especially when related functions decline. Therefore, in the design of smartphone APPs for the elderly, adherence to ergonomic design principles is necessary, closely aligning with the visual, auditory, perceptual, and cognitive physiological characteristics of the elderly.

B. Behavioral Characteristics and Needs of the Elderly

The second article of the "Law of the People's Republic of China on the Protection of the Rights and Interests of the Elderly" clearly stipulates: "The elderly refers to citizens aged sixty and above" [6]. From the perspective of social anthropology, individual behavioral characteristics are closely associated with economic status, physical health, cultural literacy, and cognition, revolving around interactions between family, friends, and society. Virtual social behaviors arising from emotional deprivation among "empty-nest elderly," "migrating elderly," and retired elderly mainly revolve around children, friends, and society. Therefore, the research process is as follows:

The study conducted general interviews with the staff of the Zhumingshan community in a random manner. Based on the predetermined script of the interviews and the relevant questions posed, free discussions were held with the interviewees, who were not required to respond in any fixed format. In this process, detailed information on the social needs of the elderly was obtained, along with their attitudes and current status regarding the use of smartphone APPs. The interviewees were free to describe events, attitudes, and feelings, and the interviews took approximately 40 minutes.

Interviews were conducted with both staff members and elderly individuals at the community elderly service center. Considering the special nature of the work of community staff, semi-structured interviews were conducted in two sessions, each lasting about 20 minutes, with the elderly individuals completing the interviews in one

session. Additionally, due to the particular nature of some questions, it was not convenient to directly elicit opinions, so oral expressions were used during the interviews according to the interview script. The following text was compiled based on the interview content:

1) *Elderly people's current living situation*

The traditional family structure centered around elderly people has transitioned to one where young children and their small families take precedence, often leading to separation from their parents, which has become a common practice. However, as elderly individuals age, their need for emotional support from their children, grandchildren, and others becomes more urgent. This emotional connection needs to be realized through communication, making the desire for intergenerational communication stronger among the elderly.

With the aging population becoming more pronounced, the overall number of elderly individuals is gradually increasing. Finding ways to engage elderly people in social activities and allowing them to express their value becomes even more meaningful. In the Zhumingshan community, many elderly individuals possess a high level of professional knowledge, with some even being scholars or experts, and they are more willing to participate in social activities.

Some elderly individuals experience reduced contact with former colleagues, classmates, and old friends after retirement, which also affects their lives. Additionally, some elderly people move to Huanggang city with their children, and adapting to a new environment can be challenging for them. Maintaining contact with old friends and making new ones are both driving forces and needs for their social interactions.

2) *Elderly people's intergenerational relationships, interpersonal communication, and social participation*

Elderly people face two levels of interpersonal communication: the first level is within the family, including spouses, children, and grandchildren. These are the most easily accessible and intimate relationships for elderly people. However, if they are widowed, divorced, or have no children or children who are not nearby, their sense of loneliness and isolation can be significantly deepened, affecting their mood and quality of life in their later years.

The second level includes former colleagues or friends. Due to the reduction in social activities after retirement, contact with colleagues decreases significantly. Meanwhile, neighbors and friends with similar interests and hobbies often replace workplace interactions. Social participation mainly manifests in activities related to hobbies and interests.

3) *The current use of smartphone APPs by elderly people in the community*

The majority of elderly people in the community use smartphones, while a small number still use feature phones due to illiteracy or economic reasons. Among those using smartphones, commonly downloaded and used APPs include WeChat, TikTok, and Kwai, primarily focusing on social chatting, short videos, electronic payments, and entertainment.

4) *Purposes of elderly people using smartphone APPs for communication*

Firstly, for entertainment and leisure, to enhance the quality of life for elderly people, help pass the time, alleviate loneliness, and relax. This includes APPs for short videos, and games.

Secondly, for convenience in daily life and to keep up with digital trends, allowing elderly people to feel connected to society and maintain a youthful mindset. This is evident in APPs for electronic payments, online shopping, and online appointments.

Additionally, for facilitating communication with family members, colleagues, and friends, including various chat APPs like WeChat groups, enriching and facilitating the leisure activities of elderly people.

5) *The most common difficulties elderly people encounter when using smartphone APPs*

The main difficulties include: small font size on APP interfaces, excessive advertisements, frequent pop-up windows, confusion about the functions of pop-ups and how to close them, and complex operations. Particularly with the development of digitization, APPs related to elderly people's lives such as social security retirement benefits and hospital online appointment booking, although they have added features like large fonts and personalized services for the elderly, still have the above-mentioned problems that need further improvement.

In addition, interviews with elderly people revealed the following characteristics when using smartphone APPs:

They are cautious when clicking on social APPs on their phones, carefully checking information and functions, fearing operational errors and insecurity.

In communication and social functions, elderly people prefer to use more intimate terms to label contacts, such as "son," "daughter," or "big brother," rather than using their names.

They have difficulty understanding the functions of icons and prefer a combination of graphics and text.

They are not keen on exploring unfamiliar APP functions and prefer to use conventional and popular functions.

They prefer bright colors, especially warm tones, and dislike black (dark-colored) themes.

When using social APPs on their phones, they prefer voice input over typing. If they have to type, they prefer a nine-key keyboard layout and are concerned about making typing mistakes. They enjoy sharing music, inspirational quotes, or motivational stories on their social circles and are prone to trusting online content easily, with weaker abilities to filter and discern information.

The practicality of the smartphone APP interface is the most important for elderly people, followed by aesthetics. The layout of the interface should be large and clear, with a hierarchical structure in content presentation to avoid confusion. Both images and text should be large. Additionally, elderly people tend to be slow in accepting new things, and while they like APPs, they prefer default settings and do not use them deeply.

III. CHARACTERISTICS OF ELDERLY PEOPLE'S SOCIAL BEHAVIOR

Behavioural and physiological outcomes are correlated [7]. Through the above interviews, it was found that virtual socialization mainly includes intergenerational communication, interpersonal relationships, and participation in social activities. These three aspects affect the culture and quality of life of the elderly. Social networking APPs on smartphones have become an important supplement to elderly people's social interactions. The existing user groups of social networking APPs on smartphones are not segmented by age, resulting in many problems, and there are few APPs specifically designed for the elderly. The main behavioral patterns are as follows:

A. *Sense of Social Helplessness*

The cognitive, perceptual, motor, and memory abilities of individuals will decline with age [8]. Therefore, based on the physiological characteristics of the elderly, Enhance the overall quality and accessibility of these APPs to better engage and empower consumers to take necessary actions to age in place [9]. Elderly people's attitudes towards socializing through smartphone APPs mainly manifest in two aspects: on one hand, they have a strong willingness to use them due to their real needs for intergenerational emotions, friend communication, and participation in social activities. On the other hand, they are unfamiliar with virtual socialization based on smartphone APPs, and even perceive uncertainty about virtual social contacts. For example, elderly people are not accustomed to text input, interface operations, and communication methods on smartphone APPs.

B. *Weakening Sense of Identity*

The weakening sense of identity mainly manifests after elderly people retire from urban community life, where their social status, power, and voice are all weakened. In actual surveys, a large proportion of respondents were retired teachers, doctors, and corporate employees. After retirement, they feel that their own value is weakened, and their sense of identity is significantly reduced compared to before. They are frustrated because their opinions do not carry as much weight as they used to. For example, they may struggle to participate in social activities, not know where to start, or where to get information. The intergenerational relationship among elderly people in China is a special emotion that represents the intimate emotional characteristics between the elderly and their grandchildren. There is a strong attachment between the elderly and children, which can affect their judgment and preference for similar behavioral characteristics and make it easier to establish intimate connections [10]. Some miss their grandchildren very much but cannot visit them frequently due to physical distance and practical reasons.

C. *Estrangement from Friend Circles*

With the process of urbanization, many elderly people have moved from rural areas to cities or relocated to other cities with their children, resulting in a situation where they are separated from friends with similar interests. It becomes difficult for them to find suitable friends and cultivate genuine friendships in their new living environment. During the interviews, it was observed that many elderly people in the community had migrated, and there was a high proportion of elderly people from outside the area who were unfamiliar with each other, resulting in superficial interactions. These elderly people are eager to have certain places and suitable times to get to know their neighbors.

IV. PRACTICE OF DESIGNING "JOYFUL AGE" SMARTPHONE APP TO MEET THE BEHAVIORAL NEEDS OF THE ELDERLY

One of the core functionalities of mobile APPs is the so-called push notifications [11]. In the design process of the "Joyful Age" smartphone APP, the user model serves as an important foundation and reference for design, which is crucial for enhancing the elderly user experience and meeting their needs. Considering the social needs and behavioral characteristics of elderly users, it is essential to establish a research model that conforms to the cognitive characteristics of elderly users, thereby achieving functional and experiential design. (See Figure 1)

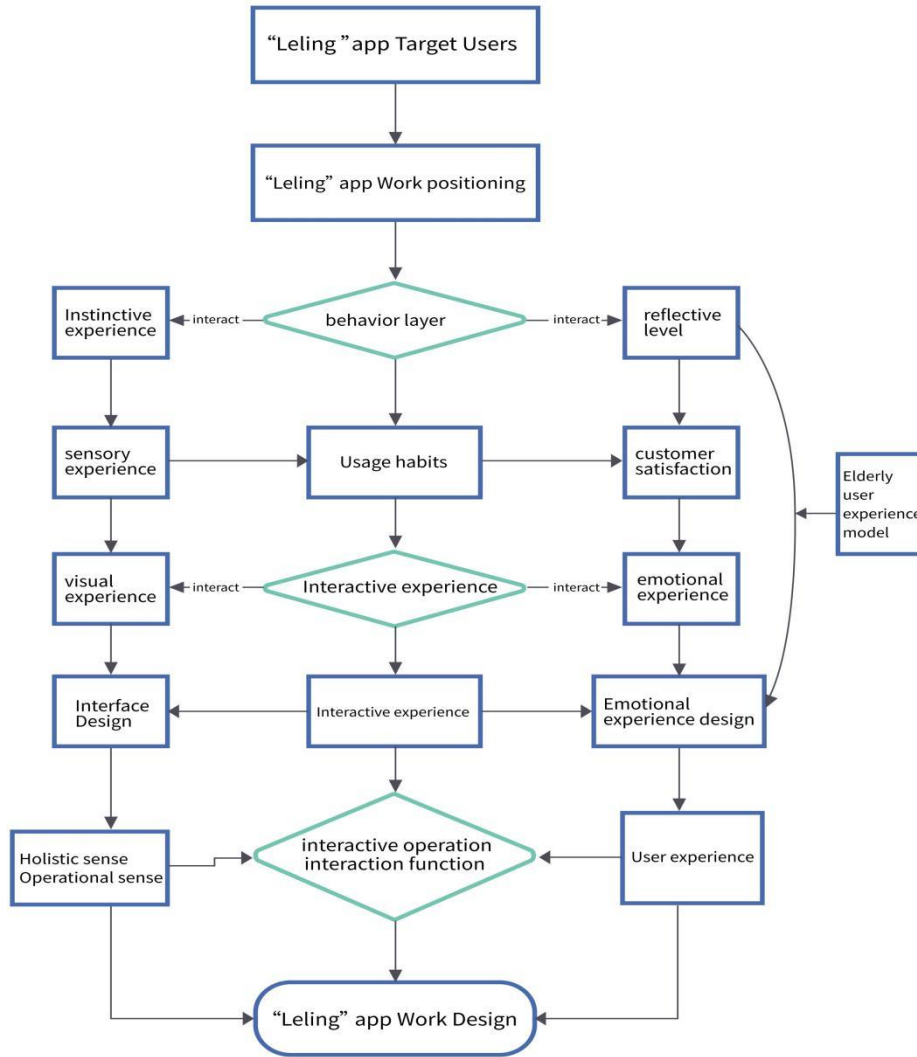


Figure 1: Design Model of the "Joyful Age" Smartphone APP (Image Source: Drawn by Zhao Zhaopo, 2023)

A. Design Positioning

The essence of design is for designers to encode and convey the information they want to convey to users, aligning it with their familiar mental models and guiding them to take expected actions [12].

User Group Positioning: The main target users are elderly people aged 60 to 70 in urban communities who have experience using smartphone APPs for social interaction. They are a group with social activity needs such as intergenerational communication, interpersonal relationships, and participation in social activities through smartphone APPs. The "Joyful Age" APP is designed for the cultural life, especially social activities, of these elderly people.

Functional Positioning: The "Joyful Age" APP is a social application designed to improve the cultural and life quality of the elderly. Through this APP, elderly users can engage in emotional communication with their children, grandchildren, etc., as well as friendly exchanges with friends and colleagues. They can also publish or obtain information about community activities to increase their participation in social activities and thus improve their cultural and life quality.

Style Positioning: The information architecture of the "Joyful Age" APP is designed with the core concept of "simplicity and ease of use" to accommodate the physiological characteristics of the elderly, reducing the burden of operation and memory through a simple hierarchical structure. The visual design of the "Joyful Age" APP primarily adopts warm color tones, large color blocks, and a flat minimalist style. In terms of interaction design, it highlights functional modules, emphasizes playful micro-interactions, and provides a user emotional experience mindset full of warmth and well-designed design.

B. Information Architecture Design

Information architecture refers to the unified management of virtual information such as images, text, and sound in interface information [13]. The "Joyful Age" APP helps the elderly access social networks more smoothly through age-friendly transformations. After determining the tasks and positioning of the "Joyful Age" APP, it is necessary to carefully comb through its information and functions to construct a rational and clear information architecture. The "Joyful Age" APP covers multiple functional modules such as intergenerational communication, interpersonal communication, Q&A interaction, and participation in community activities. Emotions, which are now commonly portrayed in social media, play a fundamental role in decision making [14]. In terms of hierarchy, simpler functions and fewer cumbersome steps are more in line with the elderly's action and memory experience, which has the potential to garner social support and stimulate cognitive reappraisal [15].

Table 2: "Joyful Age" APP Information Architecture Lis

Home	Community	Activities	Messages	My Account
Banner	Latest Community	Search Activities	New Likes	Edit Profile
Happy Family	Join Community	Post Activities	New Questions	My Fans
Friends Circle	Switch Community	Sign Up for Activities	New Help	My Followings
Zhu Ming Mountain Community	Post Threads	Join Old Friends Group	Recent Chats	My Dynamics

Due to the physiological characteristics of elderly users, in order to enable the elderly user group to quickly familiarize themselves with the functions and operation modes of the "Joyful Age" APP, the main design concept in the information architecture is based on the "simplification" of hierarchical functions and tasks. Specifically, the main information architecture pattern is within "three levels" as shown in the information architecture of the "Joyful Age" APP (as shown in Table 2).

Elderly users operate five main functions on the homepage: Home, Community, Activities, Messages, and My Account. Clicking on the relevant page will display the corresponding specific operations. Elderly users can browse information related to cultural life, family, and friends' circles on the "Home" page. Additionally, according to survey data, the demand for intergenerational emotional communication among the elderly is extremely strong. They yearn to stay in touch with their children at all times. Therefore, in this design, a "Family" module is set up, where clicking on it will lead to a first-level independent chat interface for the family. In this interface, users can send messages to their children in real-time without interference from other individuals, reducing the visual and behavioral confusion caused by dealing with diverse personal information for elderly users. Next is the presentation of the "Friends Circle" function, which is an important aspect of social interaction for the elderly in this design strategy. The friends' circles are mainly clustered with independent interfaces and communication spaces.

Lastly, elderly participation in social activities primarily relies on community engagement. Users can not only follow activity information and respond to activity content but also publish activity information and progress. This module is crucial for enhancing elderly participation in social and cultural activities, and it is also a distinctive feature of the "Joyful Age" APP.

C. Task Flow Diagram

The design of the "Task Flow" is based on three dimensions: functional requirements, operations, and user experience (as shown in Figure 2). The prototype of the "Joyful Age" APP is designed according to the functional modules.

Figure 3 illustrates the interaction flow diagram of the login and transition pages of the "Joyful Age" APP on mobile. The author used Adobe XD software to complete the design of the mobile interface prototype.

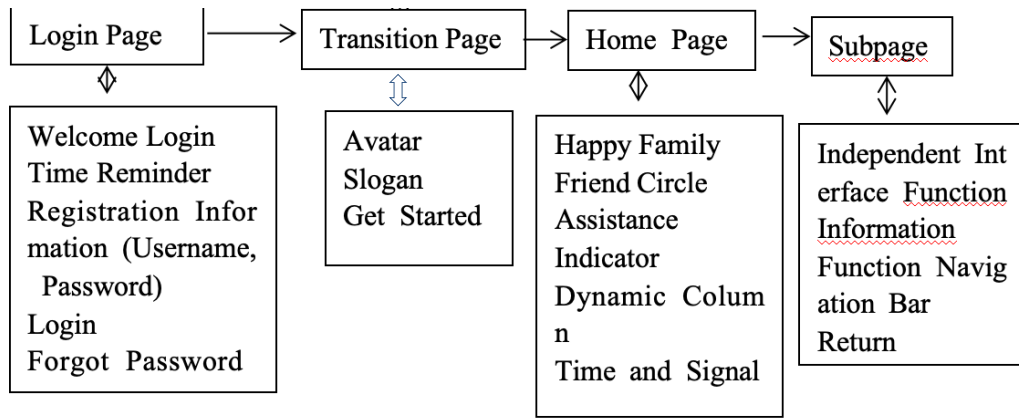


Figure 2: Joyful Age APP Task Flow Diagram (Image Source: Drawn by Shao Zhaopo, 2023)

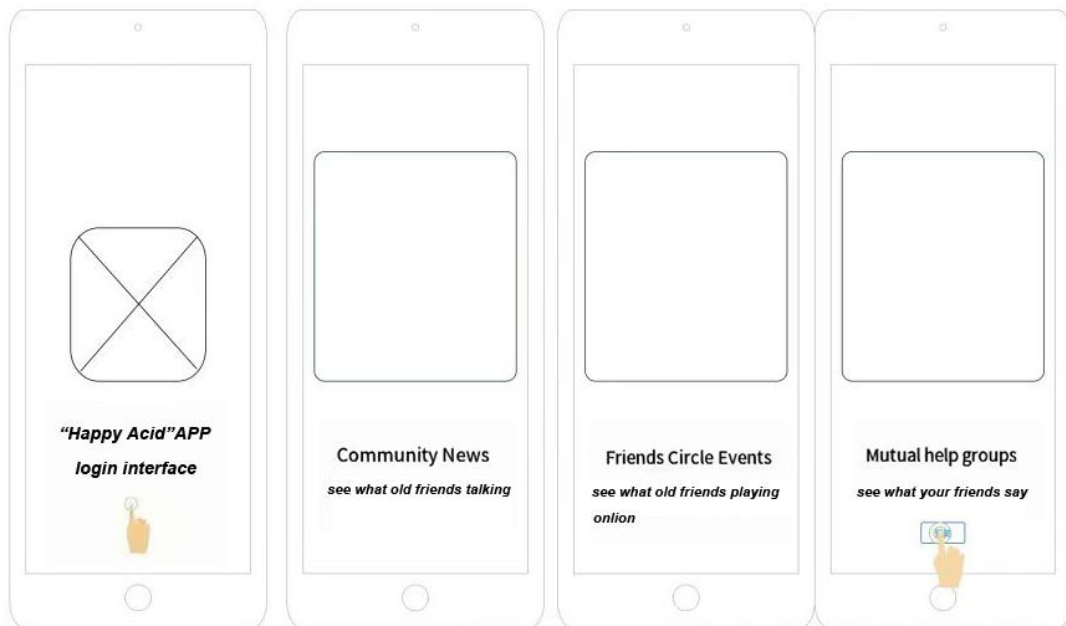


Figure 3: Joyful Age APP Login-Transition Page Flow Diagram (Image Source: Drawn by Shao Zhaopo, 2023)

D. Interface Visual Design

Visual interface design is related to emotional and action readiness theories [16]. The interface architecture design of the "Joyful Aging" APP for smartphones focuses on the design of user experience information for the elderly. It mainly completes the functional hierarchy design and information layout design of the elderly user interface, striving for the elderly users to quickly find the required information and emphasizing the reduction of cognitive costs and improvement of efficiency.

In this study, visual design was conducted based on low-fidelity prototypes. The key to visual design is not only to beautify the interface and differentiate different areas but also to help the interface better convey information to users. Through design methods such as color, layout, symmetry, spacing, rhythm, etc., a more humanized interface is created [17]. The two key elements of interface visual design are the choice of colors and the layout of the interface. Reasonable design can effectively convey information to users. Of course, designers should also combine the usage environment and scenarios, design different functions for different user groups, and consider the consistency of the overall visual style of the APP interface [18].

Combining the previous research on the use of smartphone APPs by the elderly, icons are applied to the interface design of the APP, mainly including the guide page, login page, home page, family, friend circle, Zhuming Mountain community, and mine. Several modules. The design principle of this APP interface is characterized by simplicity, intuitiveness, and structured style, emphasizing the subjectivity of serving the elderly social interaction, minimizing decoration, redundant elements, and graphics, and achieving a simple and tidy effect by retaining only the most basic design elements. This design style is more in line with the physiological needs and behavioral habits of elderly users.

Guide Page Design: Considering that elderly users have a higher difficulty in recognizing text, this guide page design follows the principle of displaying without saying much, reducing the use of text. The text is simple and serves as a suggestive slogan [19]. In addition, adhering to the principle of fun, a cartoon illustration art style is adopted in graphic design. The characters of the elderly are depicted with smiling expressions and lifelike gestures, making the picture full of life interest, thus resonating with the elderly's hearts, as shown in the figure 4 below.

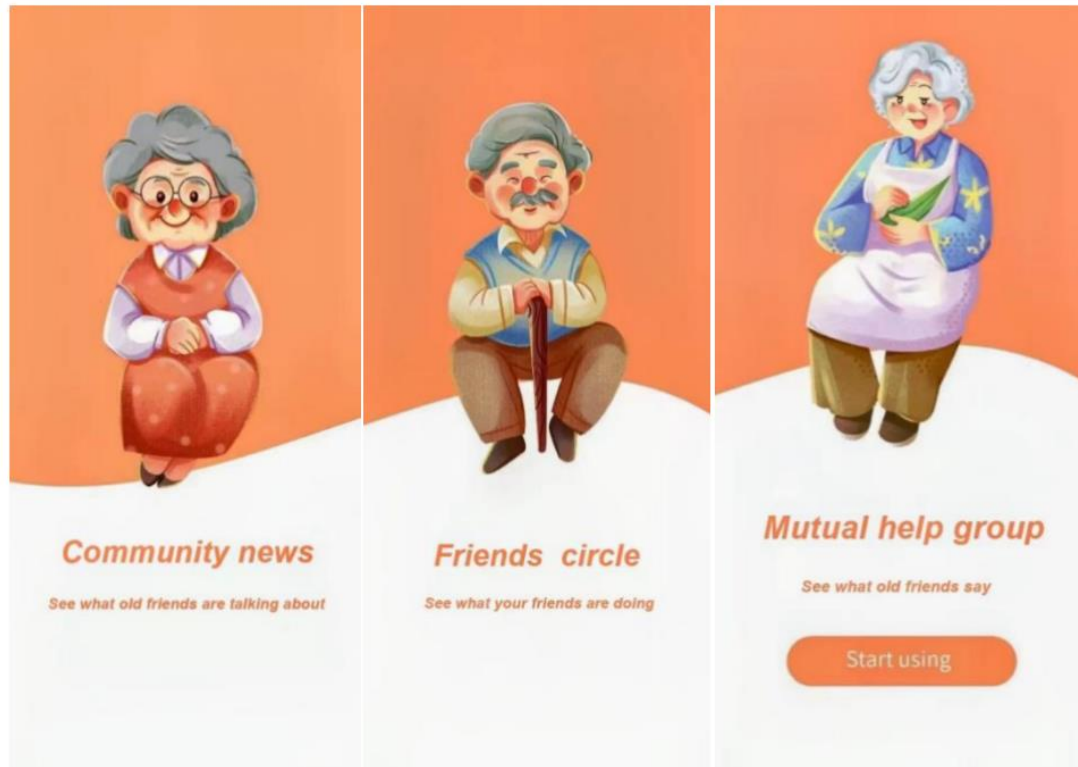


Figure 4: Guide Page Design (Image Source: Designed by Shao Zhaopo, 2023)

Home Page Interface Design

The home page interface design is mainly divided into two parts (as shown in Figure 4): one part is the application functional area, mainly composed of "Happy Family", "Friend Circle", "Zhuming Mountain Community", "Community News", and so on; the other part is the basic functional area, mainly including middle articles, family reminders, help, Q&A, and the bottom menu consisting of "Home", "Community", "Activities", "Contacts", and "Mine".

The overall style of the home page interface is lively and fashionable, and quite intuitive. The background color is white, while the headers, functions, and modules are in orange. This combination can guide the elderly users' attention to the selected functional icons and enhance their visual attention. Moreover, large areas of white space arranged neatly on the APP interface can give elderly users a clean and simple visual effect, which is less likely to cause visual fatigue [20]. Additionally, using color to differentiate different functional areas complements the overall and local design. From the perspective of color attributes, it can evoke positive emotions in elderly users when using the "Joyful Aging" APP, thereby further enhancing their experience.

E. Social Needs Function Interface Design

1) Intergenerational communication

By clicking on the "Happy Family" information area on the homepage of the "Joyful Aging" APP, the "Happy Family" page will gradually unfold in front of elderly users (Table 3). On this page, elderly users can see the names, avatars, chat records, and other information of their children and grandchildren, reducing the density of information on the page to make it easier for the elderly to identify the target information. Differences in colors, fonts, and other aspects during the chat process are in line with the physiological needs of elderly users.

Table 3: Design of Intergenerational Communication Interface for "Happy Family"

Intergenerational Communication (Happy Family)	
Visual Style	
Operational Process	<p>Open the "Joyful Aging" APP on the smartphone → Click on the "Happy Family" module → Enter the "Happy Family Communication Module" → Double-click on one person (e.g., son) → Enter the intergenerational communication independent interface → Communicate via text or voice → After chatting, click "Back" (or the close icon) to return → Complete intergenerational communication.</p>
Features	Addition of family reminders.

2) *Interpersonal communication (Friends)*

The main color tones of the interpersonal communication interface of the "Joyful Aging" APP are white, orange, and green, with contrasting colors and a simple and elegant design, making important information stand out prominently. In terms of functionality, new features such as adding likes, answering questions, and providing assistance are set up, which are not available in other social APPs. Users can also view the number of friends' fans, their level of attention, and their dynamics. Additionally, interactive features with friends such as "posts I liked," "posts I saved," and "posts I helped with" are added to effectively increase the participation and interest of elderly users, enhancing their overall experience. To enhance the social information security of elderly users, a customer service center is added in the friends' communication module, allowing users to contact and communicate directly with customer service when encountering problems, helping to verify the authenticity of information and effectively prevent deception. (See Table 4 for details.)

3) *Social activity participation*

The design of social activity participation in the "Leisure Age" APP is based on the principle of behavior proximity. For example, it intelligently recommends community activities closest to the user by default, reducing the inconvenience for the elderly to participate in activities. In order to help elderly users better understand activities, a simplified form of post information combining text and images is used to make it easier for them to grasp, reducing the reading cost for the elderly. On the operational level, to facilitate the elderly in quickly finding the activities they want to participate in, the "Leisure Age" APP provides a search function button. Activities are categorized into three levels: recreational activities, fitness activities, and cultural activities, making it easier for the elderly to find the activities they want to join. To keep elderly users and their families informed about the progress of activities, a segmented selector is used to categorize activities into three types: available for registration, ongoing, and completed, helping the elderly to filter out activities they can participate in. Additionally, the recognition of key information about activities, such as activity name, creator, time, location, and number of participants, is enhanced. To achieve this, button differentiation is implemented, and button hierarchy management is designed, using ghost buttons to distinguish them from primary buttons. Furthermore, an "Activity Notes" feature is added to prevent the elderly from selecting the wrong activities, reducing unnecessary issues and minimizing the cost of misunderstanding and misoperation for the elderly. See Table 5 for details.

Table 4: Interpersonal Communication (Friends) Interface Design

Interpersonal Communication (Friends)	
Visual Style	
Operation Process	<p>Open the "Joyful Aging" APP on your smartphone → Click on the "Friends" module on the homepage → Enter the friends' communication module → Double-click on a person (you can first view their profile) → Enter the independent communication interface → Communicate through text or voice → After the conversation is finished, click on the return button (or the close button) to complete the communication.</p>
Innovations	<p>1, Information security customer service center. 2, Function switching between the friends' circle and the customer service center.</p>

Table 5: Community Activity Participation (Interaction) Interface Design

Activity Participation	
Visual Style	
Operational Process	<p>Open the homepage of the "Leisure Age" APP → Click on the Zhuming Mountain Community module → Enter the activity participation section → Understand activity information (able to post and receive posts from others) → Complete the interaction.</p>
Innovations	<p>1, Community independent chat window; 2, Information posting and chatting in the same module.</p>

V. CONCLUSION

The social issues arising from the profound aging of society cannot be ignored. The "virtual socialization" facilitated by smartphones is becoming an integral part of the cultural and social life of the elderly. This paper, through the integration of multidisciplinary methods and cognitive approaches, based on the physiological characteristics and behavioral needs of the elderly, constructs a theoretical model of "aging-friendly" design for the smartphone APP "Leisure Age" from three dimensions: intergenerational communication, interpersonal relationships, and participation in social activities. It aims to provide a reference for the age-friendly design of products for the elderly.

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