Research on Age-Adaptive Design of Information Interaction Based on Physiological Characteristics of the Aged

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Abstract. The research on age-adaptive design of information interaction based on physiological characteristics of the aged is carried out to make functional reconstructions to the interactive information output from the perspective of interaction mechanism according to interactive demands on the basis of the life styles, behavioral characteristics and behavior patterns of the elderly population. The structure form is manifested as cognitiom-understanding-decision-implementing-feedback, which constructs the information interaction prototype for observing and understanding, the information interaction prototype for exploring and iterative design, the information interaction prototype for communication and evaluation. These prototypes are applied to look into the information exchange mechanism and pattern of the products for aged people and the mapping and correlation between behavior pattern of the old and the way of interaction of products. This is combined with the principles and methods of information interaction design to obtain the rules and integrate the behavioral paradigm of the innovation of product information interaction, thus constructing an innovative method system of "age-adaptive design of information interactive". With the information interactive performance of the products for the elderly improved from aspects including inclusiveness and usability, the information exchange between elderly users and products is more accurate, natural, smooth and easy, so that products designed for the elderly become more safe, comfortable, healthy and efficient, more "useful, easy to use, want to use", in which way the validity and reliability of the information exchange of the products for the aged is deepened and the breadth and depth of information interaction design of the products for the elderly are expanded.

Keywords: Elderly · Age-adaptive design · Information interaction

1 Introduction

Ministry of Civil Affairs authoritative statistics show that as of the end of 2015, China's elderly population aged 60 and over 22200 million, accounting for 16.1% of the total population, of which 65 years and over population of 143.86 million, accounting for 10.5% of the total population, China has entered a serious Of the aging society. With the

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growth of age, the physiological capacity of the elderly, habits and adaptability to the external environment are rapidly declining, especially in the context of the ever-changing information technology interactive information technology products has been far beyond the way the elderly Based on the physiological characteristics of the elderly population, this paper studies the appropriate aging design strategy of information interaction, and improves the information interaction performance of elderly products from the aspects of inclusiveness and usability so as to make the information exchange between the old users and the products Information exchange is more accurate, natural, smooth, easy, so that older products more secure, comfortable, healthy, efficient, more "useful, easy to use, want to use."

2 Elderly Physiological Characteristics Extraction and Information Interaction Demand Mining

Cognitive ability includes intelligence, attention or alertness, language, memory and learning function, visual spatial ability, psychomotor ability and executive function. Cognitive ability of the elderly mainly presents two significant features: (1) degenerative changes, that is, the general trend of decline or aging rather than growth or development. (2) differences in changes. On the one hand, the performance of different psychological functions of the early and late aging, and different rates, such as the perception of recession earlier and faster, and slow aging and other thinking; the other hand, between individuals: some elderly and even elderly people As senior government officials or managers of large and medium-sized enterprises or decision-makers, showing unusual insight and a very high intelligence, but some elderly memory significantly recession, mental significantly passivation, thinking serious delay. When they are in their 60s, cognitive abilities begin to decline, but decline slowly. By the time they are in their 80s, the speed of performance declines rapidly. Speech and verbal memory decline dramatically. Digital ability and intuitive speed The most obvious decline. The current study shows that the cognitive decline in the elderly is mainly due to information processing and slow response rate caused.

2.1 Changes in Intelligence

If the intelligence is divided into language ability (crystal intelligence) and fast learning ability (liquid intelligence) of these two parts, the liquid intelligence increases with age and a large degree of decline, the decline in liquid intelligence is mainly due to slow processing speed. Therefore, the need to quickly complete a number of designated tasks in a short time, the elderly showed greater difficulties. The crystalline intelligence is acquired mainly acquired, and it is knowledge, culture, experience accumulation and ability to understand. As the elderly experienced a wide range of experience, crystal intelligence easy to maintain. Senile mental decline, mainly for the memory impairment, stubborn thinking, attention is difficult to focus on.

2.2 Memory Changes

According to the cognitive load theory, the working memory capacity of the individual is extremely limited, especially in the elderly with cognitive deficits. The memory of the elderly tends to decline with age, but the decline is not significant. The general trend is: after the age of 40 there is a more pronounced decline stage, and then maintained at a relatively stable level, until after 70 years of age there is a more pronounced decline stage. Assuming an average score of 100% (highest) for memory between 18 and 35 years of age, the average score for memory at age 35–60 is 95% and 80–85% for 60–85 years of age. It can be seen that most of the elderly, the general trend of memory changes with the aging decline, mainly as follows: mechanical memory decreased significantly, significantly slower memory speed, memory span smaller, memory capacity decreased significantly.

2.3 Visual Function Changes

The increase of age has almost all negative effects on the visual system. Most of the visual function changes of the elderly show narrowing of vision, absolute threshold of brightness, decrease of visual acuity, decrease of contrast sensitivity, increase of glare sensitivity and color Discrimination decreased. In particular, the elderly have decreased visual acuity at night. In order to see objects, 60-year-old people need 20-year-old 5 or 6 times the light, and need to use magnifying glass to see the writing, an increase of about 20% of the lighting. In addition, the focus of the eye slows down, especially for low-frequency wave color recognition ability, often on the green, blue and purple and other low-frequency wave color is unclear, doubling the eye reaction time, glare to make eyes blind time doubled. Most of the elderly suffer from astigmatism, presbyopia, myopia and hyperopia of the disease. With increasing age, visual spatial capabilities and execution speed have declined.

2.4 Changes in Behavioral Functions

In the process of interaction, the important factors that affect the motor function of the elderly mainly include: independent activities, physical and range of activities, physical flexibility and coordination, daily living ability. With age, the elderly there is the phenomenon of muscle atrophy. Ordinary people reduce the muscle tissue from about 50 years of age, 60 years after the greatly accelerated. Therefore, once the elderly limb function degradation is more serious or suffering from certain diseases caused by limb can not be flexible operation of the mouse, for example, some elderly people will tremble, as well as amyotrophic lateral sclerosis (amyotrophic lateral sclerosis (ALS) patients Fingers lose the ability to exercise, the elderly it is very difficult to interact with the machine.

3 Aging Information Exchange Decision-Making Mechanism

Interaction design is a complex decision-making logical process, which involves the use of context, behavior pattern, cognitive psychology, meaning construction and so on. "After abstraction, process of behavior, acting on refining the general information structure, and make it has a positive feedback".

Information architecture focused on product information, the core task is to organize information, so that information is ordered. Concerned about the structure of product content, but also concerned about the behavior used to access the content, and how to present the content to the user; behavioral logic describes the user may occur interactive behavior, and the use of product-specific behavior of the process of the process, Behavioral design, but also concerned about how the behavior and form and content to contact. Adaptive aging information exchange decision-making is described from the origin of interactive design decision-making rules that match the information architecture and behavioral logic, so that the formation of symbiotic relationship between man and machine.

In the interaction design derives the product frame from the user demand process, the information architecture and the behavior logic match is the vital point of convergence. Behavioral logic does not exist in the imagination, it is the interface for the media to the information structure under the interface as the foothold and carrier. It is precisely because of the existence of information architecture, making the behavior of interactive design logic can be extended over time to happen. Design process to improve the information structure and behavior of the degree of matching logic, you can enhance the user control and the corresponding user experience.

The matching mechanism between information architecture and behavior logic can be summarized into three levels: the implicit layer: Alan Cooper points out the existence of mental model and realization model from the perspective of user cognition, and the cognitive friction existing between them results in the user operating product obstacle; Interactive layer: the interaction designer does not directly design the psychological model and implementation model, directly deal with the information architecture and behavioral logic, the important work is to match the construction of a user-oriented performance model; explicit layer: the user operating the product, Of the behavior directly on the interface of information, performance model in the user and the product plays a connecting role between the link. Interaction between User Behavior and Product Information A situation occurs where the context can help people act on information in a manner that is necessary for accomplishing the goal. Interaction design is the logical relationship between behavior and information of the explicit layer, and the matching process is based on the mental models of the implicit layer and the realization model matching, and finally through the expression model with real structure or concept structure.

4 Aging Design of Information Interaction Task Based on Cognitive Characteristics of the Aged

4.1 Information Exchange Interaction Channel Selection for Cognitive Characteristics of the Elderly

The decline of physiological function of the elderly population, the formation of a certain degree of cognitive and interaction barriers, need a simple, natural visual, auditory and tactile channel interaction to achieve "useful, easy to use" goal.

Visual, auditory and tactile effects channels are designed in parallel. Users can choose one or several interactive ways to interact with the interface according to their special physical condition or preferences. For example, if the eyes turn right or "right" When the voice or the right mouse button is pressed, the task dialog box bounces to the right. One visual and auditory (voice) channel in the interactive process, users can more directly and more naturally to express their ideas, to the user with a friendly, humane feeling. This user-friendly experience can greatly reduce the user of the traditional human-computer interaction in the machine gives a cold feeling, especially for the elderly, they are more in need of such a sense of relevance. This is the visual, auditory (voice) channel relative to the mechanical channel unparalleled advantage. However, visual and auditory (speech) channels also have some problems: for example, visual channels have "Midas contact" problems, and auditory (speech) channels are susceptible to background noise. Therefore, to interact with other means, such as tactile interaction, one or several interactive ways to operate the interface in parallel, allowing users to more comfortable and convenient way to convey their orders, while improving interface efficiency. In recent years the rise of multi-channel interaction is to solve similar problems with these.

4.2 Definition of Information Interaction Task for Elderly Cognitive Features

For example, for a person with a disability, "I want to eat" is to meet the people's cognitive semantic requirements of the information organization, and "I want to listen to the network," said, "I want to listen to the Internet," the task of the user's interaction is not chaotic but to meet certain cognitive semantics, While satisfying the grammatical rules does not meet the normal semantic requirements of cognition. Different information regions constitute cognitive semantics according to human's cognitive rules. Therefore, the essence of information interaction is that the user constructs the dialog box combination of cognitive semantics through the physiological channel as the input to finish the series interactive task and the intelligent response process of the computer (or machine).

Such as the line of sight to track human-computer interaction system is divided into $n + 2$ interactive interface dialog box, respectively, for the dialog box $1 \sim n$ and the dialog box "start" and "end." The symbol di ($i = 1, 2, \ldots, n$) represents a staring dialog i, {di, …, dj} representing a stare dialog combination which is related in sequence and constitutes a specific cognitive semantics. S, E, respectively, stare at the dialog box "start" and "end", the development of interactive tasks: $Ti = \{S, di, \ldots, dj, E\}$, that stare

at the dialog box "start" to confirm the user began to interact, Then the dialogs "di", "dj", which contain specific cognitive semantics on the interface, are stared, and the end of the interactive task is confirmed by looking at the "end" of the dialog. The time taken to view the Start dialog box to the End dialog box is recorded as the task execution time t. K represents the number of times a single dialog box continuously responds to a single dialog in the interactive dialog Ti, …, dj, and the number of successive responses di is num (di), then:

$$K = \max\{\text{num}(di), \ldots, \text{num}(dj)\} \tag{1}$$

For example, Ti = {"Start", "I", "To", "Drink", "End"}, the user to complete this interactive task need to stare at the dialog box "Start", "Water" and "end", that is, by ①→②→③→④→⑤ orderly stare at the dialog box, the task contains the cognitive semantic information "I" drink water.

4.3 Information Exchange Appropriate Aging Design of the Principle of the Gestalt

- The principle of Gestalt: proximity

The proximity principle is that the relative distance between objects affects whether we perceive them as well as how they are organized together. A number of objects closer to each other appear to belong to one group relative to other objects, and those that are far away do not belong to that group. The principle of proximity is closely related to the layout of the operator panels and dialogs in software, websites, and electrical equipment. Designers often use a column bar to separate the action buttons and parameter settings on the interface. However, according to the principle of proximity, we can not need the column lines, but only by the same category of objects to be closely arranged to open this group of operational objects and other objects from the distance, so that this group of operating objects in the user To belong to a group, they can meet the same task requirements. Many graphical user interfaces use this approach to reduce visual clutter and the amount of code on the user interface. On the other hand, if the operational objects are placed improperly, for example, the distance between the relevant operational objects is too long, it becomes difficult to perceive them as relevant and the software becomes more difficult to learn and memorize.

- The principle of Gestalt: similarity

Gestalt similarity principle points out another visual perception rule that affects our cognitive classification: people tend to regard visual objects with the same or similar shapes, colors, and structural features as a group. If several objects in an interface are the same in shape, color, structural features, etc., then the user will see them as a class to meet the needs of the same task components; If the designer to allow users to quickly Effectively differentiate between the different operational objects, they will be for each category of operational objects to set a unique shape, color, structural characteristics.

- The principle of Gestalt: continuity

The principle of continuity is that our vision tends to perceive continuous forms rather than discrete fragments. The volume slider control is an example of a user interface that uses the continuity principle. The slider bar represents the threshold of the sound, and there is an icon on the slider bar where the user does not regard the icon as a separator for the slider, but instead treats it as a volume that adjusts the volume, because of the continuity principle Drag-and-drop controls. Even showing the sliders at the ends of the icons in different colors does not completely break our awareness of the slider as a continuous whole, although choosing a strongly contrasting color will definitely affect people's perception of continuity slightly.

- The principle of Gestalt: closed

Related to continuity is the principle of Gestalt Closure: Our vision system automatically tries to close an open pattern, perceiving it as a complete object rather than a fragmented fragment. Our visual system has the tendency to organize the objects in the field of view to obtain a stable, independent graph, a trend known as Gestalt in Gestalt psychology. The closure principle is often embodied in the graphical user interface. For example, when users open multiple software interfaces on the screen at the same time, the operation interface of these software is superimposed on each other. The software interface arranged in the back only exposes a part, but the user will still recognize this part as a certain border Complete interface, but the rest of it is obscured.

- Gestalt principle: symmetry

Gestalt symmetry principle is that when our field of vision of the object has multiple cognitive possibilities, our visual system will be in accordance with the most simplified form to recognize the object, symmetry is a simplified tendency in a common organization form. Human brain in the cognitive process to take up some cognitive resources, but the brain's cognitive resources are limited, subject to short-term memory capacity constraints, so the human visual system is often the most simplified form of organization to interpret To the object, because this is the most savings cognitive resources, but also to speed up the speed of cognition. In the interactive interface layout design, using symmetrical, balanced or appropriate proportion of composition methods, users can simplify the process of cognitive page layout, to speed up the user identification information.

- Gestalt principle: the main/background

The subject/background principle states that our brains divide the visual area into subjects and backgrounds. The main body consists of all the elements in the scene that occupy our main attention, and the rest is the background. The subject is located above the background and usually has a well defined profile with a smaller area than the background; the background is relatively vague and often has no definite edge. The reason our brains distinguish objects in our vision is to simplify our cognitive processes so that we can identify visual information as quickly as possible and place the visual focus on important objects for primitive humans in the grasslands or forests Rapid identification of food and natural enemies have a crucial role. In the user interface design, the subject/

background principle has two purposes. First, to provide operational feedback to the user, the feedback information can be pop-up dialog box in the form of highlights in the current user interface above, as the subject is our attention and interpretation; Second, the dialog box form of feedback does not occupy the user interface Of the total space, the user can still know through the background information they are in the current environment in which the whole process of that stage.

- Gestalt Principle: common destiny

The six Gestalt principles are for static (non-motion) graphics and objects, and the last Gestalt principle - common destiny, involves moving objects. The principle of common destiny is related to the principle of proximity and the principle of similarity, which affects whether or not the objects we perceive are grouped. The common fate principle states that objects that are moving together are perceived as belonging to one group or are related to each other. For example, if there are multiple files in a folder, if you want to move several files of any distribution, you can set the file to move with the mouse, the file will follow the movement of the mouse displacement, the movement Feedback gives the user a sense of whether their actions are valid and whether multiple or fewer occurrences occur.

Of course, in the real-world visual scene, the various Gestalt principles do not operate in isolation, but work together.

4.4 Research on Aging Design Based on Information Interaction Task

According to the information interaction task and the interaction decision mechanism, the task Ti is judged if the task satisfies the cognitive semantics in the specified time. F (Ti) to determine the principle is:

$$F(Ti) = 1 \text{ The task is completed as required}$$

$$F(Ti) = 0 \text{ The task is not completed as required} \tag{2}$$

(Ti) and the error rate Pf (Ti) for the interactive task Ti are: () () () () () () () ()

$$Ps(Ti) = ?\, F(Ti)\, Ni \tag{3}$$

$$Pf(Ti) = 1 - Ps(Ti) \tag{4}$$

Set t0 as the maximum time allowed to complete a task Ti, k0 is the maximum number of consecutive responses allowed for a single dialog in the process Ti, and PT is the probability threshold of the system state judgment. According to formula (2) and (3), the total execution power of each task is calculated according to cognitive judgment semantics, time criterion, single dialogue box continuous response times and other judging criteria. When the success rate Ps (Ti) < PT, it indicates that the system can not meet the normal human-computer interaction requirement, and the system is not working properly. (2) If the total power is not less than the set threshold PT, the system does not need re-calibration.

Information adaptive aging is as follows:

Step 1: Select the parameters. The interaction task Ti is selected. According to the usage experience of the line-of-sight tracking human-computer interaction system, the maximum time t0 allowed for the execution of the task is set. The single dialog box allows the continuous response times k0 and the system operating state judgment probability threshold PT.

Step 2: The implementation of interactive tasks and records. According to the selected interactive task cognitive semantics request to start the task, record the task execution time t, a single dialog box continuous response times k.

Step 3: To judge the implementation of the task. According to the joint judgment criterion, we can judge the performance of this task, f (Ti) = 1 if $t \neq t0$ and $k < k0$, otherwise f (Ti) = 0 when the task completion process satisfies cognitive semantic requirements.

Step 4: Identify the working status of the system. (Ti) is calculated according to the formula (3) and compared with the set probability threshold value PT to determine the current system operating state.

5 Discussion

The design of interactive information aging has a bright future in the field of helping the old and disabled, especially for people with loss of language expression and limb movements such as ALS patients, but the mental normal people, information exchange design can be used to help them through the available channels To achieve the expression of will. The main research work in this paper is:

(1) According to the cognitive rules of the elderly group design interactive tasks, to effectively prevent misunderstanding of information generated by misuse of older users, which is only the basic cognitive capacity of the elderly incapacitated mobility, people with disabilities is particularly important to reduce its Cognitive load and memory burden.

(2) According to the set of interactive tasks, when the implementation of personnel in the calibration position when the system has a high reliability, the accuracy of the implementation of interactive tasks up to 90%; with the implementation of personnel to leave the system calibration position, system reliability and leave The farther the calibration, the worse the reliability.

(3) According to the cognitive ability of the elderly population, the information interaction channel should try to make the interaction mode simple, natural and easy. In the selection of the effect channel, although the accuracy of the line-of-sight tracking interaction technique is not very high, the vision is the most direct and natural channel for information acquisition and consciousness expression. 80% of the human information is obtained by the visual, and most of the elderly executive dysfunction, the eye is the normal rotation, so the system to select the visual channel as one of the effect channel.

(4) The results show that based on the method proposed in this paper, the design of interactive tasks combined with the history of the implementation of interactive tasks can effectively identify the status of the current system to avoid the Midas contact

problems, local miscarriage of justice on the system working conditions, Reduce the system calibration caused by misjudgment. In addition to the above findings, this study also needs to be improved, mainly in: the method does not apply to all user groups, cognitive decline will significantly affect the accuracy of system state identification.

6 Conclusion

Based on the analysis of the cognitive changes of the elderly and the multi-channel characteristics of human-computer interaction, the paper presents a simple, natural interactive multi-channel information interaction based on the visual, auditory (haptic) and tactile effects channels Very suitable for a certain cognitive impairment of the elderly use. In addition, in addition to a certain cognitive impairment of the elderly, for the use of ordinary interactive means of the disabled people with disabilities, the system also has a certain applicability.

According to the requirements of cognitive interaction semantics, the interactive task is set up, the execution of interactive task is judged and the results of task execution are statistically analyzed. The current system working state is estimated according to the probability and statistics of historical interactive task execution. The experimental results show that the method can judge the working status of the current system more accurately, and avoids the miscarriage of the working state of the system caused by Midas contact problem.

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