WISE: a Wizard Interface Supporting Enhanced usability

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Problem & Motivation

As computers become ubiquitous and complicated, the challenge of making them usable becomes both increasingly important and difficult. Repeated failures by implementation and interaction experts to build usable systems have motivated the creation of many successful design approaches by interaction designers. However, there are still many groups of end users that have not successfully overcome the difficulties they perceive in computer use. Such groups include individuals with unique needs, such as physical or mental disabilities, and those with age-related challenges. As a larger percentage of Americans are considered "old" (60+), living well into their 70's and baby boomers are reaching retirement age, the lack of a system tailored to the needs of this demographic has resulted in a part of the population being disconnected from the "digital world". Technology can allow older adults to stay engaged with the world around them and can improve their quality of life. The current state of software that targets older adults' ability to use computers focuses on physical issues, while largely ignoring the volumes of gerontological cognitive research that could make computers both usable and intuitive for older adults. This research examines the existing body of literature on age-related cognitive challenges, in order to construct and test a set of design principles for systems targeting novice older adult users.

Background & Related Work

Accessibility is a major concern today for most mass-produced computer systems. As a group, the number of people aged over 60 is growing at a record pace [3]. As commonly framed, accessibility/usability deals primarily with physical and sensory issues (e.g., changing colors or font sizes) but comparatively few systems make adequate use of gerontological cognitive research [3,10]. For older adults, smooth and productive computer usage requires a system that supports their objectives and works with knowledge of their possible cognitive challenges [10].

We address this challenge by using current gerontological cognitive research as a guide to create a set of design principles for system design. Using these principles, and to test their implications, we have designed an alternative to the standard OS and application UI targeting older adults (65+).

The body of existing gerontological cognitive research made it apparent that an effective design must support an interaction with less cognitive stress than that presented by a traditional OS user interface. The related cognitive literature can be grouped into 4 main areas, which directly relate to the 4 guiding design principles proposed: Linerar Interaction, Effective Cognitive Strategy Prompting, Uniform Limited Scope, and Accessibility.

Linear Interaction:

There are essentially two issues facing an older adult who wishes to use a computer. First, there is the walk-up-and-use aspect facing a novice computer user who needs to find information without much background knowledge about the system itself. The second issue concerns the situation in which one uses a computer repeatedly for the same task. Older adults can experience problems associated with walk-up-and-use even in situations involving repeated use. It is hypothesized that this is due to age-related memory limitations. Thus a solution needs to support both novice interaction and provide affordances to aid remembering or at least substitute recognition for recall [3,10].

A linear style of interaction seemed to provide a solution to both issues. Knäuper suggests that working memory declines somewhat with age and that parallel processing provides the most stress on the working memory system [8]. His research centers on the ordering of questions in a survey, but it is hypothesized that it extends to the ordering of tasks in a user interface. Accepted cognitive psychological research indicates that a high level of parallel processing penalizes the depth of processing for any individual task and hence reduces retention for the aged [1,6]. Craik's work extends this finding, noting that such division of attention affects older adults to a greater extent than it does younger people [1,3].

Further research indicates that episodic memory, the ability to remember autobiographical information that occurred recently, is the most grossly impaired form of memory in late adulthood [2]. This deficiency can manifest itself in an inability to remember faces or other images, making a "History-Bar" in support of linear interaction crucial. It may be difficult for an older user to remember the recent screens associated with a path from the start of an application to some goal. Thus, we theorize that a solution should reduce or eliminate the need to remember, providing constant cues to reinforce the correct interaction. A novice user can get from point A to point B simply by making choices. We believe that the History-Bar concept developed in this research will reinforce the user's episodic memory (i.e., recall) of decisions until the action set becomes second nature.

Effective Cognitive Strategy Prompting:

Research by Hultsch looked into the differences in organization of free recall by people of different age groups. His first result was expected: young people have a tendency to perform better at such tasks than older adults. His second result shows that, when prompted with better cognitive strategies for remembering (such as mnemonics and imagery), older people improved at a much greater rate than young people, almost catching up their performance level to that of the young [5]. This finding indicated that older adults were less likely to spontaneously use effective cognitive strategies than young people. This would account for the increased benefit of providing such prompting to older subjects. Thus, a tool targeting older adults should provide imagery, mnemonics, and metaphors for the tasks that they are attempting to accomplish.

However, there is a body of research that indicates that visual memory is the most problematic form of memory in older individuals. Extensive research by Winograd and Simon indicates that, while there is a real reduction in spontaneous pictorial encoding of information in memory, images can help older individuals to remember things more effectively. They conclude that most of this result comes from increased prompting for organization rather than the pictures themselves. Hence, one would be wise to try multiple organizational prompts when building memory training for late adulthood [12]. Thus tools targeting older adults should utilize redundant cues for improved organization. Further, to leverage the more stable verbal memory, tasks should be identified by an image and by a consistent naming scheme that is always visible in multiple [3].

Research by Poon et al., on the effectiveness of mnemonics for older adults, concurs with Hultsch's work by showing that young people are more apt to use spontaneous effective encoding strategies [5,7]. This work goes one step further by demonstrating that repeated exposure to effective cognitive strategies can eventually allow older subjects to generate spontaneous effective organizational strategies [7]. In other words, by reinforcing simple interaction, a tool may eventually facilitate more complex and effective interaction between computers and older adult subjects. This should be the ultimate goal of any such tool.

Uniform, Limited Scope:

"Interface uniformity" is an overarching HCI design principle. Uniformity can consist of consistent placement of key features (buttons) and state (title bar and History-Bar) on every step in the task path, or methods of interaction with the interface (always using buttons for interactions). Such uniformly limited and simplified interaction method should require less cognitive burden to operate. Limiting and unifying the look of the interface is a common heuristic leveraged against any justified user interface to allow for the 'method of loci' to be utilized as an effective way to navigate and get information from the interface. Kausler indicates that location-based memory can be an effective way to associate and encode memory for older adults [7].

Accessibility:

There is a great deal of anecdotal evidence that older adults often face sensory impairments. The interesting observation is that they can often compensate for these limitations by relying on the context of information [7]. As such, good software for older adults will utilize contextual affordances to help those users with reduced sensory function to navigate the interface [7]. Some of the more straightforward aspects of accessibility design deal with coloration and sizing decisions. Of note, a desaturated set of beige and yellow hues can reduce eyestrain and fatigue, as well as focus attention on colors that are highly visible, even to users with reduced visual acuity. Yellow and green are the two colors that human retinal cones are most able to distinguish [4]. Other affordances to consider include the use of large, high-contrast fonts with serifs. Further, the use of large buttons not only makes them more visible, but it also reduces Fitt's Law limitations by increasing target size. This will help both users with reduced vision and those who may have lost some motor ability [4].

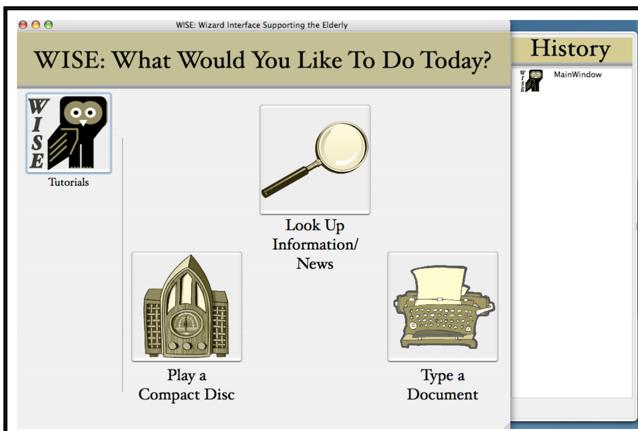

Figure 1: The start screen/basic layout of WISE

Uniqueness of the Approach

The integration of these design principles with the Apple Cocoa API (Application Program Interface) for Objective-C and AppleScript resulted in a system named **WISE**: *the **W**izard **I**nterface **S**upporting **E**nhanced usability.* WISE (Figure 1) is an easily extensible system that creates an interface tailored to the needs of older users, based on gerontological research. Because the API and scripting language are closely coupled to the OS X operating system, the focus could be placed on quality of design, by leveraging existing protocols and widgets.

Goal Metaphor

Since verbal memory tends to persist better than visual memory for older users, tasks in WISE use a goal metaphor, allowing users to consider their task verbally as a set of sub-tasks with discrete choices. WISE, therefore, provides an inherent organizational and cognitive strategy for common computational tasks, general choices to specific ones (e.g., Look Up Information, then Looking Up News, then Choosing your News Source). In essence, WISE abstracts away from the application-centered view of modern operating systems, and "hides" the end process (thinking about "looking up a movie time" rather than remembering to use a web browser and the specific URL). Task and choices are separated semantically even if they use the same end "application" (i.e., looking up news online and looking up movie times online).

To avoid making possibly false assumptions about cross-generational computer views, WISE abstracts away from technical applications towards goals and a vernacular that does not necessarily have to be accomplished with a computer [9]. For example, instead of "media player", the term "Compact Disc Player" was used. Menus and button titles were phrased as questions or tasks to perform, rather than as one-word technical phrases, whenever possible. It is theorized that this decision will reduce the novice user's computer learning curve and will greatly increase the user's computer usage speed.

Linear Interaction

To abate division of attention, WISE relies on a linear interaction model and never requires a user to attend to multiple windows at any one time. Linear interaction can limit the number of actions that a person can do at one time. However, reducing the cognitive burden on the user is of primary importance. To alleviate this, WISE will save the user's place inside of a given goal/application, to allow the user to resume a task.

Figure 2: The History-Bar showing a depth of 4

The embodiment of this linear interaction is shown in a persistent History-Bar (Figure 2) that tracks all of the user's choices from start screen to destination. This allows the user to visually understand and recognize the choices that the user made (menu/application selections) to get to the current window/task displayed on the screen. It may be difficult for an older user to remember the recent screens associated with a path from the start of an application to some goal—the persistent History-Bar removes the need to remember, providing constant cues to reinforce and learn the correct interaction. A user can see all of his or her choices and trace the path backwards to a previous location. In addition, a "go back" button is present that allows the user to dynamically return to any menu/application (with the same state) they had previously been in. A novice user can get from point A to point B simply by making choices and retracing their steps. The History-Bar seeks to reinforce this user's episodic memory of decisions until the action set becomes second nature.

Every time the user makes a choice, the menu's name and icon are placed on the bottom of the History-Bar. The layout of the list is done vertically to help convey a 'zooming' linear perspective, mirroring the scope of their choices. As more and more options are placed on the History-Bar, the user will have the feeling of zooming deeper and deeper into the program, without ever losing perspective of their current menu or how to get back up the chain. In the spirit of walk-up-and-use systems, the depth of interaction with the system and the methods necessary to successfully use WISE were reduced, following Czaja. There are no standard navigation paths with a depth of more than five screens (e.g. depth of four: MainWindow ⇒ Information ⇒ News ⇒ CNN). Back navigation is thus easy: a user can see all of his or her choices, trace the path backwards to a previous location, and return to that state with a single mouse click.

Beyond simple linear interaction, WISE focuses on effective cognitive strategies for remembering, as recommended by Hultsch. To this end, WISE uses redundant cues for improved organization. Each task is identified by both by an icon and by a consistent naming scheme that is always visible in multiple locations following the suggestions of Czaja.

To conform to the limited-scope design heuristic, the History-Bar functions under the single click design. Without selecting a specific item from the History-Bar, pressing the "go back" button moves the user back one "step" in the history. This design choice enables the user to traverse their history, even if they have no concept of selecting items in their History-Bar. If a menu/function is selected in the History-Bar, then the "go back" button displays that menu/function's name, and pressing it will jump the user back to that step, thus allowing faster traversal of their history.

Uniform Limited Scope

In addition to goal-oriented design to hide the concept of Web browsing, a Wikipedia Web-page parsing algorithm designed by Sean Timothy Billig for his Wikipedia widget (http://www.whatsinthehouse.com/widgets/) was incorporated. His algorithm eliminated the general layout of the Wikipedia Web page and presented a simplified HTML layout containing text and images only (though still properly formatted). This allowed us to modify the text size and color scheme to make Wikipedia articles easier to read. In time, a similar algorithm could be developed to parse other Web-based parts of WISE to make browsing the Web more uniform and even easier to read/interact with.

Another design choice was to leverage the single button Apple Mac mouse, to create an interface based exclusively on button selections, single clicks and text entry. There is no concept of right clicking, pull-downs, modifier + click or double clicking for the standard navigation actions available in WISE. By reducing the palette of interaction methods, the cognitive load resulting from multiple equivalent navigating methods is reduced.

To provide further redundant cues, each set of choices is represented by an icon, a title, and a name. These appear in multiple locations on the screen in addition to the History-Bar (as stated before). Their arrangement on the screen is uniform throughout WISE, creating a common visual theme. For example, each page has a consistently placed title bar describing the current step in the task path from start to goal.

Accessibility

Some of the more straightforward aspects of WISE's accessibility design were the coloration and sizing decisions contained with the system. WISE was built on a desaturated set of beige and yellow hues. This was designed to reduce eyestrain and fatigue, as well as to focus on colors that are highly visible even to users with reduced visual acuity. Yellow and green are the two colors that human retinal cones are most able to distinguish [4]. Combining this with the concept of a lens that yellows with age, it was apparent that a yellow coloration would be the best choice for visibility. As a result, there is little red. What red is used was softened to reduce strain. Overall, the desire was to have WISE have a soft effect on the eye, to help ease any trepidation against using a computer.

Other affordances include our use of large, high-contrast fonts with serifs and the reinforcement of text with icons and vice versa. The use of large buttons not only makes them more visible, but also reduces Fitt's Law limitations, by increasing target size. This will help both users with reduced vision and those who may have lost some motor ability.

Focus-Group / User Tests

Following the construction of WISE, a focus group was held consisting of 10 older adults (mean age 74 year) from a retirement center in Westchester County, New York. Users had a median experience with computers of 10 years (range 1 to 45 years). Subjects were compensated financially and given a free lunch for participating in the session. During the 2-hour session, subjects were asked to use WISE in groups of two and three to perform simple tasks (e.g., look up information about Alzheimer's, summarize it, and print it). Before and after the task, users were given questionnaires. In addition, a discussion was conduced, after completion of the task. Both questionnaires and oral discussion were utilized to illicit individual, unbiased feedback, as well as synthesized reactions determined by group discourse. The main focus of the session was to gage user reactions to the new interface and determine which features were and were not useful. The reactions could then be extrapolated to determine which design decisions were beneficial to older adults, and which were not.

Results and Contributions

The results of the user group showed that WISE met many of its goals. The feedback indicated that WISE was generally accepted as "simple to use," "user friendly," "not intimidating," "helpful when using the computer," "having as much control as wanted," and a piece of software subjects would "like to install." Discussion with the subjects and questionnaires pointed to three key features that made use successful: the History-Bar, large easy to find icons as main method of navigation, and explicitly asking or directing searches by allowing users to search by "asking a question," rather then typing keywords. During discussions, the History-Bar was widely appreciated. Users repeatedly mentioned how useful it was for remembering what they did, how they got to the current screen, and for navigating within the system. In addition, subjects asked for additional information to be stored in it, for more fine-grained control and recall. Using these results, future tools for older adults can be better refined and designed.

One such application of these results could be a dynamic quick link application that places short cuts to most frequent applications and websites on the desktop with size directly proportional to use. Much like WISE's interface focused on easy application/goal finding, a similar approach and utilization of the computer's desktop could have a positive effect on computer usage by older adults.

Most significantly, a system History-Bar could be devised to allow users to track their steps and choices throughout their entire computer usage. This system History-Bar could function much in the same way as the WISE History-Bar, capturing state, history, as well as providing a method for easy inter-application, inter-task navigation. Not only could a tool such as this help older adults, but it also could potential help a larger demographic of computer users multi-task, remember and learn how to use the computer.

In addition to the positive feedback, some criticisms and negative feedback were also made. First, users almost unanimously said that they want to use "common" software: programs that everyone else has. In addition, subjects felt that, though WISE would be an excellent tool for novices and new comers, the interface was too limiting for individuals with moderate experience. From this, it can be concluded that future software targeting older adults should function as either a plug-in or an assistant, rather than by replacing a specific application or OS. Second, subjects requested a traditional Web browser. Even with the promise of "more goals," users felt that the lack of an explicit Web browser limited their computer usage by dictating what Websites could and could not be reached. Lastly, subjects felt the single window approach was limiting, because they would like to have multiple windows open at a time for certain types of tasks (i.e., looking up information while writing a document). Unfortunately, there was no acknowledgment of the "goal metaphor" being either useful, or a hindrance.

One interesting observation of the subjects was that when looking up information online to be included into a document, they first wrote their findings down on paper then re-typed them into the computer. When asked about this observation, users stated that they would like a notepad-like tool on the computer so they can keep/move notes between applications. Clearly such a capability would need to be closely integrated across applications, so as to avoid the addition of complexity or other impediments to this group's usage of it.

This research shows that through the examination of cognitive research on age related challenges, novel solutions to enhancing computer usage for older adults can be created. Specifically, this work has shown that keeping context and utilizing it to navigate is a method of interaction older adults find useful and natural. In addition, this work also suggests that application/Website activation is still a task that remains difficult in current OS implementations, and suggests a potential solution to alleviate this problem.

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