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# Improving web accessibility for older adults based on error detection strategies

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**Improving web accessibility for older adults based on error detection  
strategies**

by

Alfred Taylor, Sr.

A dissertation submitted to the graduate faculty  
in partial fulfillment of the requirements for the degree of

**DOCTOR OF PHILOSOPHY**

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Ames, Iowa

2012

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**DEDICATION**

I dedicate this

to my family:

my patient and persevering wife, Norma,

and my children:

Teshia, Alfred, Jr., Lorenzo, Angelo, and Leonardo.

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**ABSTRACT**

This research examines error detection strategies as a method for ensuring effective World Wide Web accessibility for older adults. It evaluates the underpinnings of web accessibility and their relevance to error detection strategies for the support of older adults. The research provides a contextual definition of computer systems and an account of how error detection relates to accessibility. The Error Detection System strategies focused on developing profiles of the participants. The profiles (self-assessment, testing, observation, and error detection) were used to modify webpages that the participant accessed. This research compares the performance of each profile, using a task list and error collection from the Error Detection System. Different error detection strategies that may be employed are presented, as well as their potential in the development of error detection strategies.

## CHAPTER 1. INTRODUCTION

The normal aging process lessens the abilities of older adults. Hanson (2001) notes that web interfaces that are not user-friendly will worsen the problem. Web design issues related to fonts, colors, graphics, background images, navigation, and search mechanisms prevent some older adults from taking full advantage of resources such as online health information. As the population ages, there will be a demand for website designers and Human Computer Interaction (HCI) professionals to provide better interfaces for online resources (Keegan, Gross, Fisher, & Remez, 2004).

Keegan et al. (2004) and Alpay, Verhoef, Xie, Te'eni, and Zwetsloot-Schonk (2009) discussed the importance of providing better health care to older adults. It is important to be able to stay up-to-date on developments in health care and through the Internet older adults have access to a large volume of useful health-related information. In addition, the Internet provides an excellent means of staying in contact with family members and friends, which also provides positive health outcomes (Ziebland and Wyke, 2012). Many older people have problems performing tasks that require leaving their home, due to restricted mobility, lack of transportation, memory problems, or fear of crime (Czaja & Lee, 2003). The Internet can reduce the negative impact of these issues because it can be accessed in the person's own home or a senior center and usually requires little physical mobility and minimal training. Memory problems can be overcome with written instructions that can be followed for each step of any type of Internet use (e.g., using e-mail or searching out information).

This study's research focus is on older adults and the overall goal is to improve the quality of their lives by enabling them to use emerging technologies for accessing websites.

The work presented in this dissertation looks at the errors older adults make in order to improve the usability of the Internet for them.

### **Purpose of the Study**

The goal of this research was to find a way to improve webpages so they are easier for older adults to use. If such web improvement can be computer-generated, it would save labor and be more practical. There were two key questions addressed in this research: 1) Can error detection be used as a means of understanding limitations of older adults? and 2) Does the use of automatic error detection compare favorably with other methods of determining an individual's limitations?

### **Contributions**

The primary contribution of the work was the development of an error model (visual and motor skill errors) and a mechanism for using the error model to determine the limitations of older adults while using computers. The results of our studies show that our proposed error detection strategy was statistically equivalent to observation. In particular the study indicated that there was no statistical difference between the means of the results of the observation-based profiles and the results of the error detection-based profiles. The study results also indicated that observation was superior with respect to the user error rates when compared to self-assessment and written tests. These results encourage the development of practical solutions to improve web accessibility for seniors.

A major contribution of the work is the development of the error detection strategy for maintaining a current profile, based on the impairments of older adults. The error detection strategy was shown to be statistically equivalent to observation and superior to both self-assessment and testing in older adults.

This contribution is important because it addresses the issue of cost mentioned previously. The error detection approach performs as well as observation but is less costly. Also, it scales very well compared to observation and gives much better performance than testing or self-assessment.

### **Dissertation Organization**

Chapter 1 of this dissertation focuses on the introduction and organization of the dissertation. Chapter 2 is the literature review and discusses past and present literature in the area of computer usage and the older adult. Chapter 3 presents the software platform that was used to conduct our tests. The design of the research study is examined in Chapter 4 and Chapter 5 has results and discussion. Finally, Chapter 6 provides the conclusions and thoughts about future research in this area.

## **CHAPTER 2. LITERATURE REVIEW**

### **Introduction**

The relationship between individual abilities (e.g., computer skills, vision, cognition, and motor skills) and Internet accessibility for older adults is a very important issue today. Dealing with this problem brings together research from the areas of cognitive science, gerontology, design, and human and computer interaction (HCI). Because these are distinctly different areas, each discipline offers a different perspective on how older adults interact with computers.

Cognitive science studies the structures of the human mind. These structures include vision, internal mental processes (e.g., language, thinking, reasoning, and problem solving), motor skills, and the adaptation of memory and attention (Iyer, 2003). The field of Design combines applied art, engineering, and architecture to improve computer interface design (APA, 2007), while Gerontology is critical for understanding the abilities and limitations of older adults. The discipline of Human Computer Interaction (HCI) includes all of these areas, with the purpose of understanding the ways people interact with computers.

### **The Birth of the Computer Age and How it Changed the Way People Access Information**

#### ***The Internet***

The Internet has fast become a critical source of gathering and sharing information for people of all ages. There are many opportunities to access the Internet, including reading email via a smartphone or using a computer in an office, coffee shop, Internet café, or a public library in almost any city of a reasonable size in the world. Even low income families can often use a computer at a public facility such as a school or library.

Users have many software applications with which they can communicate. Since the early days of the Internet, originating from Arpanet and the Milnet (Military Networks), its key use has been communicating and transferring files. It has been a productive tool that has changed the way business and personal communication is conducted. For example, individuals now commonly establish social networks and support groups with interactive communication through the Internet.

The Internet provides users the flexibility of using computing technologies anywhere they choose. There are many possibilities for using the Internet to communicate that can change the lives of people who are not familiar with computers. There also are many ways the Internet can stimulate users. McKenna and Bargh (2000) and Kwon and Noh (2010) noted that using the Internet can help reduce boredom and provide options that may not be available otherwise, such as person-to-person meetings or shopping at a store. Computer technology provides people with new opportunities and options to develop relationships and explore ideas.

Total comprehension of the impact of the Internet has not been realized at this point in time. It is an ongoing task to develop all of the ways it can be utilized, but we know it offers many useful tools that allow people to explore and communicate (Anderson & Tracey, 2001). This holds true for older adults who would like to access the same tools (Weare et al., 2007; Sloan et al., 2010), but sometimes understanding and/or having the ability to operate the computer are obstacles. As Anderson and Tracey (2001, pp.456-475) wrote, "People are not simply Internet users. Different kinds of people make differing uses of the range of applications and services that the Internet supports and probably for differing reasons."

The use of the Internet has surpassed the use of any other communication medium since the beginning of the Information Age (Hannemyr, 2003). Most young people in the more developed parts of the world have been raised during the time when the Internet was becoming popular and their attention has been focused on what this new approach to communication had to offer (Lenhart et al., 2001).

There have been dramatic changes in adult Internet usage over the past several years. For example, Madden (2003) wrote that the number of adults using the Internet increased from 63 million to 123 million just within the three years from 2000 to 2003. Online banking increased 32 percent during that time. Online shopping increased 26 percent and information retrieval for health and travel increased significantly, as well (Hoffman et al., 2004; Medlock et al., 2012). There are a variety of applications that have been important in increasing Internet usage, such as, Instant Messaging, Voiceover IP, and music and video downloading and sharing, in addition to e-mail, social networking, and e-commerce. Early on, startup e-commerce organizations became very popular and profitable because of the flexibility and power of the Internet (Sampler, 1998). More recently, with social networking and the downloading of music and video, and the addition of more users in other parts of the world, the rate of Internet use has been estimated to be doubling every two years (Mann, 2008). Still, Zickuhr (2011) reported that only 45% of people age 65 and older own a computer of any kind and only 40% that age group use the Internet. Slightly fewer people age 75 and older (38%) use the Internet.

The total number of Internet users does continue to increase and more recently the fastest growing segment of the Internet users in the U.S. has been older adults (Liu, 2010; Medlock et al., 2012).

### ***Email and social networking***

Daily online reading of newspapers and communicating with friends and relatives increased by 10 percent from 2000 to 2003. Hoffman et al. (2004) attributed this primarily to electronic mail usage. The only requirement has been access to a basic personal computing device that supports access to the Internet. Other Internet uses, such as chatting and game playing were identified, but email usage was by far the most used (Hoffman et al., 2004). The availability of free email applications (e.g., Hotmail, Yahoo, and gmail) has increased since that time.

Madden noted “Social networking among Internet users ages 50 and older almost doubled - from 22% to 42% during the 2009-2010 period” (2010, p. 2). The use of social media use has grown rapidly across all age groups, but older users have been especially enthusiastic about the new networking methods. While email is still the main way older users keep in touch with friends, family, and colleagues, many users now use social networks for daily communications (Madden, 2010). Improvement of communication technology has increased the efficiency and lowered the cost of Internet technologies. It costs less now to acquire a faster Internet connection than it did several years ago. The information age has changed the way we do business and email is now a very important method of communication.

The wide availability and usage of lower priced personal computers have made it easier to acquire computer technology. Forbes (1997, pp. 129-131) wrote “to quantify the spread of computers more precisely, in the United States, computer memory per person has been advancing at 67 percent per year since the mid-1960s.” The continuing improvement of the technology has users constantly anticipating more sophisticated interfaces.



## **HCI and Older Adults**

The Internet has a vast amount of resources that can be useful to older adults. If there are no physical, mental, or financial barriers to these resources, older adults can obtain information about their health, personal services available to them, and government programs relevant to their needs or concerns. In addition they can find fun activities, such as games, puzzles, history, genealogy, and information about any type of hobby. Sloan et al. (2010) wrote that such information has the potential to greatly improve the quality of people's lives. However, Mazur et al. (2012) noted that recent research has not been so positive about improvements in quality of life.

Uphold (2012) found that older adults are the most likely to seek information on the web. Older adults have become the fastest growing computer and Internet user group (Wagner et al., 2010; Lee, 2012; Medlock et al., 2012). Berry (2011) pointed out that it isn't possible to treat older adults as a single user group because of the vast differences in the situations that older adults find themselves in.

One of the basic goals of Human Computer Interaction (HCI) is to enrich the user interface by making it friendlier to user needs (Baidya, 2008). HCI has the capacity to help older adults become computer users in spite of any age-related limitations. One group especially likely to need help is older adults on fixed incomes. They may own older or no computer equipment and may suffer from physical impairments that necessitate special interfaces to effectively access computers.

In order to test universality in computer access, there need to be (1) a variety of technologies, (2) a variety of users, and (3) a variety of expertise (Shneiderman, 1998).

According to Browne (2000, p. 1), two obstacles have retarded “the synergy between older adults and Internet use.” Browne described these obstacles as (1) many older adults have not been exposed to computer technology and (2) they face many other problems, associated with computer literacy, technological usability, and physical and/or cognitive impairments.

Melenhorst et al. (2001) and Festervand, Meinert, & Vitell (2011) looked at the feasibility of acquiring computer literacy for older adults. They emphasized the need for user interfaces that are easy to use and visually useful.

### **Age-related Changes in Older Adults**

According to Keegan et al. (2004), older adults need to seek stability in health services (mental, physical) to give them financial independence. Anyone can obtain health information for mental health, physical health, counseling, and/or general information since it is readily available via the Internet. We expect some older adults will need assistance in accessing such information. Understanding and designing interfaces requires knowledge of the demographics of users. Lee (2012) noted that this is especially true with older users.

It is likely that older adults have different needs than general users have because of age-related impairments in vision, mobility, or cognition (Lee, 2012; Mazur, 2012).

#### ***Changes in visual abilities***

Some older adults suffer from age-related macular degeneration (AMD). This disease normally affects the vision of older adults and when vision is impaired by AMD, it becomes very hard to read standard text on a webpage. Jacko and Sears (2003, p. 1277) explained “(i)n the United States, at least ten percent of persons between the ages of 65 and 75 years have some central vision loss due to AMD; among individuals over the age of 75 years, thirty

percent have vision loss due to AMD.” There is no permanent cure or treatment for AMD, although there are many scientists researching retinal disorders.

### ***Visual challenges***

During the aging process, the vision of older adults changes and may decrease. The changes in vision often affect their ability to distinguish small objects at certain distances. For example, normal sighted users have the ability to see links on a webpage without any problem. They can readily see and understand how text is related and embedded in the page. Studies have shown that they also can return quickly to the starting point of their search (Zajicek & Arnold, 1999; Zajicek & Reeves, 1998).

Zajicek and Reeves (1998) showed that normal sighted users rely upon short-term representations and visual suggestions to help them navigate webpages. Older adults who are visually impaired find it difficult to form these representations because of their impairments as do those who are memory-impaired. However, visual impairments do not necessarily affect performance of cognitive and awareness functioning (LoPresti et al., 2002; Radin et al., 1990). Accommodating and addressing vision issues can enable older adults to take advantage of services and information available through the Internet (Bucar et al., 1999; Deets, 1999; Ogozalek, 1994; Shneiderman, 1998).

### ***Supports for visual challenges***

In order for older adults to use the Internet, they must be able to read and interpret the information retrieved. Visual impairments present one of the most frequent difficulties for older adults using a computer to access the Internet. The vision difficulties that older adults encounter generally come from small fonts and character color distinction (Hanson, 2001).

Watzman, (2003) looked at the importance of layout in helping users with visual impairments. He noted that the appearance and choice of typography is critical when designing a webpage for older adults. The choices of font size, color, layout, and format all have an impact on whether or not a page is read and successfully understood.

The World Wide Web Consortium (W3C) (1999) has suggested that there should be a basic set of icons and that actual object representation should reflect definite ideas. They also recommended that using larger button sizes and increasing the area that is sensitive to mouse clicks would reduce errors from older users. Rizzo (1999) suggested that a 14-point font size would help older adults.

### *Changes in motor skills*

Computing devices are becoming smaller, more mobile, more powerful, and less expensive. They also are more available to everyone, including older adults, and even to those with low incomes through senior centers and public libraries (Jacko & Sears, 2003).

Although computing devices open up many opportunities, they can also function as barriers to individuals with impairments (Sears & Young, 2003). Physical impairments (PIs) can hinder the motor capacity of older adults. It is important to identify these PIs to clarify the nature of the problems that older adults have with access to effective computer usage. Sears and Young, (2003, pp. 482-503) wrote, “More specifically, PIs may hinder an individual’s ability to physically interact with computing technologies (e.g., PIs affecting the upper body).” Table 2.1 highlights the relationship between impairments and design considerations.

Table 2.1. Summary of age-related changes and corresponding design guidelines<sup>1</sup>

Age-related Changes	Design Guidelines
Visual impairments: decline in color sensitivity, decrease in dark adaptation, decline in the ability to detect targets.	<ul style="list-style-type: none"> <li>• Provide only relevant information on screens, highlight important screen information, and maximize contrast</li> <li>• Use speaking outputs</li> <li>• Develop magnifying tools</li> <li>• Develop big mouse pointers</li> <li>• Develop keyboards with larger letters on them</li> </ul>
Decline in motor skills: slower response times, declines in ability to maintain continuous movements, disruptions in coordination, etc.	<ul style="list-style-type: none"> <li>• Design new input devices that would be easier for older adults to use</li> <li>• Design reliable speech recognition software</li> </ul>
Decline in cognitive abilities: memory dysfunctions, decline in ability to learn new techniques	<ul style="list-style-type: none"> <li>• Use simpler and shorter messages for instructions.</li> <li>• Reduce amount of output</li> <li>• Develop low functionality systems with possibility of adding extra features later</li> <li>• Develop programs that minimize demands on working memory</li> </ul>

Difficulties as a result of arthritis or similar symptoms make using a mouse and keyboard complicated. An occasional twinge in an older adult's hands or arms from arthritis impedes efficiency when surfing a webpage. These problems in motor skills have direct relevance to the ability of older adults to use current input devices, such as a mouse or keyboard. It has been proposed that this problem can be helped through error detection strategies by increasing the target area for the pointer of the mouse, as well as increasing the size of buttons and decreasing the difficulty of the mouse clicking mechanism.

### ***Motor skills challenges***

Older adults can have difficulties becoming accustomed to using input devices like the mouse and keyboard (Zajicek & Arnold, 1999; Walker et al., 1996; Rogers & Fisk,

<sup>1</sup> Adapted from Czaja, S., & Lee, C. 2003. Designing computer systems for older adults. In *The Human-Computer Interaction Handbook*.

2000). These difficulties can be a result of motor skill impairment (Czaja & Sharit, 1998; Czaja & Sharit, 1999; Smith et al., 1999).

Assessments of the skills and abilities of older adults have revealed they are able to utilize computing technology when support is provided through the appropriate design of computer peripherals (Czaja & Lee, 2001; Fisk, 1999). Wood et al. (2005) investigated the proportional performances of older adults with a wide range of computer literacy when using different types of input interfaces, such as a touchpad touchscreen, and a mouse ball to perform simple tasks. Thirty men (mean age 71.0) and 55 women (mean age 71.9), aged 54.8 to 90.2 and living in a medium-sized Canadian city, completed 10 trials in which they played two computer games using the two types of input devices. Achievement was based on precision and time to complete elements of the game for the two difference devices (Wood et al., 2005).

Experienced users had higher accuracy and speed performance when they were able to work with a device of their choosing, compared to other devices. The study found that the mouse was the most challenging because it required more thinking and motor control. The experienced users had better performance scores with the mouse, while the beginners showed better performance with the EZ ball apparatus. Using either a keyboard or a mouse can be very difficult for some older adult users (Czaja, 1996, 1997). There sometimes seems to be a conceptual problem with understanding how a mouse functions (e.g., double clicks, single click, or drag and drop).

### ***Support for motor skills challenges***

Aging results in some loss of motor/mobility skills (AAN, 2003). Some of the motor/mobility changes that old age brings are:

- reduction in reaction time,
- a slight reduction in strength and stamina,
- some loss of steadiness and dexterity, and
- possible involuntary movement or tremors.

Guidelines and standards suggest that designers should consider older adults' physical impairments and potential frustration levels by implementing different technology, such as a mouse that is easier to use, and also by providing more support (e.g., mouseover technology) (NIA & NLM, 2002). Burkhard and Koch (2012) tested the display size and touch input accuracy of touchscreen tablet computers in a multi-directional tapping task according to the proposed ISO 9241-9 standard (for non-keyboard input). Other researchers are testing new kinds of interfaces for older people.

### *Changes in cognitive abilities*

There are two states of impairment that describe the human cognitive system; impaired and unimpaired (Newell et al., 2003). Newell et al. (2003) wrote that there are continual changes in the ability of people to think. These changes can be gradual as we age and they can start at any time. Older adults may experience one or more impairments as they age and as they age, their ability to retain and interpret information diminishes (Liu et al., 1999; Mazur, 2012). Newell et al. (2003, pp. 464-481) stated "Aging can have substantial effects on cognitive ability, which is particularly marked in ...age-related conditions, such as dementia." Slowed cognitive ability interferes with ability to search, navigate, and traverse through websites to find desired information (Zajicek & Hall, 2000). According to Zajicek and Hall (2000, pp. 299-307), "specific age-related memory changes and their effects on learning are the reasons for the difficulties older adults have in using computers." Cognitive

impairments in older adults make it difficult for them to learn the most up-to-date computer skills (Czaja, 1996; Zajicek, 2001; Mazur et al., 2012). Wilkniss et al. (1997, pp. 372-375) stated, “the ability to navigate successfully and build strategies deteriorates with age; an aspect which is especially important when moving from page to page in the World Wide Web.” Retrieval of information from short-term memory requires more time for a mentally impaired older adult and the time needed to make decisions is much longer (Liu et al., 1999). These mental impairments make searching the web for information and traversing through various links difficult for many older adults.

Kelley and Charness (1994, p. 16) wrote that “(l)ittle is known about the role of various cognitive constructs in mediating the computer performance of older adults, since only a few studies have included instruments that might measure their effect on computer use by older adults.” More recently there has been some research that helps our understanding.

Backman et al. (2000) studied older adults (80 years of age and above) and found that short-term memory decreases more rapidly than long-term memory declines. This would make it harder for an older adult to remember why and how they got to a certain website (Wilkniss et al., 1997).

Berg et al. (1998) studied adults from ages 45 to 92 years old. The participants were evaluated while completing a series of memory and learning tests associated with a memory task. The researchers didn’t find any association between self-evaluation and completing a test. People rated themselves poorly in comparison with their actual performance on the tests, but rated themselves favorably when compared to others (Berg et al., 1998). Short-term retention of new ideas and remembering identities appeared to be the most challenging for the participants. Self-perception seemed to affect the older adult’s memory capability and



the study showed that they had a tendency to believe typical stereotypes of what the “norm” should be for older adults. Participants in the study had a higher rate of pessimism about their ability to remember concepts. They also tended to associate their judgment or thinking problems with aging, as has been found in other research (Dixon et al., 1988; Elliot & Lachman, 1989; McDougall, 1995; Ryan & Kwong See, 1993). Several studies have found that what older adults believe about themselves and their thinking ability influenced their ability to perform cognitive functions (Berry, West, & Dennehey, 1989; Devolder & Pressely, 1992; Lineweaver & Hertzog, 1998; McDougall, 1995; Ryan, 1992; Seeman et al., 1993).

Salthouse (1985) found that mental acuity was the most vital factor for recognizing age-correlated disparities in computer task execution. Echt and Morrell (1998) found that testing where older adults were compelled to make decisions based on their understanding of written material was a better method of determining if they are capable of performing computer tasks. They also found subjects’ scores on perceptual speed and short-term memory problems were better when short-term memory demands were at a minimum.

Some studies have shown that the way a person feels can be a strong factor in their performance (Bandura, 1997; Schunk, 1994). Several studies have shown viewpoints about usefulness, implied theoretical principles, labels of a class of people, and attitudes can weaken or strengthen one’s performance (Berry, 1999; Cavanaugh, Feldman, & Hertzog, 1998; Miller & Lachman, 1999; Ryan & Kwong See, 1993).

Results from an AARP survey reported that users 65 years and older experienced less confidence in their ability to operate computer equipment than younger people who were measured to actually be less proficient than the older users were (Bucar et al., 1999).

Interestingly, Nascimento Ordonez, Sanches Yassuda, and Cachioni (2011) found that learning to access the Internet via a computer helped increase the cognitive abilities of older adults when compared to the control group (who were not taught to use the Internet).

Short-term memory problems can be very frustrating to an older adult trying to use a computer. Newell et al. (2003) suggested that the development of special technology should continue to provide support for older adults with various types of cognitive impairments. Sayago, Sloan, and Blat (2011) wrote that cognition problems are typically the largest barrier to computer use by older adults as they age.

### *Cognitive challenges*

A number of studies have shown there are differences in computer performance due to age (Charness, Schumann, & Boritz, 1992; Czaja & Sharit, 1993; Elias et al., 1987; Hartley, Hartley, & Johnson, 1984; Zandri & Charness, 1989; Sayago, Sloan, & Blat, 2011). Differences in the ability to learn computer skills are affected by cognitive mechanisms related to one's ability to understand textual information, as well as to the decline of short-term memory (Morrell & Echt, 1996, 1997). How fast a user can think and process while performing an information entry task is an important indicator of performance (Czaja, & Sharit, 1998). Charness et al. (1992) showed when older adults perform computer tasks there are a higher number of errors and they tend to need more help than younger users.

Czaja et al. (2006) conducted a study to compare age and educational differences when using computers. The participants provided information such as age, education, and ratings of their health, computer literacy, attitudes toward computers, and fundamental reasoning abilities. The association between age and acceptance of technology was mediated in the study by cognitive abilities, computer aptitude, and anxiety. Perceptions of Internet

usage abilities and technological acceptance are very important issues for older adults. However, difficulties such as their openness to new ideas, age related memory, and visual impairments can be roadblocks to achieving their goals. If a good conceptual model cannot be developed, the older adult will have difficulties associating and understanding computing concepts. When new methods are introduced, it may be very difficult and confusing for an older adult, especially if the computer interface or mode of use is not related to anything they have ever used before. Results from Jay & Willis (1992) and Czaja et al. (2006) suggested that computer literacy education programs, especially those for older adults, should focus on assuring effective computer usage techniques and reducing unnecessary anxiety.

Executing a computer task is influenced by particular demands on the thinking ability of the individual (Jacko & Sears, 2003). For example, exploring a set of webpages is a difficult cognitive task that makes use of short-term memory, logic, thought, education, and understanding (Jacko & Sears, 2003).

Age-related deterioration in thinking capabilities, such as memory, conceptual speed, and textual understanding are also significant causes of age-related disparities in learning new computer skills (Morrell & Echt, 1996; Sloan et al., 2010). Studies have shown that older adults face barriers when using computer software (Zajicek & Hall, 2000). Also, they have difficulty recalling procedures they have previously performed. Age can affect learning new ideas and concepts (Stuart-Hamilton, 1999; Sloan et al., 2010). It is possible that cognitive impairment is putting older people at greater risk for scams and being cheated through the Internet, also (Garg et al., 2011).

### *Support for cognitive challenges*

Processing speed can be an important challenge to a person with slight or medium mental deficiency. Technology can help to provide support for solving intellectual tasks in less time (Salthouse, 1991). Users can lose performance if they perceive external pressure (Jacko & Sears, 2003). Clearly formatted webpages can help by reducing the pressure on the older user.

Tasks that require the user to consider more than one concept at a time are known to increase the probability of errors and user frustration (Detterman et al., 2000; Salthouse, 1985). An effective model of cognitive tasks can reduce frustration.

McDonald et al. (2000) suggested that a user could build an exploratory model through repeatedly performing tasks and then not be dependent on memorization once the model is in place. They also noted that using a simple interface design could support development of a conceptual model and user prompts.

Newell et al. (2003) emphasized that an efficient computer environment makes it possible to increase the quality of life of a mentally impaired older adult by:

- Providing them with the ability to control their own destiny,
- By remotely helping people who are in danger of injuring themselves,
- Providing a means of stimulating people to think and remain mobile,
- Creating platforms for social interaction.

The idea of providing support for cognitive functioning is not new. Newell et al. (2003, pp. 464-481) describes memory as being the “first cognitive function to be augmented.” Providing people help with their general recall is very useful, because their

crystallized memory may be still good, while fluid memory may suffer (Jacko & Sears, 2003).

Computer environments, like Internet browsers, should have built-in functionality. The software could provide prompts for retrieval of information and suggested websites. In addition, if a user were able to successfully perform a sequence of tasks and actions, this would increase their confidence in using a computer.

Comprehension and the ability to do simple tasks are helped by an environment that allows older adults to pace themselves (Beier & Ackermen, 2005). Such an environment helps older adults maintain a sense of control and eases their perception of using computers. Their approach decreases the notion that the computer is in control. People needing computer help do not want to be targeted as a special group, in the same way as people with impairments do not want to be labeled as “handicapped.”

Thinking ability is a key factor in older adults’ acceptance of technology. For older people to become skilled at new ways of completing old tasks (being in touch via email and texting versus using a standard telephone to communicate) requires them to have sufficient ability to think (Czaja et al., 2006). Older adults who can demonstrate higher levels of long term (crystallized) memory are more able to obtain new knowledge and skills (Beier & Ackerman, 2005).

The ease of use is always important but is especially important when designing an interface for older adults. Interfaces with cognitive support provide valuable assistance to older adults. Fisk et al. (2004, p. 27) asserted “technology interfaces should place minimal demands on working memory, and environmental supports, such as cues and reminders or

navigational aids, should be provided.” Jacko and Sears, (2003) suggested that software and educational materials should be designed to lessen the cognitive load on older adults.

Jacko and Sears (2003) saw the importance of thinking (memory) capacity in the performance of an older adult traversing through websites. This is due to the fact that parts of mental performance that utilize cognitive abilities deteriorate along with age (Jacko & Sears, 2003). Park (1992) noted that the processes that deteriorate are short-term memory, communication abilities, problem resolution and interpretation, the ability to understand models, and the ability to translate facts into meaningful information.

In addition, aging has been seen to be closely related to declines in how quickly information is processed (Salthouse, 1985). Normally, an older adult processes information more slowly, and requiring extra time to react to and understand information (Czaja & Lee 2007). This slower reaction requires interface design that lowers the pressure on users to respond to feedback from queries or lookups. Failure to provide such support is likely to lead to frustration when older adults are surfing the web. Therefore, “interactive systems” need to relieve the mental frustration of the user by offering assistance via helps and site maps (Newell et al., 2003).

Newell et al. (2003, pp. 464-481) also stressed “careful consideration of the steps in an interaction and the way they are presented to the user can help mitigate the most common problem of deficient short-term and working memory.” A useful and effective system should include mechanisms to allow for correction of mistakes or confusion. Also, the system should provide positive feedback when appropriate. More importantly, it should help users avoid making such errors in the first place.

While the proposed work in its current form falls short of providing direct cognitive support, the use of error detection should help provide users with a clearer idea of what kind of help they need.

### **Computer Challenges for Older Adults**

#### *Lack of experience*

It is well known that older adults typically have been less familiar with computer technology and techniques than younger adults and teens (Adler, 1995; Rogers et al., 1996). Morrel and Echt (1996, 1997, pp. 335-361) noted that “there are several reasons for this discrepancy in use” of computers and training in their use. Children have received technology education in school and have grown up using computers. Moreover, the technology has been designed for a younger audience (Morrel & Echt, 1996; 1997). The designers and engineers that build the computer systems are usually young themselves (Makris, 2001; Newell, & Gregor, 2001).

Kelley and Charness (1995) reported that teaching older adults requires more time than teaching younger people. They also found that older adults make more mistakes while learning computers and that software training is helpful but difficulties are nonetheless encountered with bad interfaces (e.g., websites primarily used by younger people).

Obtaining computer skills requires many older adults to learn completely new concepts. Hummert, Nussbaunn, and Wiemann (1992) showed that cognitive impairments associated with aging could be a barrier to learning new concepts, as discussed earlier. Research has shown that older adults want to learn new technology (Charness & Czaja, 2005; Czaja, 2005). Czaja and Lee (2003) found that while older adults experience difficulty

learning how to use the computer, they gain technological competence by actually working through the difficulties and succeeding.

*Support for inexperienced users*

Proposing a computer system for older adults necessitates awareness of the user's impairments, other user characteristics, and the level of inexperience with computer technology (Demiris, 2001). Limitation from impairments such as reduced intellect, cognitive reasoning, and/or mobility related to becoming older, suffering a short-term injury, or suffering a long-term disability makes it difficult for an individual to communicate, work, play, or simply perform tasks that other people can do normally (Demiris, 2001). In addition, user performance can be affected by the person's lack of awareness or acceptance of technology (Mackie & Wylie, 1988).

Older adults' lack of experience can be a problem when introducing solutions. Most websites have not been designed for accessibility, especially for older adults. The failure to consider user characteristics and limitations is an important reason for user errors and the resulting frustration sometimes felt by older adults. Researchers have found that older adults differ in their patterns of Internet use, including the way that they shop online (Mazur, Signorella, & Hough, 2012). Kwon and Noh (2010) found that online retailers who are targeting older users have to understand these differences in order to be successful.

Sloan et al. (2010, pp. 26-27) noted that in order to successfully develop improvements in accessibility it is necessary to accurately understand user needs and accommodate those needs in an unobtrusive way. Sloan et al. (2010, pp. 26-27) wrote "(the improvements) should be implemented as imperceptibly as possible, (to minimize) any traumatic disruption to the way in which a user interacts with their



computer. The extent to which this process can be fully automated will depend on the nature of the adaptation.”

It is vital to provide “older adult users” with a positive experience and to avoid making it difficult when asking them to learn a new technology (Wood et al., 2005; Iyer & Eastman, 2006). The US government and HCI professionals have cited this need for a “good experience” when promoting equal access to the Internet via computers to benefit older adults (Lawson, 1999). Literacy training and testing have been seen to help older adults understand technology and gain confidence in working with computers (Charness et al., 1992).

Our error detection strategy solution addresses the issue of mobility by using mouseover technology to effectively show location and information to help the user navigate through a site that is not compliant with National Institute of Aging (NIA), National Library of Medicine (NLM), or World Wide Web Consortium (W3C) guidelines. W3C guidelines also suggest large buttons to minimize the necessity for precise mouse movement to initialize an icon (NIA & NLM, 2002).

### ***Other support***

Sato et al. (2011, pp. 155-162) have extended “a voice-based augmentation technique originally developed for blind users.” They wanted “to reduce the cognitive load on older adults by providing contextual support.” Researchers at IBM (Watson facility) have explored solutions addressing more effective ways of creating webpages for use by older adults using client server technology and using user-defined preferences to format the webpages (Hanson, 2001). Many researchers are testing and developing new methods for older people to use the internet that will meet their specific needs (Alpay et al., 2009).

Nagao et al. (2001) used a type of transcoding that considers a user's environment-devices, network bandwidth, and profiles to provide content changes to webpages. The primary shortcoming of the work at IBM is that it relies on users defining their own preferences. As will be seen in Chapter 5, user-defined preferences are not very accurate.

Other researchers have looked for ways of determining user needs. Mobasher et al. (2000) used data mining techniques to determine older adults' user preferences. Similarly, Shardanand and Maes (1995) investigated applications that used information about users to develop queries to return information. The problem with both of these methods is that they are hard to effectively use at runtime.

Saba and Mukherjee (2003) have developed methods for users to meet their needs transparently. The problem with these methods is that there isn't much information about user needs available.

The next chapter looks at the software model used in our study. The software allows us to combine information about a user's performance with his or her current activity. This approach allows us to maintain a good picture of user needs at runtime and to provide the support needed at the time it is needed.

## CHAPTER 3. SOFTWARE PLATFORM

### **Introduction**

This chapter describes the design, implementation, and operation of the Error Detection System software used to support our study. The purpose of the Error Detection System is to measure efficiency in an unobtrusive and dynamic Internet browsing environment that is capable of evaluating user performance and providing dynamic modification of webpages according to individual user profiles. Section 3 examines the platform in more detail and provides an example. Section 4 gives a technical overview of the platform. Finally, Section 5 provides a very brief example of the processes involved with participants using the instrument.

### **Overview of Platform**

The Error Detection System's platform provides the mechanism to collect relevant information to gain insight into some of the problems that older adults encounter while browsing the Internet. The software creates a user profile for each individual to assist participants surfing the Internet, while tracking their error rates. The result is that users are able to get page modification without having to make manual adjustments in their browser.

The architecture was designed to capture errors related to vision and motor skills through computer programs and hardware. In this study, user performances were compared based on profiles created by self-assessment tests, observation, actual performance tests, and our Error Detection System. Details on the design and generation of the four types of profiles are given in Chapter 4. Here it is sufficient to note that the user profile variables (font size and motor skills) represent the perceived limitations of the owner of the profile.

## Experiment Platform

### *Basic concepts*

A block diagram of the software platform used in the experiment is shown in Figure 3.1. URLs for the webpages requested by the user are sent to the *Webpage Convertor* module. The module downloads the requested webpage and modifies it based on the contents of the user's profile (Table 3.1). For example, font size of the text on the page is increased to the font size value given in the user profile, as needed. The motor skills scores are used to enlarge the area of interactive screen features, like buttons, and text boxes. We used the phrase, *sensitive area*, to represent this enlarged area. When the user clicks inside the sensitive area, the feature is activated (e.g., the button is clicked).

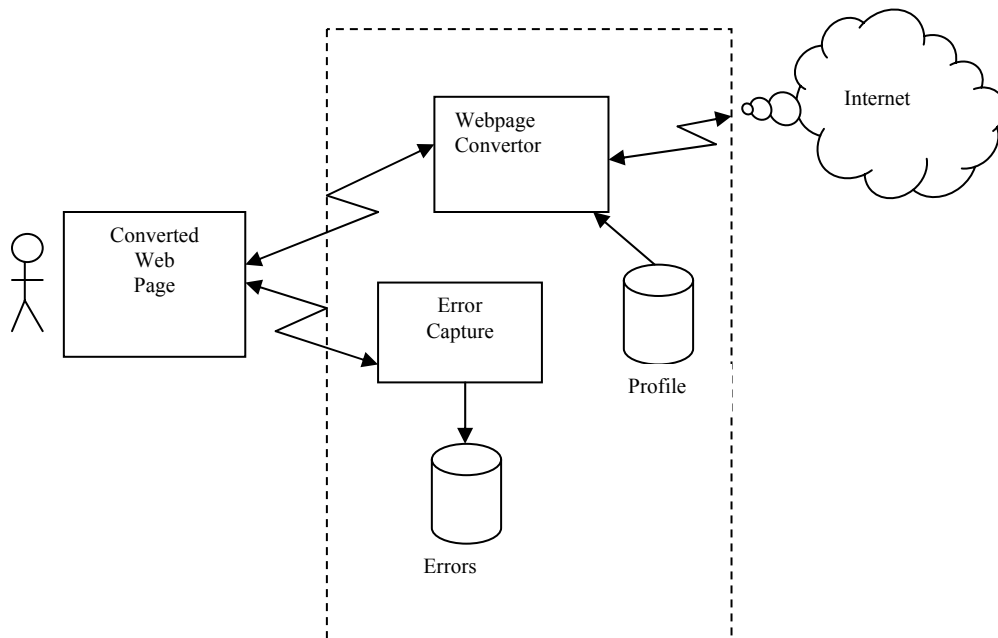


Figure 3.1. Block diagram of the software platform used by participants

Table 3.1. User profile used in the current studies

Username
Date
Time
Profile Level
Font Size
Motor Skills Score

Each converted webpage is supplemented with code (JavaScript) to support error detection. The errors made by the user are captured on the webpage and sent to the server level and stored to support analysis. An example of an error would be a user clicking near the sensitive area of a button but not close enough to activate the button

The system uses an account logon system to identify each user. The user identification information is stored in the session state and it links users to their performance and profile information.

A user may navigate the web either by a universal relocation link (URL) box at the top of the page, by clicking on links to a website, or by clicking a submit button. These actions will trigger the system to retrieve the HTML code for the specified webpage. The HTML codes are modified to meet the specific needs of the user, based on the user profile.

When the webpage is requested, the page is retrieved and loaded onto the server. The webpage is then parsed for font parameters, tags, size, and area. Once it has found the tags, the webpage convertor replaces the values based on the profile values. If the values are the same or larger than required, it does not change the fonts or button size. Then it loads the modified page and sends it to the user.

### ***Errors***

The study focused on two error types: motor skills and vision (font size). There were several types of motor skill errors recorded: mouse errors, scrolling, access, and clicking errors. Mouse errors were errors made as a direct consequence of problems related to using the mouse (e.g., failure to double-click immediately to complete an action). Scrolling and access errors indicate an informational architecture problem that would affect the participants' precision and accuracy. Committing a clicking error involved making a random or unnecessary mouse click unrelated to the process. The session time length was also recorded, in addition to the specific error types.

### ***Profiles***

Four approaches to constructing the user profile have been used in the work. Each profile had the same composition and structure. They all had the same fields and attributes. They only differed in the way values in the fields were generated. Details on the four profiles are given in Chapter 4. Here we provide a brief overview.

Self-assessment profile - Participants were asked to make a self-evaluation of their visual ability and to rate their motor skills. The self-evaluation was the participants' perspective of their own ability and their assessment of what they thought were the optimal settings for them to perform effectively. The self-assessment was used to generate a user profile for each user. In the remainder of the manuscript we use the phrase *self profile* to represent this profile.

Written test - Each participant was given a series of measurable tasks to perform to check their limitations with respect to vision and motors skills. The exam results were recorded and

used to create a user profile. This profile is called the *test profile* in the rest of the manuscript.

Observation - Participants were observed while they were completing a task set. To ensure consistency, an observation evaluation form was developed with the help of a developmental psychologist specializing in aging. All observations were conducted by the same reviewer to reduce any observer biases. The phrase *observation profile* is used to represent this profile in the rest of the manuscript.

Error detection - The errors generated by a user as he/she worked his/her way through a set of tasks were captured and used to generate a user profile. Figure 3.2 shows the block diagram of the modified platform. During the tasks, the errors that are captured are analyzed and used to modify the current profile when the number of errors is above a preset threshold. The process continues until the system sees no additional change in the performance of the user. As in the observation approach, the number of clicks around a button or link is counted to determine the motor skill score. The font size is set based on the user's performance (correct steps in the task set) after giving the users different font sizes to work with.

The strategy behind error detection was to provide a transparent tool to measure errors and change the current profile to reduce the user errors. We use the phrase *error profile* in the remainder of the manuscript when referring to the use of this profile.

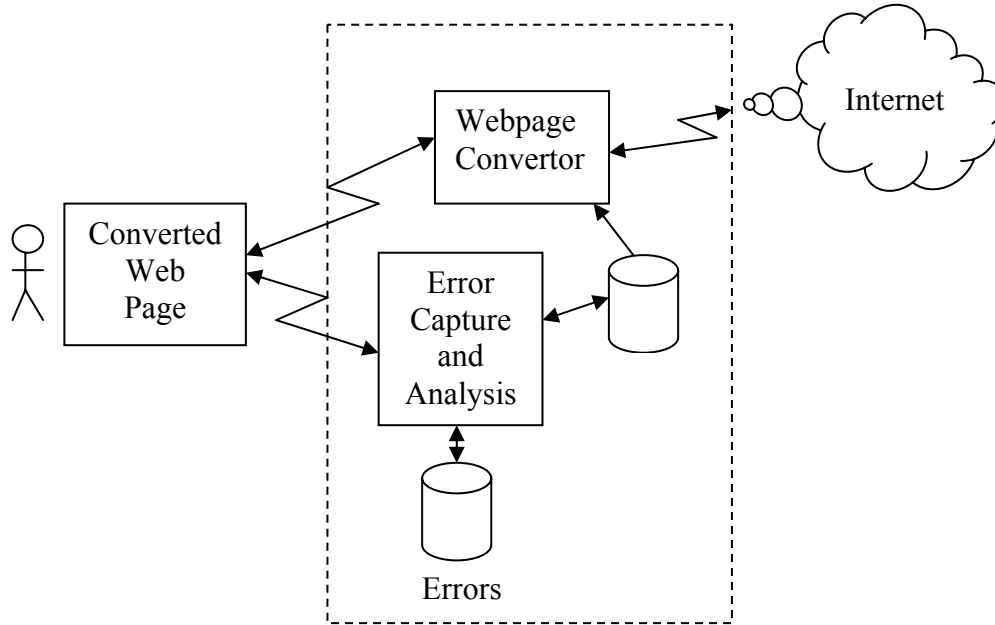


Figure 3.2. Block diagram of the system platform for supporting development and use of an error-based user profile

### Technical Overview

In the previous sections of this chapter we looked at the conceptual underpinnings of the software instrument. In this section we investigate the technical aspects of the instrument. We start by looking at the software platforms used to develop the software.

#### *Overview of software packages used*

The technical layout of the software instrument is given in Figure 3.3. A number of existing technologies have been used to design and implement the system.



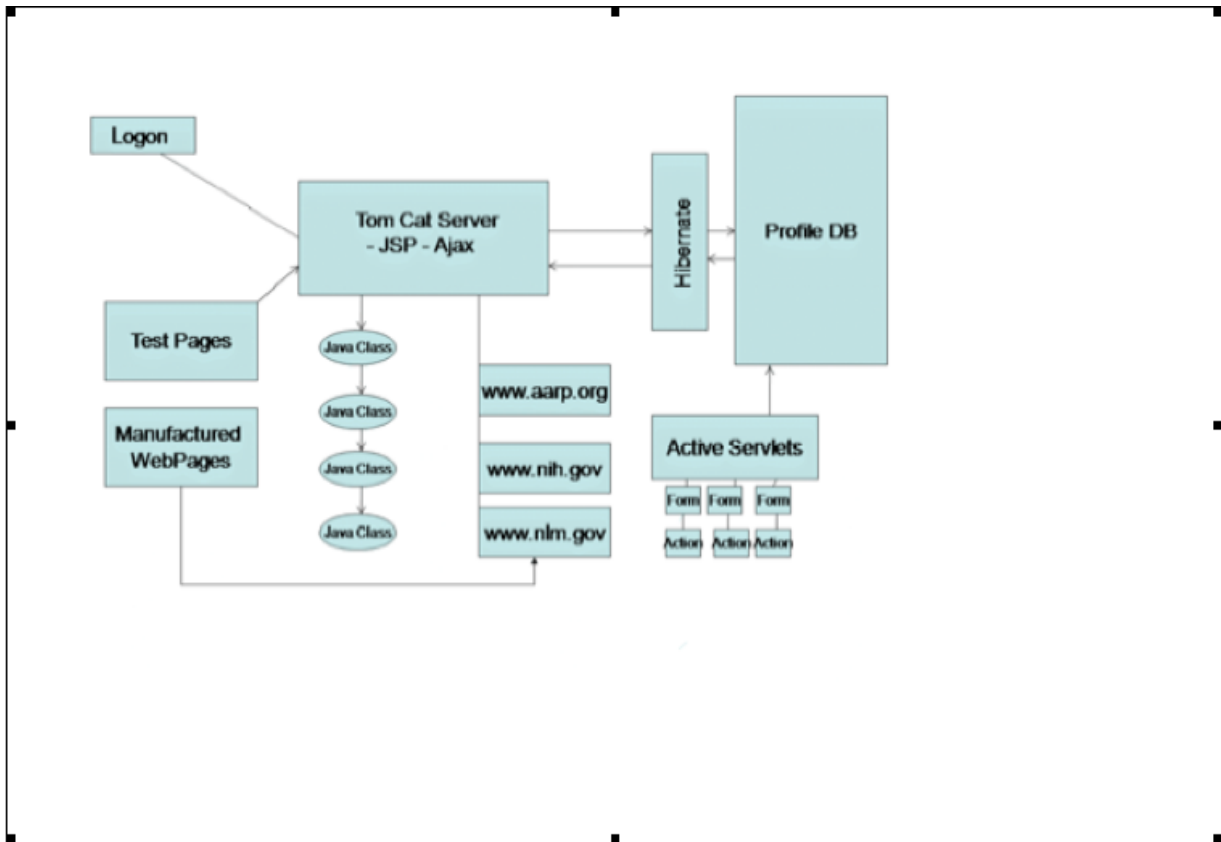


Figure 3.3. Components of the software instrument

Here we briefly summarize some of the more important technologies used in the system. The architecture of the system makes use of:

Java - The algorithm used to detect the errors on a webpage was based upon the Java programming language. Java is an object-oriented programming language that offers flexibility and great functionality for developing software solutions (Linden, 2010). Java classes or subprograms were developed that included the error collector, the webpage convertor, and a collector of mouse operations.

Java server pages - The java server page (JSPs) contained the code necessary to change the font size of a participant's webpage (Perry, 2004). The page content was based upon the cascading style sheets (CSS) codes. The font was used to format the look in the markup language of the webpage as it was returned to the participant.

Servlets - A servlet is a program in the Java Enterprise Edition that is used by the Java servlet application-programming interface (Perry, 2004). Java servlets are used with web and server applications. Each JSP is converted into a Java servlet by the servlet engine being used (e.g., Tomcat).

Ajax - Ajax is an asynchronous JavaScript and extensive markup language (Crane et al., 2006). It has methods that were used to develop web applications. This was done in a client-server environment.

Tomcat - The Tomcat server was the middleware that housed the software system. Tomcat is a Servlet Engine (Negrino & Smith, 2007). The server was used to tie the user to the system software via Internet browsers. The server software environment transformed webpages into customized pages for the older adults to see. It was used to keep track of errors and user profiles.

Hibernate - This is an object relational mapping library for Java that allows the Java classes to view the data stored in a relational database as persistent objects (Negrino & Smith, 2007).

Struts - This is an action- and form-driven technology (Alur et al., 2003). Struts provide a J2EE framework for web applications, such as error detection that supports the model-view-controller pattern.

JavaScript - This is a scripting language (Negrino & Smith, 2007). It can be used to communicate and validate form information with the server. Each converted webpage is

supplemented with code (JavaScript) to support error detection and support expansion of sensitive areas around action-based components.

Hyper Text Markup Language (HTML) – HTML is a markup language for defining and describing a webpage (Negrino & Smith, 2007). An HTML page contains HTML tags that define the webpage. The purpose of a web browser (such as Internet Explorer or Mozilla Firefox) is to read HTML documents and display them on the computer screen. The use of HTML helps by increasing understanding through better information architecture (layout) and by increasing readability for understanding through layout options (CSS and XML).

Figure 3.4 displays the software components of the server (in the form of Java Jars) that were used to capture and track the web activities of the participants while completing tasks. The integrated development environment (IDE) was Eclipse Enterprise with an Apache Tomcat web server.

In the next subsection we look at a key technical point – how errors were detected.

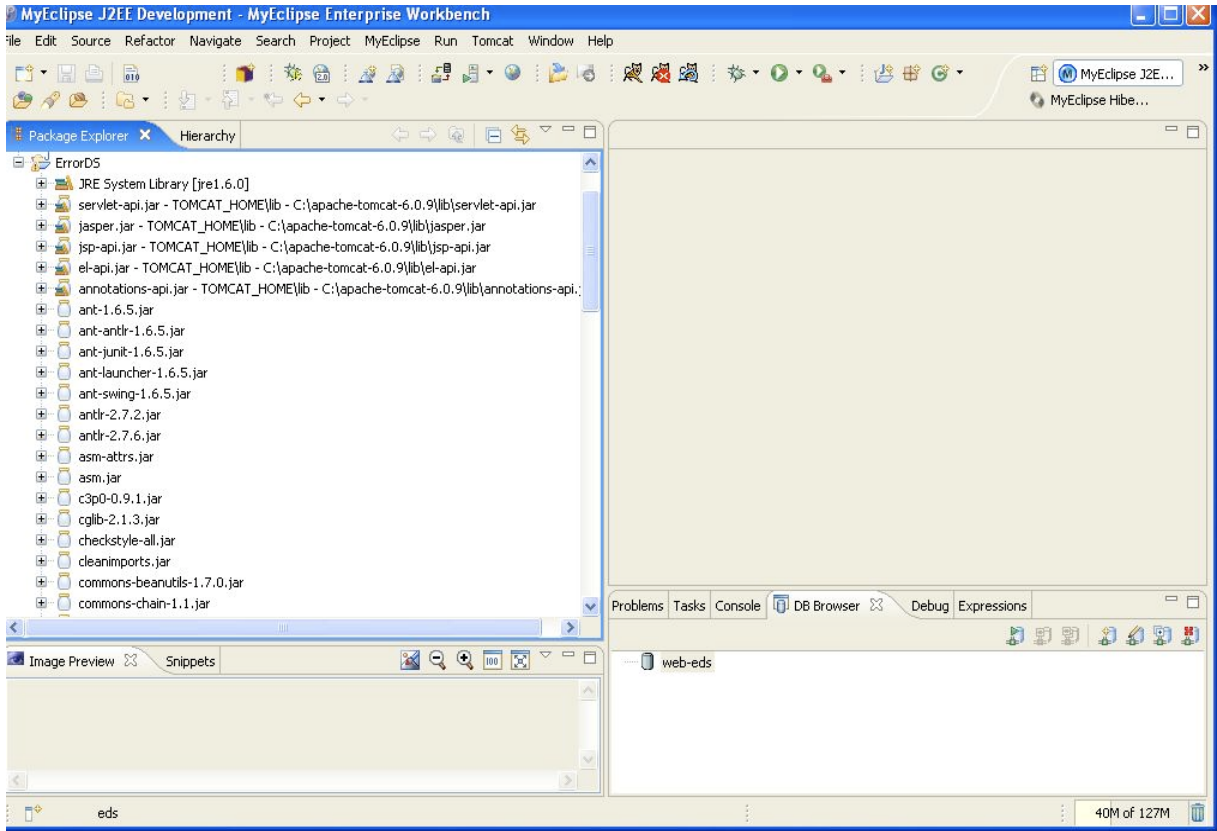


Figure 3.4. Software component jars used in error detection system

### ***Error detection***

A key aspect of the software instrument is the successful determination of when an error has occurred and how to assign the error type. In the present work, we have used two error types: motor skills errors and vision errors.

To detect errors, we saw the screen real estate as being broken into two disjointed regions, namely, a sensitive region and a non-sensitive region. The *sensitive region* of the screen is defined as the portion of the screen where an action is initiated whenever a mouse click occurs within its boundary. For example, if a user clicks on the sensitive area around a web link, the browser action is to transfer the user to the webpage indicated by the web link.

Similarly, the browser takes actions when a user clicks on a button, a textbox, radio button, or any other action-based HTML component.

The *non-sensitive region* of the screen is the part of the screen where a mouse click does not cause an action to occur. The non-sensitive portion of the screen can be made up of empty space or screen components that do not generate actions (such as labels, images or text that are not defined by HTML as web links).

### ***Index***

To support the detection of mouse click errors, we developed a screen real estate index designed to index the active components of a webpage. The structure of the index (shown in Figure 3.5) makes use of an x-list (the x-values of the set of points on the webpage that define the location of the action-based components). For each  $x_i$  entry we have a list of  $u$  objects, where  $u$  consists of a  $y$  value and a pointer to the list of action-based components that are within a threshold  $t$  distance from the  $(x, y)$  point indicated by the  $u$  entry. Consider the simple webpage shown in Figure 3.6

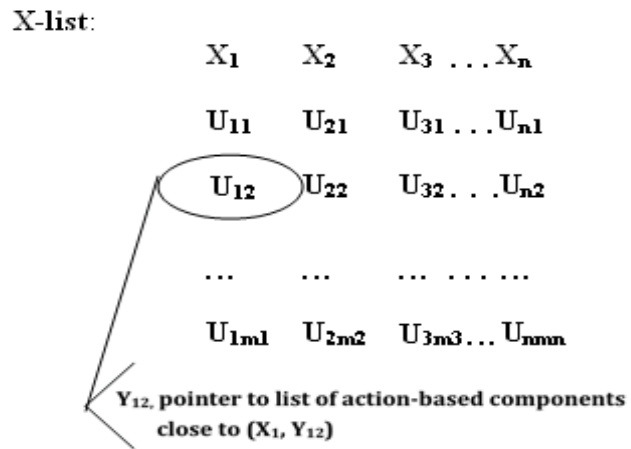


Figure 3.5. Basic index structure used for error detection

Participant Information:

Name:

Email Address:

Sex:  Male  Female

Do you have computer experience?

Yes

Useful links

[Project description](#)

[Participant questionnaire](#)

The screenshot shows a light blue background with a form titled 'Participant Information:'. The form contains five input fields: a text box for 'Name', a text box for 'Email Address', two radio buttons for 'Sex' (Male and Female), a checkbox for 'Do you have computer experience?' with the label 'Yes' next to it, and a 'Submit' button. Below the form, there is a section titled 'Useful links' containing two blue underlined text links: 'Project description' and 'Participant questionnaire'.

Figure 3.6. Simple webpage example

An idealized version of the index for the simple webpage from Figure 3.6 is shown in Figure 3.7.

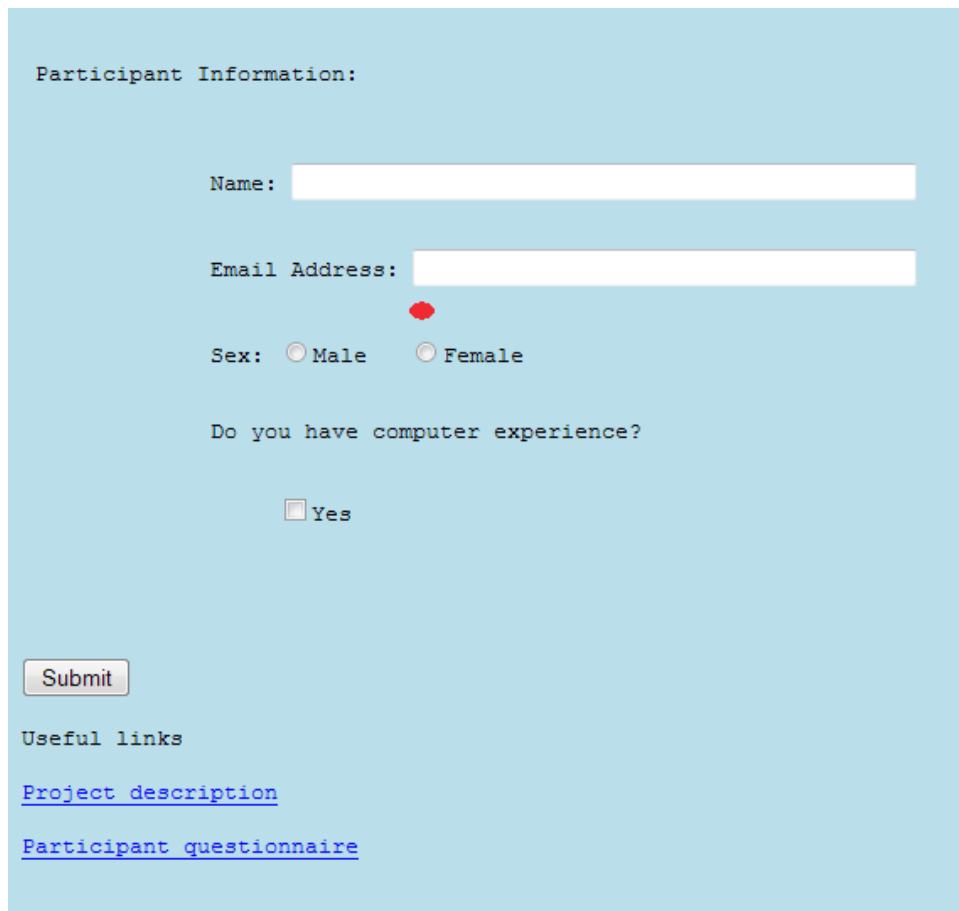
X-list	8	71	163	168	177	209	240	255	538	
	{	385	385	195	92	289	491	144	195	92
		409	409	210	113	305	506	164	210	113
		457		289				195		144
Y-lists		475		305				210		164
		491		457						
		506		475						

Figure 3.7. Idealized version of the index for the simple webpage from Figure 3.6

### *Detecting errors*

To detect errors, the index described in the previous subsection is used whenever the user clicks in the non-sensitive region of the screen. Suppose a mouse click occurs at location  $(x^1, y^1)$  in the non-sensitive region. The  $x$  value is used to determine if any action-based components on the webpage are sufficiently close to  $(x, y)$  to label it as an error. The  $x^1$  value is used to search the  $x$ -list of the index to locate the two  $x$  values that bound  $x^1$  (note that  $x^1$  cannot be in the  $x$ -list or it would not have occurred in the non-sensitive region). Once we have found the two  $x$  values (say  $x_1$  and  $x_2$ ) that bound  $x^1$ , we examine the  $u$ -lists for  $x_1$  and  $x_2$  to find the  $y$  values that bound  $y^1$  in each list. We can then use the components that are linked to the  $u$ -list entries to determine if our mouse click at  $(x^1, y^1)$  is sufficiently

close to one of the components to label it an error. We define *sufficiently close* to mean that  $(x^1, y^1)$  is within a distance  $t$  (a system-defined threshold) from one or more action-based components. A simple example using the webpage from Figure 3.6 and the index from Figure 3.7 is given in Figure 3.8.



Participant Information:

Name:

Email Address:

Sex:  Male  Female

Do you have computer experience?

Yes

Useful links

[Project description](#)

[Participant questionnaire](#)

Figure 3.8. Mouse clicks shown as red oval

In Figure 3.8 the mouse click is represented by the red oval. The location of the mouse click is at (245, 179). The x-value (245) falls between 240 and 255 in the x-list of the



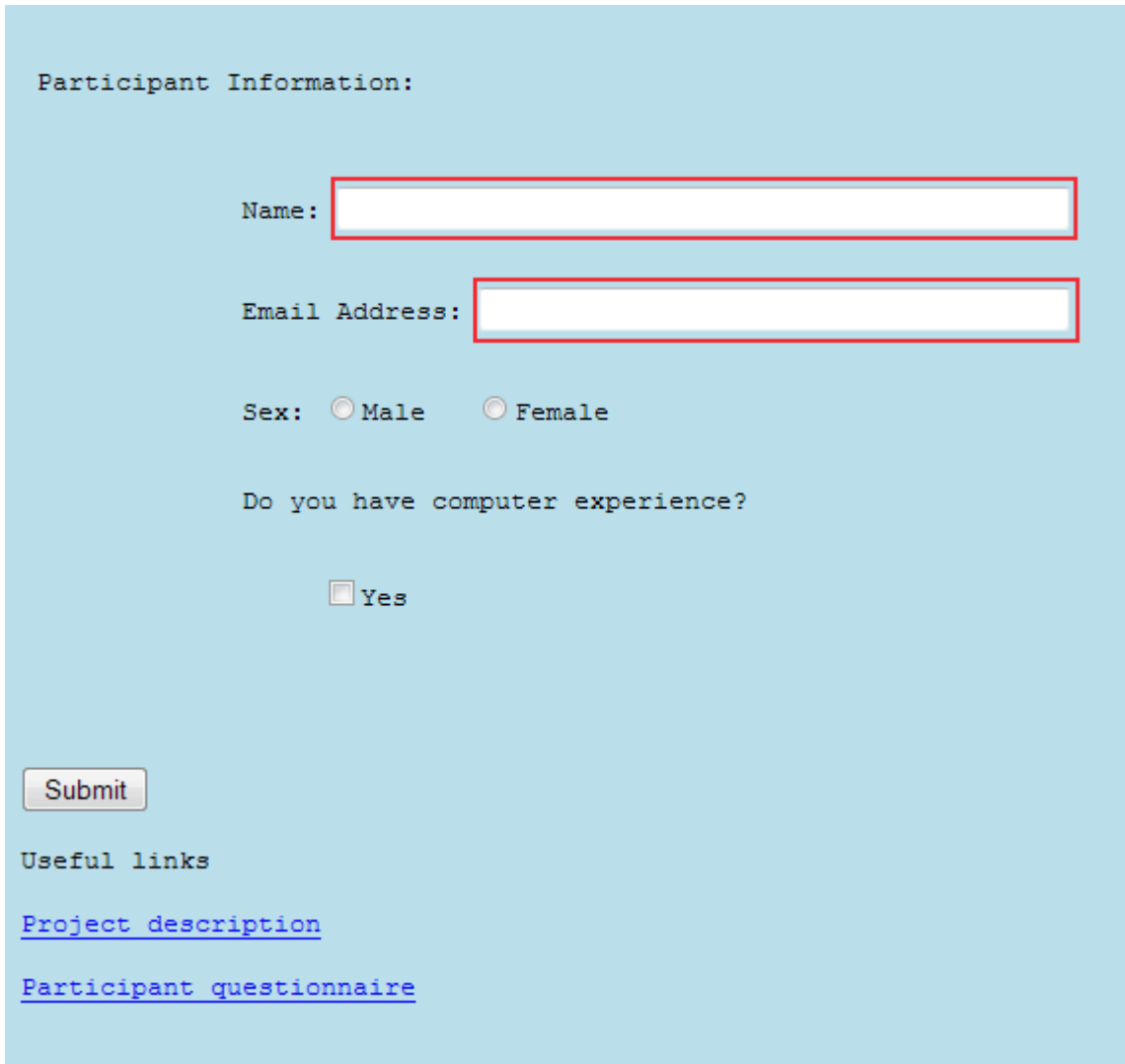
index. The y-value (179) falls between 164 and 195 in the y-list for 240 and is less than 195 in the y-list for 255.

For the points we have

<u>Point</u>	Components within $t = 40$
(240, 164) →	1) Email text box 2) Female radio button
(240, 195) →	1) Email text box 2) Female radio button

Testing the distance from the mouse clicks to the two components, we find that the mouse click is closer to the email text box. We assign the error type as a text box error. Since mouse click error can either be a motor skill or a vision error, we first look to extend the sensitive area around the components of the type found to be sufficiently close to the mouse click (in case of a tie, the sensitive area around all tied component types are inspected). The sensitive areas are investigated to determine if they can be expanded without causing the sensitive areas of action-based components to overlap. If no overlap is found, the error is considered to be a motor skill error; otherwise we label it as a vision error. The errors are logged. Figure 3.9 illustrates what we mean by expanding the sensitive area around a component type. The figure shows the expanded areas around the textboxes as a red rectangle. Since the expanded sensitive areas around the textboxes do not overlap, we assume that the error is a motor skills error and we log the error. Note that at this point we are only interested in classifying the error, so no actual expansion of the sensitive area

occurs. Details on how the user profile will be modified and how the profile is used to expand sensitive areas are discussed in detail in Chapter 4.



Participant Information:

Name:

Email Address:

Sex:  Male  Female

Do you have computer experience?

Yes

Useful links

[Project description](#)

[Participant questionnaire](#)

Figure 3.9. Expanded sensitive areas for text boxes

### Example

In this section, a simple example consisting of basic input, logon, simple webpages, and the transformation of these pages is described. Figure 3.10 displays a simple logon

screen that is linked to each participant. Once the user is logged in, the participant's profile is used as the basis of converting webpages for the user.

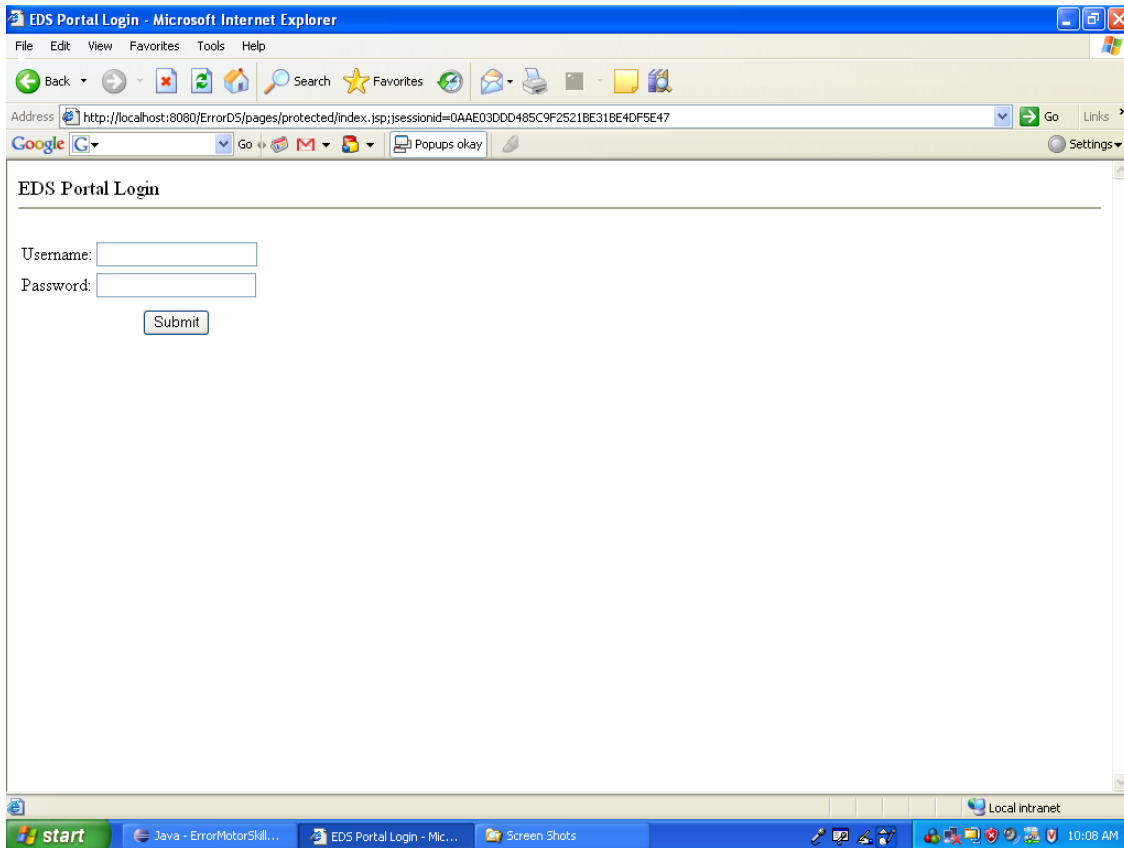


Figure 3.10. Login page for participant to access server

Figure 3.11 displays the webpage before modifications, with no change in font size at its starting state with a normal set of fonts. After the profile font sizes are loaded into the webpage, it is presented to the user as shown in Figure 3.12.

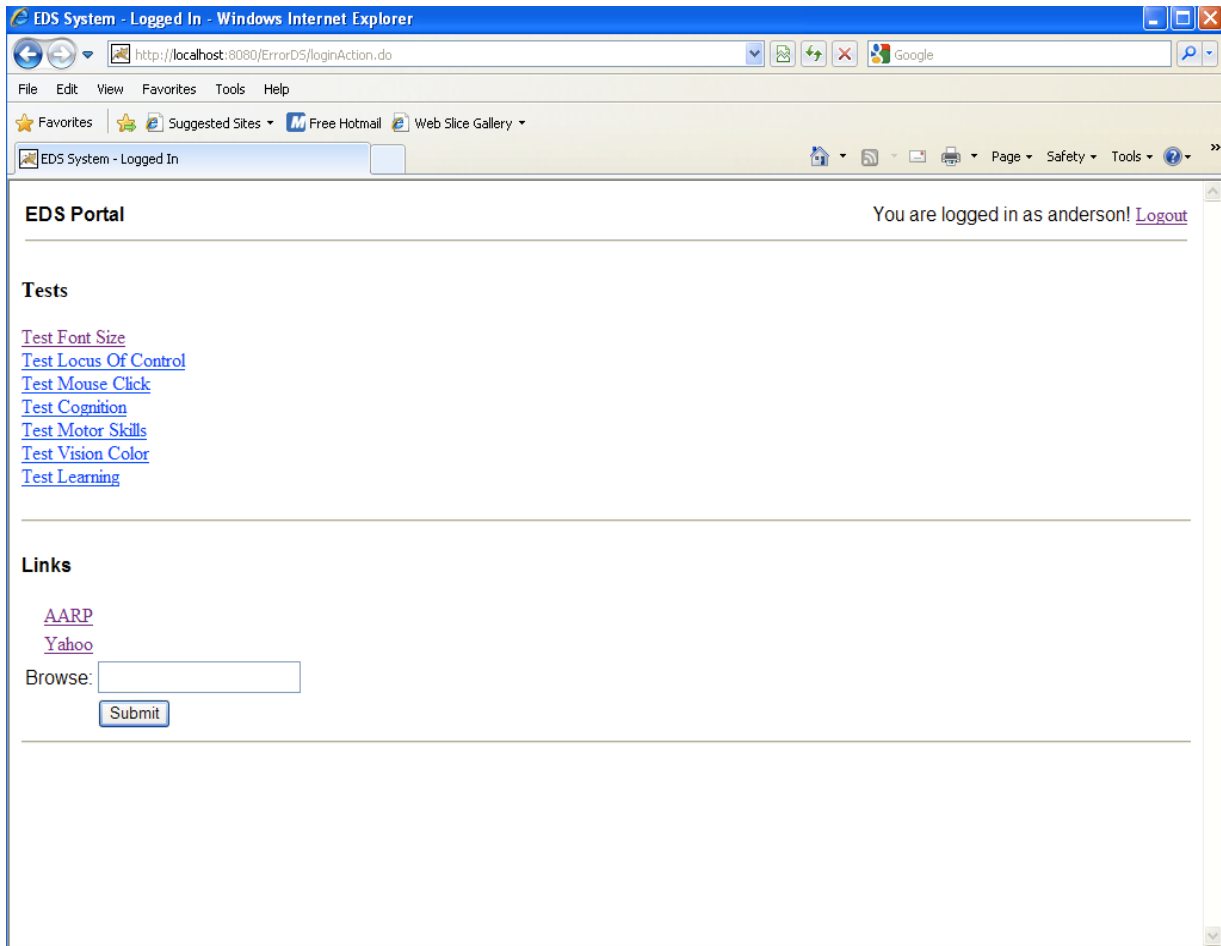


Figure 3.11. Login test page before font size modified

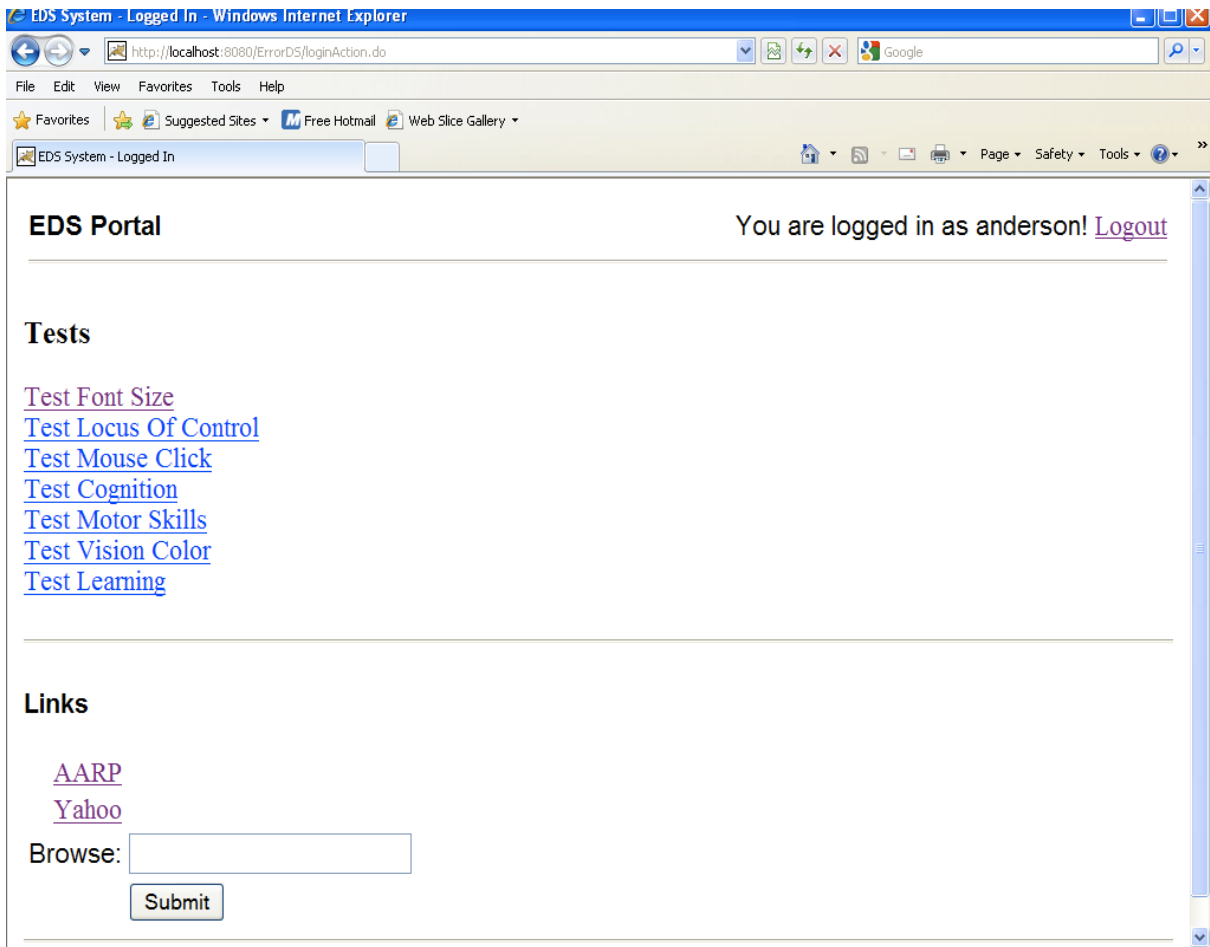


Figure 3.12. Login test page after font size has been modified

The next chapter looks at the design of the experiment.

## CHAPTER 4. EXPERIMENTAL DESIGN

### Introduction

The focus of the discussion in this chapter is the design of the experiment. Our ultimate goal was the development of an error-based strategy that used the errors collected by the error detection system to create a new profile. To study the effectiveness of the error detection approach, we compared it to the traditional methods: self-assessment, written test, and observation. The remainder of the chapter describes the basic experiment, training used, task description, and the details of how the profiles were created.

### Participants

Twenty-five participants were recruited for the study. They were comparable in health and received comparable treatment throughout the study. The background and characteristics of the participants who completed the study were similar to those reported in other studies of usability for older adults. No significant differences in demographic characteristics or baseline performance were observed between the participants who completed the study (N=25). The participants were scheduled individually for each step of the study.

The study was conducted at a retirement community that provides services for independent living, assisted-living, and nursing care residents. The sample size was 25. There were 24 independent living and one assisted-living participant. The 25 participants were a convenience sample. The participant group consisted of fourteen females and 11 males took part in the study as shown in Table 4.1. The age of the participants ranged from 62 to 97 years old with a mean of 77. All of the participants met the preconditions of being over the age of 60 and not having any severe physical impairment such as blindness or

inability to use the mouse and/or keyboard. They had to be willing to learn and to be able to sit at a computer for a 30 to 60 minute session. Computer experience was collected through a questionnaire. A copy of the questionnaire is shown in Figure 4.1. The participants were not paid.

Table 4.1 shows the basic demographic information about the participants. The participants all lived in their own apartments.

Table 4.1. Participant demographic data

Male (n)	11
Female (n)	14
Age (mean)	77 years
Age range	62-97 years

### **Basic Experiment Description**

Participants were placed approximately 25 inches from a 20-inch viewable Dell monitor display screen. Screen resolution was set at  $1024 \times 768$  pixels, with a 32 bit-color setting. The icon and the target folders sizes were 36.8 mm (diagonal distance), based on the findings from Jacko et al. (2001). To perform the experiment, each participant used an IBM Pentium computer. The operating system was Microsoft Windows XP Professional. The computer used a Digital Subscriber Line (DSL) for Internet access. The computer was housed on a computer desk with an accompanying chair in the retirement community.

At the initial meeting, each of the participants was given a letter of consent to read that explained the study. They were told that there would be four tests and their activity would be recorded. At the first meeting, each user was asked to give a self-assessment of

their limitations and their abilities. At the second, a pen and paper test of vision, motor skills, and memory was administered and recorded, and then their performance using the

Participant Name: _____	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="font-size: small;">ISU IRB # 1</td> <td style="font-size: small;">06-647</td> </tr> <tr> <td style="font-size: small;">Approved Date:</td> <td style="font-size: small;">27 August 2007</td> </tr> <tr> <td style="font-size: small;">Expiration Date:</td> <td style="font-size: small;">28 January 2008</td> </tr> <tr> <td style="font-size: small;">Initial by:</td> <td style="font-size: small;">jlc</td> </tr> </table>	ISU IRB # 1	06-647	Approved Date:	27 August 2007	Expiration Date:	28 January 2008	Initial by:	jlc
ISU IRB # 1	06-647								
Approved Date:	27 August 2007								
Expiration Date:	28 January 2008								
Initial by:	jlc								

**Participant Self- Assessment Questionnaire**

1. Rate your motor (hand movement) skills ability 1 to 5, (5) being excellent.  
1-Poor 2-Below average 3-Average 4-Above average 5-Excellent
2. Rate your vision level 1 to 5, (5) being excellent.  
1-Poor 2-Below average 3-Average 4-Above average 5-Excellent
3. Rate your thinking skills 1 to 5, (5) being excellent.  
1-Poor 2-Below average 3-Average 4-Above average 5-Excellent
4. Rate your comprehension (understanding) skills 1 to 5, (5) being excellent.  
1-Poor 2-Below average 3-Average 4-Above average 5-Excellent
5. Rate your learning skills 1 to 5, (5) being excellent.  
1-Poor 2-Below average 3-Average 4-Above average 5-Excellent
6. Rate your memorization skills 1 to 5, (5) being excellent.  
1-Poor 2-Below average 3-Average 4-Above average 5-Excellent
7. Rate how you feel about yourself 1 to 5, (5) being excellent.  
1-Poor 2-Below average 3-Average 4-Above average 5-Excellent
8. Rate how well you think you can learn to use the computer 1 to 5, (5) being excellent.  
1-Poor 2-Below average 3-Average 4-Above average 5-Excellent

Figure 4.1. Participant self-assessment questionnaire



profile based on the pen and paper test results was recorded. At the third meeting, there was an observational assessment of the participant's abilities based on his/her vision and motor skills. Afterwards, the participants completed a set of tasks and their performance was captured via the server. Finally, each participant was evaluated using the Error Detection approach. We initially set the participant's profile settings according to the test profile settings for the Error Detection study.

The four experiments were conducted within a twenty-one day period. Each experiment was scheduled for one hour. All of the participants completed the four experiments.

Three user profiles were created for each participant, based on the self-assessment, test assessment, and observations, separately. Each participant repeated the usability task based upon each profile. One, with the profile based on the self-assessment, another based on test assessment profile, and the third using the profile generated from the observational assessment. Next, the participants utilized the system using Error Detection for determining the values for the profile.

The usability test was designed to capture how many times the participant had to click the mouse to complete the task and how well they could see an icon/button to continue through a task. If the participant did not click the icon correctly, they could not complete the task. Each time they missed an icon/button because of low vision, mobility, or motor skills it would be captured. Four tables of data (captured errors) were used to create statistical information used in this study. Each table assigned to each participant's profile captured

how many errors they made while executing the tasks using each of the four profiles (self, test, observation, and error detection).

### **Profiles Creation**

As discussed in Chapter 3, all of the user profiles have the same data structure shown in Figure 4.2. The profile was used to guide the modification of the webpages that a participant requested during the completion of the task. The main difference was the way that the profiles were constructed. The remainder of this chapter details how the individual profiles were generated for each participant.

```

-----
Username
Date
Time
Font Size
Motor Skills Score
-----

```

Figure 4.2. Profile fields

Each instrument supplied different results. The self-assessment provided information and results based on the participant's perspective of their capacity to use their motor skills, the ability to see efficiently, their thinking ability, and their ability to use a computer. This information was used to build the self-profile.

The test questionnaire provided information about the actual capabilities of the participants. The areas tested were motor skills, font size, thinking/reasoning, and memory, although we focused on the correct font size and motor skills. This information was used to build the test profile.

The observation evaluation form provided information about the observed capabilities of the participant. The main areas observed were vision and motor skills. This information was used to build the observation profile.

The error detection profile generation was based on actual performance and errors that the participant made. These profile parameters (vision and motor skills) were automatically adjusted by a computer program.

### *Self-profile*

Each participant completed a self-assessment (Figure 4.1) of their limitations and computer skills. The responses from the self-assessment were used to define the parameters in the self-profile. The assessment asked the participant how they rated themselves in the context of using the Internet, their vision, motor skills, and their cognitive abilities.

The self-assessment questionnaire results provided profile parameter categories (in Figure 4.3) and values were created, based on their rating.

1. Rate your motor skills	“motor /mobility”
2. Rate your vision	“font size”
3. Rate your thinking	“thinking/reason”
4. Rate your comprehend	“understanding”
5. Rate your learning	“learning”
6. Rate your memory	“memory”

Figure 4.3. Self-assessment measurement categories

The answers from the self-assessment questionnaire were the basis for the initial coding of the parameters for the self-assessment profile. Figure 4.4 explains the process of the participant answering the questionnaire and the answers being translated into coded parameters for the profile.

**Introduction**

This table explains how the values for the self profile are created using the answers from the self-assessment questionnaire.

**Procedure**

The steps in the table below show the procedure for creating values in the self-profile.

<b>Step</b>	<b>Action</b>												
1	Participant selected the best answer to rate their motor skills.  <b>Result:</b> A value between 1 and 5 is selected												
2	The information below was used to determine the value to code in the profile. <table border="1" data-bbox="586 806 1338 1039"> <thead> <tr> <th><b>If answer is...</b></th> <th><b>Then code parameter...</b></th> </tr> </thead> <tbody> <tr> <td>1 – Poor</td> <td>Extra Large icon</td> </tr> <tr> <td>2 - Below average</td> <td>Large icon</td> </tr> <tr> <td>3 - Average</td> <td>Normal icon</td> </tr> <tr> <td>4 - Above Average</td> <td>Medium icon</td> </tr> <tr> <td>5 - Excellent</td> <td>Small icon</td> </tr> </tbody> </table> <b>Result:</b> Value coded in the Motor Skills field of the self-profile.	<b>If answer is...</b>	<b>Then code parameter...</b>	1 – Poor	Extra Large icon	2 - Below average	Large icon	3 - Average	Normal icon	4 - Above Average	Medium icon	5 - Excellent	Small icon
<b>If answer is...</b>	<b>Then code parameter...</b>												
1 – Poor	Extra Large icon												
2 - Below average	Large icon												
3 - Average	Normal icon												
4 - Above Average	Medium icon												
5 - Excellent	Small icon												
3	Participant selected the best answer to rate their vision level.  <b>Result:</b> A value between 1 to 5 is selected												
4	The information below was used to determine value to code in the profile. <table border="1" data-bbox="586 1373 1338 1606"> <thead> <tr> <th><b>If answer is...</b></th> <th><b>Then code parameter...</b></th> </tr> </thead> <tbody> <tr> <td>1 – Poor</td> <td>18 px</td> </tr> <tr> <td>2 - Below average</td> <td>16 px</td> </tr> <tr> <td>3 - Average</td> <td>14 px</td> </tr> <tr> <td>4 - Above Average</td> <td>12 px</td> </tr> <tr> <td>5 - Excellent</td> <td>10 px</td> </tr> </tbody> </table> <b>Result:</b> Value coded in the Font size field of the self-profile.	<b>If answer is...</b>	<b>Then code parameter...</b>	1 – Poor	18 px	2 - Below average	16 px	3 - Average	14 px	4 - Above Average	12 px	5 - Excellent	10 px
<b>If answer is...</b>	<b>Then code parameter...</b>												
1 – Poor	18 px												
2 - Below average	16 px												
3 - Average	14 px												
4 - Above Average	12 px												
5 - Excellent	10 px												

Figure 4.4. Self-assessment profile values process

The answers from the self-assessment questionnaire were the basis for the initial coding of the parameters for the self-assessment profile. Figure 4.5 shows the process of the participant answering the questionnaire and the answers being translated into coded motor skills parameters for the profile.

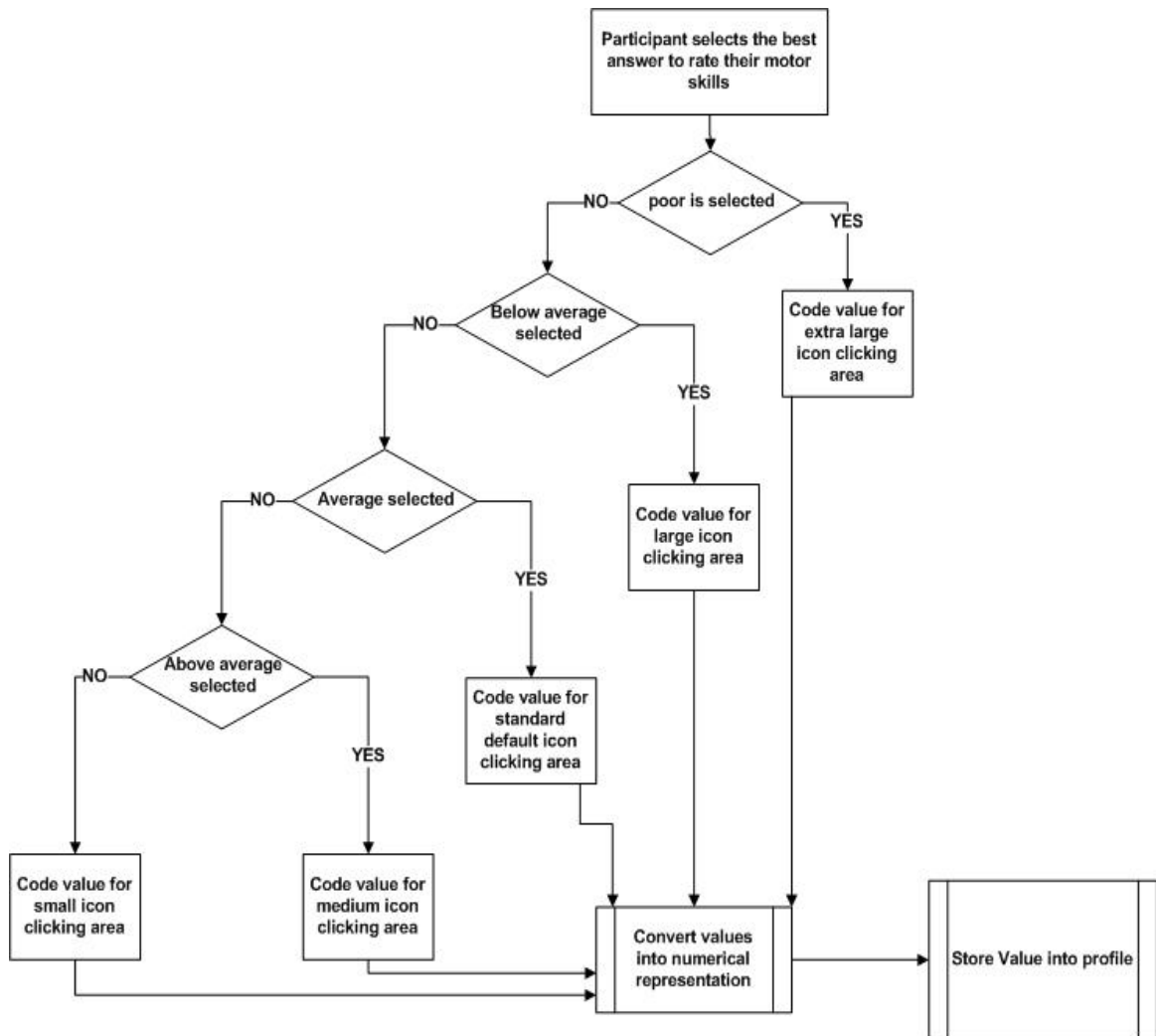


Figure 4.5. Self-assessment profile of motor skills parameters process flowchart

The answers from the self-assessment questionnaire were the basis for the initial coding of the parameters for the self-assessment profile. Figure 4.6 shows the process of the participant answering the questionnaire and the answers being translated into coded vision parameters for the profile.

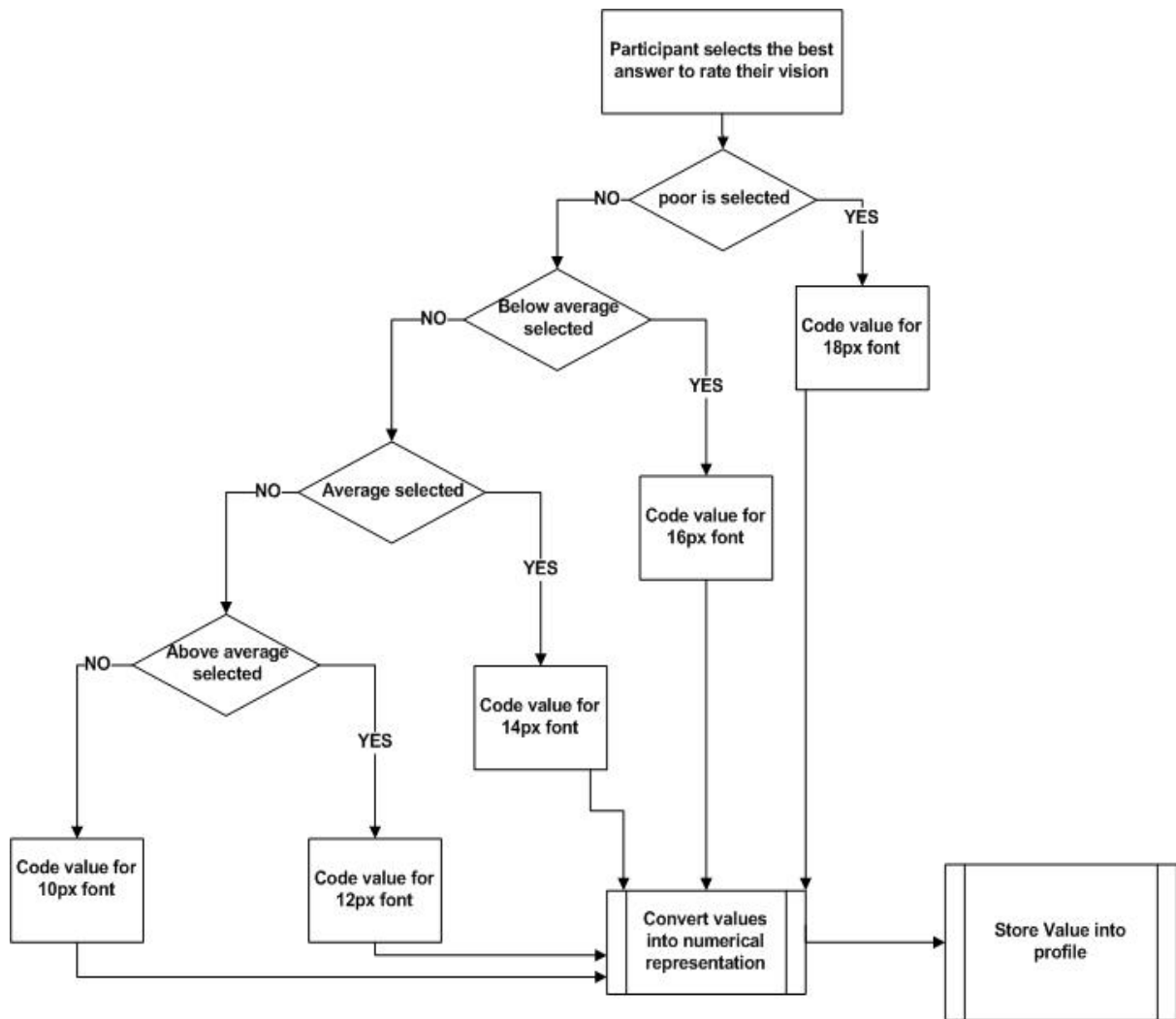


Figure 4.6. Self-assessment profile of vision parameters process flowchart

### ***Test profile***

The paper-based tests were given to the participants after the self-assessment and then the numbers of errors were captured during usability testing, using the paper-based results. As mentioned previously, the values were entered into a profile. The paper-based test showed the actual capabilities of the participant through their test question answers. The response values from the paper-based test defined the test profile parameters.

The results of the test questionnaire were used as parameters in establishing the test profile. These values were derived from how the participant performed on the test questionnaire in Figure 4.7. The participant was administered the test to measure actual performance in the areas of vision and motor skills.

The answers from the Participant Test Questionnaire were the basis for the initial coding of the parameters for the test profile. Figure 4.8 explains the process of the participant answering the questionnaire and the answers being translated into coded vision and motor skills parameters for the profile.

Participant Name: \_\_\_\_\_

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### Participant Questionnaire

1. Do you typically wear glasses?

Yes       No

2. Are you wearing glasses now?

Yes       No

3. Do you wear glasses when using the computer?

Yes       No

4. Gender

Female       Male

5. Check the word size that you prefer.

Apple     banana     orange     pear     grape

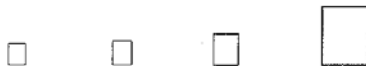
6. How long have you worked on a computer?

less than 3 months     More than 6 months  
 More than 1 year       Never

7. How often do you use a computer?

Less than Monthly     Monthly     Weekly     Daily     None

8. Please place a period . in the middle of each box.



9. Please match the symbols with the corresponding number. Place the number in the object.

1. Star    2. Rectangle    3. Square    4. Circle    5. Triangle



10. Age \_\_\_\_\_

Figure 4.7. Test questions used to generate the test profile



- 
11. Education Level in years \_\_\_\_\_  
 Grade School  Some High School  "12" High School  "14" Associate Degree  
 "16" Bachelors degree  "18" Masters degree  PhD
12. How well do you think you can learn computer technology?  
 Superior  Above average  Average  Fair  With some difficulty
13. Please choose an answer to the statement. Computers are for: \_\_\_\_\_  
 Playing games  Solving problems  Shopping on-line  Business
14. Ethnicity  
 Caucasian  Hispanic  Asian  Indian  African American
15. Prior occupation  
 Farmer  Professional  Homemaker  Medical  Teacher
16. Last Occupation \_\_\_\_\_
17. Income range  
 5,000-30,000  30,000-50,000  50,000-70,000  70,000-above
18. Marital Status  
 Married  Single  Widowed  Divorced
19. How many children do you have?  
 None  1  2  3  4 or more
20. Rate your health  
 Excellent  Good  Fair  Poor
21. List the number from highest to lowest.  
\_\_\_\_\_  
 23  2  16  eleven  33  31
22. Who was Franklin D. Roosevelt? \_\_\_\_\_

Figure 4.7. (continued)

**Introduction** This table explains how the values for the test profile are created using the answers from the self-assessment questionnaire.

**Procedure** The steps in the table below show the procedure for creating values in the test profile.

Step	Action												
1	Participant select the best answer to rate their vision. e.g., Question # 5. "Check the word size that you prefer."  <b>Result:</b> A value between 1 and 5 is selected.												
2	The information below was used to determine to value to code in the test profile.  <table border="1"> <thead> <tr> <th>If answer is...</th> <th>Then code parameter...</th> </tr> </thead> <tbody> <tr> <td>1 – Apple</td> <td>10 px</td> </tr> <tr> <td>2 - banana</td> <td>12 px</td> </tr> <tr> <td>3 - orange</td> <td>14 px</td> </tr> <tr> <td>4 - pear</td> <td>16 px</td> </tr> <tr> <td>5 - grape</td> <td>18 px</td> </tr> </tbody> </table> <b>Result:</b> Value coded in the font field of the Test profile.	If answer is...	Then code parameter...	1 – Apple	10 px	2 - banana	12 px	3 - orange	14 px	4 - pear	16 px	5 - grape	18 px
If answer is...	Then code parameter...												
1 – Apple	10 px												
2 - banana	12 px												
3 - orange	14 px												
4 - pear	16 px												
5 - grape	18 px												
3	Participant select the best answer to rate their motor skills level. e.g., Question # 8. "Please place a period in the middle of each box."  <b>Result:</b> A value between 1 and 4. Based upon accuracy of the period in the box. The most accurate to the center of box marked was selected as the best value.												
4	The information below was used to determine to value to code in the test profile.  <table border="1"> <thead> <tr> <th>Whichever box has the period closest to the center...</th> <th>Then code parameter...</th> </tr> </thead> <tbody> <tr> <td>Enter box number</td> <td>1, 2, 3, or 4 accordingly in respect to box selected.</td> </tr> </tbody> </table>	Whichever box has the period closest to the center...	Then code parameter...	Enter box number	1, 2, 3, or 4 accordingly in respect to box selected.								
Whichever box has the period closest to the center...	Then code parameter...												
Enter box number	1, 2, 3, or 4 accordingly in respect to box selected.												
5	Code motor skill field parameter according to results.  <table border="1"> <thead> <tr> <th>If period is closest in...</th> <th>Then code parameter...</th> </tr> </thead> <tbody> <tr> <td>1<sup>st</sup> box</td> <td>Small icon</td> </tr> <tr> <td>2<sup>nd</sup> box</td> <td>Medium icon</td> </tr> <tr> <td>3<sup>rd</sup> box</td> <td>Large icon</td> </tr> <tr> <td>4<sup>th</sup> box</td> <td>Extra Large icon</td> </tr> </tbody> </table>	If period is closest in...	Then code parameter...	1 <sup>st</sup> box	Small icon	2 <sup>nd</sup> box	Medium icon	3 <sup>rd</sup> box	Large icon	4 <sup>th</sup> box	Extra Large icon		
If period is closest in...	Then code parameter...												
1 <sup>st</sup> box	Small icon												
2 <sup>nd</sup> box	Medium icon												
3 <sup>rd</sup> box	Large icon												
4 <sup>th</sup> box	Extra Large icon												
6	<b>Result:</b> Value coded in the motor skills field of the test profile.												

Figure 4.8. Participant test questionnaire – the profile values process

The answers from the Participant Test Questionnaire were the basis for the initial coding of the parameters for the test profile. Figure 4.9 gives the process flow of the participant answering the questionnaire and the answers being translated into coded vision parameters for the profile.

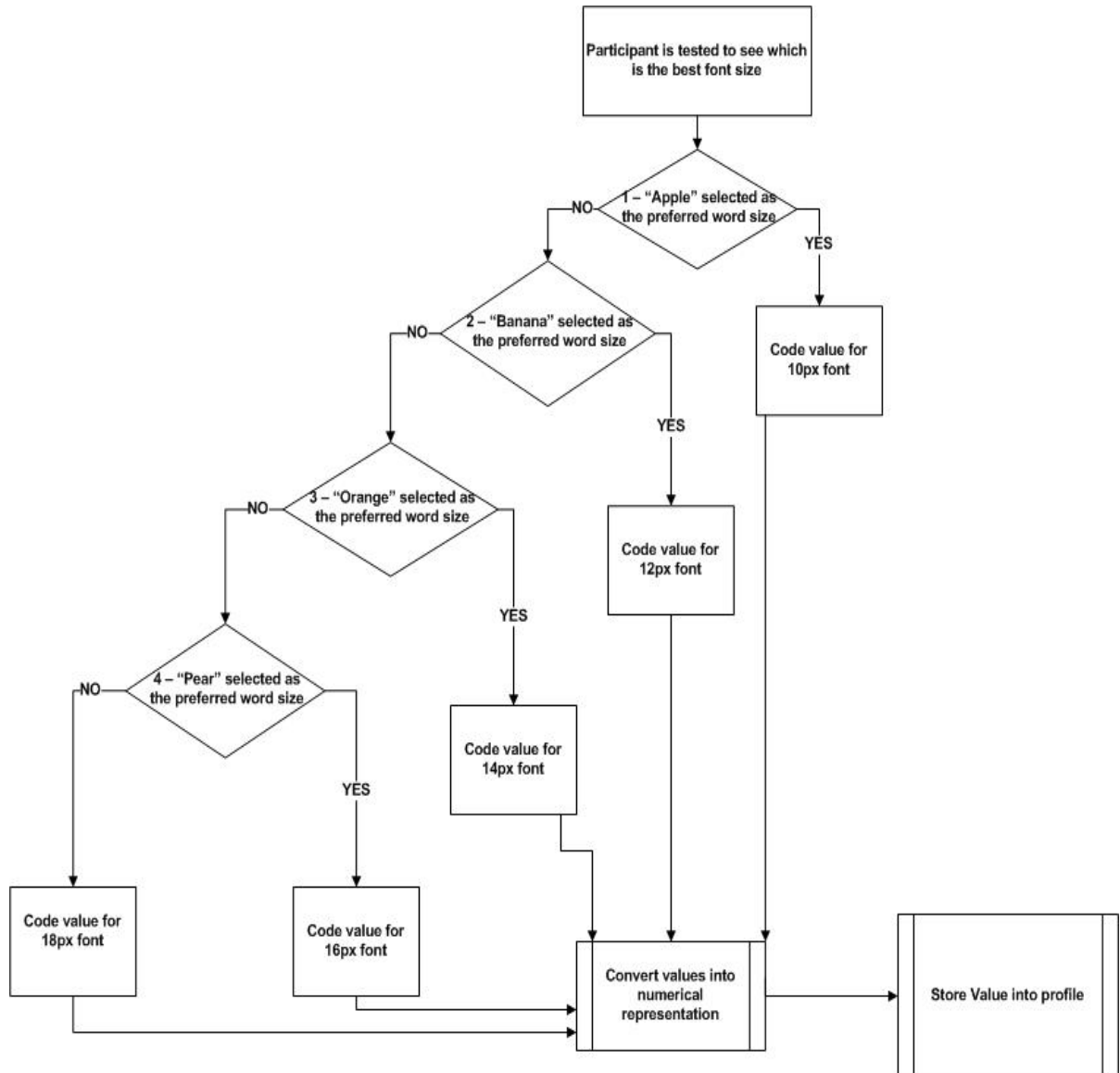


Figure 4.9. Test questionnaire profile for vision parameters process flowchart

The answers from the Participant Test Questionnaire were the basis for the initial coding of the parameters for the test profile. Figure 4.10 shows the process flow of the participant answering the questionnaire and the answers being translated into coded motor skills parameters for the profile.

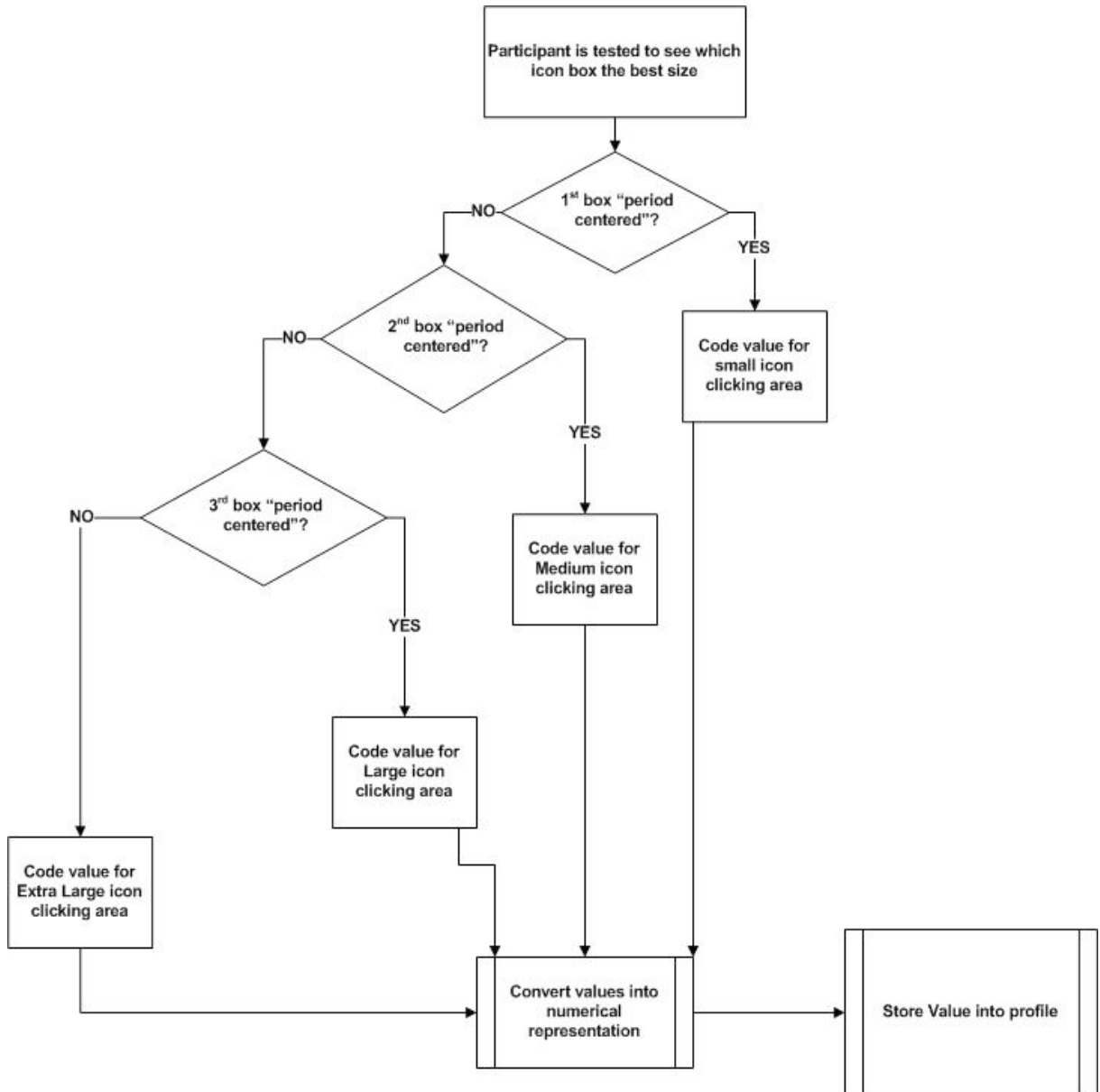


Figure 4.10. Test questionnaire profile for motor skills parameters flowchart

### *Process flowchart*

The output or results of the participant answers to the questionnaire were used to generate the profile parameters. Each question had a measurement assigned to each answer (e.g., question #5, word size). There was a font size associated with each block presented to the participant; apple = 10 point font, banana =12 point font, orange =14 point font, pear =16 point font, and grape =18 point font. The response to Question 8 helped determine the motor skills value. The participant had to accurately place a dot in the middle of the boxes presented. This profile is supplied with parameter information from the test questionnaire as shown in Figure 4.11.

	<u>Test Questionnaire Groupings</u>	<u>Measure</u>
1.	Word size	Font size
2.	Period placement	Motor

Figure 4.11. Test questionnaire measurement categories

The main objective of the participant test was to gather seemingly more accurate measures from the participants. That way we could create a test profile with measured values taken directly from the participants' actions. Questions contained on the test questionnaire included checking to see if there were any other possible factors that could affect the outcome of the measurements. For example, the participants were asked if they wore glasses and if they had the glasses on at that time. If the participant wore glasses but did not have them on, we would request that they get them. That way we insured a more accurate

assessment of their vision part of the test. We tested their long term memory and reasoning with questions 21 and 22 (see Figure 4.7).

### ***Observation profile***

The observation data were gathered when the participants were administered a set of tasks. The numbers of actions while the participants completed the usability task were recorded, using the observation form shown in Figure 4.12. The form was constructed in consultation with a developmental psychologist specializing in aging. The results were entered into a profile and then used as a preference for the participant while completing usability tasks. The responses from the observational session defined the observation profile.

The main objective of the observation of the participant was to collect observable behavior of the participant surfing the web. The usability observation evaluation form was used to collect and record varied characteristics of the interaction of the participant, such as accuracy in moving and clicking the mouse, traversing through a webpage, asking questions, talking out loud, and accomplishing tasks efficiently. More importantly, we were interested in the way the participant could effectively use their motor skills and see. The observational behavioral measures were used to evaluate and score specific behaviors that the participant displayed.

Observation identification - The icon identification items involve symbolic learning or the ability to match a pictographic representation of a word with an actual picture of the object. The item measures reading identification skills in identifying icons on the screen.

Cognition - The ability to understand instructions is the first item in the set, measuring understanding and coherence related to the task.

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Usability Observation Evaluation Form

Task 1: 1. 2. 3. 4. 5. (Rate 1 – 5)

- Read Instruction\_\_\_\_\_
- Screen Response \_\_\_\_\_
- Type\_\_\_\_\_
- Visually scan\_\_\_\_\_
- Non verbal\_\_\_\_\_
- Body Language\_\_\_\_\_
- Questions\_\_\_\_\_
- Talk out loud\_\_\_\_\_

Cognitive:

- Questions
- Talk out loud
- Efficiency
- Effectiveness

Motor Skills:

- mouse movement
- scrolls
- clicks
- access

Vision:

- Prog (aarp)
- 2<sup>nd</sup> site

Task 1:      Questions| Non-verbal's | Lean forward | adjust glasses |Other

Steps time

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_
9. \_\_\_\_\_
10. \_\_\_\_\_

Clarify language – Confounding knowledge

Behaviors:

Coding sub-behaviors

- # of clicks\_\_\_\_\_
- Steps to get to desired end\_\_\_\_\_

Figure 4.12. Usability observation evaluation form

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Initial by:	jc

Rating fluidity by time and #

1| \_\_\_\_\_  
2| \_\_\_\_\_  
3| \_\_\_\_\_  
4| \_\_\_\_\_  
5| \_\_\_\_\_

Vision =

- body gesture
- leaning forward
- verbal
- non-verbal

Figure 4.12. (continued)

Screen response - The ability to respond to a prompt and an icon presented on the webpage is the second item in the set measuring responsiveness and appearance of the webpage.

Type - The third item measures skills such as typing, vision, and dexterity.

Visually scanning - This fourth measure assesses participant's skill in application of material read and analyzes instructional skill. The ability to understand unfamiliar printed words.

Non-verbal - This fifth measure assesses the participant's facial countenance to capture any computer anxiety or frustration that would be otherwise undetectable.

Body language - This sixth measure, evaluates the participant's communication using body movements or gestures in the performance of task assigned.

Questions - This seventh measure assesses participant's skill and how well he or she performed the usability task with or without asking questions.

Talk aloud - This eighth measure, gauges the participant's cognitive processing and reasoning skills in applying analysis skills.



The results from the Usability Observation Evaluation Form were the basis for the initial coding of the parameters for the observation profile. Figure 4.13 explains the process of the participant answering the questionnaire and the answers being translated into coded motor skills parameters for the profile.

The results from the Usability Observation Evaluation Form were the basis for the initial coding of the parameters for the observation profile. Figure 4.14 shows the process flow of observing the participant and the observations being translated into the coded vision parameters for the profile.

The results from the Usability Observation Evaluation Form were the basis for the initial coding of the parameters for the observation profile. Figure 4.15 shows the process flow of observing the participant and the observations being translated into coded motor skills parameters for the profile.

**Introduction**

This table explains how the values for the observation profile are created using the results from the Usability Observation form.

**Procedure**

The steps in the table below show the procedure for creating values in the observation profile. Observer evaluated the participant based upon the observable key characteristics related to motor skills and vision. The observer rated the participant from 1 to 5.

Step	Action												
1	<p>Observe and rate participant with task related to vision. e.g., “Reading task one instructions.” e.g., “number of clicks, number of scrolls, mouse movement, ability to read material on screen.”</p> <p><b>Result:</b> A value between 1 to 5 is recorded.</p>												
2	<p>The information below was used to determine the value to code in the observation profile.</p> <table border="1"> <thead> <tr> <th>If rated as...</th> <th>Then code parameter...</th> </tr> </thead> <tbody> <tr> <td>1 – successful first try</td> <td>10 px</td> </tr> <tr> <td>2 – somewhat successful first two times</td> <td>12 px</td> </tr> <tr> <td>3 – somewhat unsuccessful first three times</td> <td>14 px</td> </tr> <tr> <td>4 - unsuccessful first four times</td> <td>16 px</td> </tr> <tr> <td>5 – strongly unsuccessful first five times.</td> <td>18 px</td> </tr> </tbody> </table> <p><b>Result:</b> Value coded in the font field of the observation profile.</p>	If rated as...	Then code parameter...	1 – successful first try	10 px	2 – somewhat successful first two times	12 px	3 – somewhat unsuccessful first three times	14 px	4 - unsuccessful first four times	16 px	5 – strongly unsuccessful first five times.	18 px
If rated as...	Then code parameter...												
1 – successful first try	10 px												
2 – somewhat successful first two times	12 px												
3 – somewhat unsuccessful first three times	14 px												
4 - unsuccessful first four times	16 px												
5 – strongly unsuccessful first five times.	18 px												
3	<p>Observe and rate participant with task related to motor skills. e.g., “Clicking on icons and links.” e.g., “number of clicks, number of scrolls, mouse movement, ability to click on boxes accurately.</p> <p><b>Result:</b> A value between 1 and 5 is recorded.</p>												
4	<p>The information below was used to determine to value to code in the observation profile.</p> <table border="1"> <thead> <tr> <th>When ...</th> <th>Then ...</th> </tr> </thead> <tbody> <tr> <td>Observe and rate for motor skills score</td> <td>1, 2, 3, or 4 accordingly.</td> </tr> </tbody> </table>	When ...	Then ...	Observe and rate for motor skills score	1, 2, 3, or 4 accordingly.								
When ...	Then ...												
Observe and rate for motor skills score	1, 2, 3, or 4 accordingly.												
5	<p>Code motor skill field parameter according to results.</p> <table border="1"> <thead> <tr> <th>If rated...</th> <th>Then code parameter for...</th> </tr> </thead> <tbody> <tr> <td>1 - successful first try</td> <td>Small icon</td> </tr> <tr> <td>2 - somewhat successful first two times</td> <td>Medium icon</td> </tr> <tr> <td>3 - somewhat unsuccessful the first three times</td> <td>Large icon</td> </tr> <tr> <td>4 - strongly unsuccessful the first four times</td> <td>Extra Large icon</td> </tr> </tbody> </table>	If rated...	Then code parameter for...	1 - successful first try	Small icon	2 - somewhat successful first two times	Medium icon	3 - somewhat unsuccessful the first three times	Large icon	4 - strongly unsuccessful the first four times	Extra Large icon		
If rated...	Then code parameter for...												
1 - successful first try	Small icon												
2 - somewhat successful first two times	Medium icon												
3 - somewhat unsuccessful the first three times	Large icon												
4 - strongly unsuccessful the first four times	Extra Large icon												
6	<p><b>Result:</b> Value coded in the motor skills field of the observation profile.</p>												

Figure 4.13. Participant observation profile value process

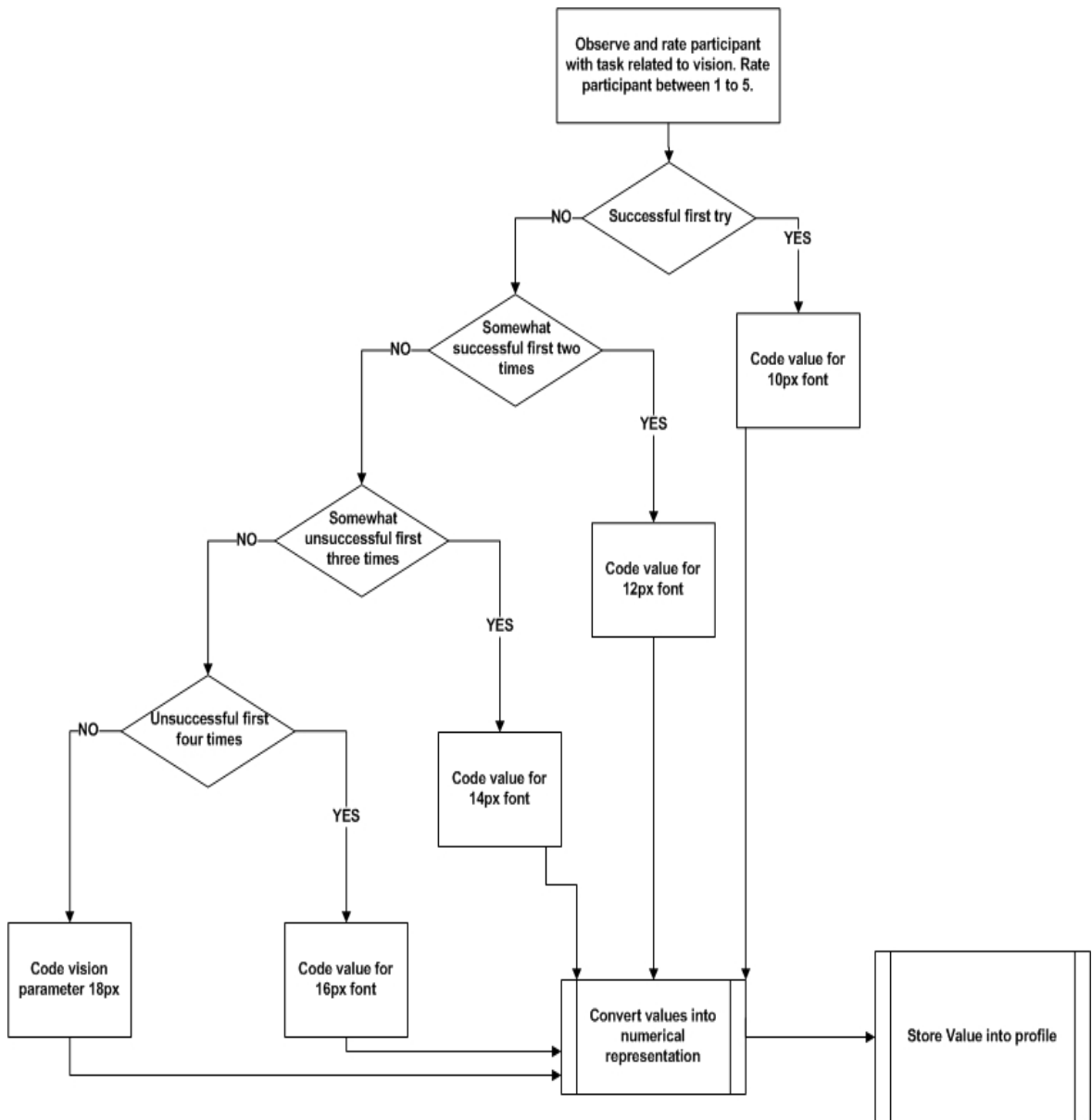


Figure 4.14. Observation profile vision parameter process flowchart

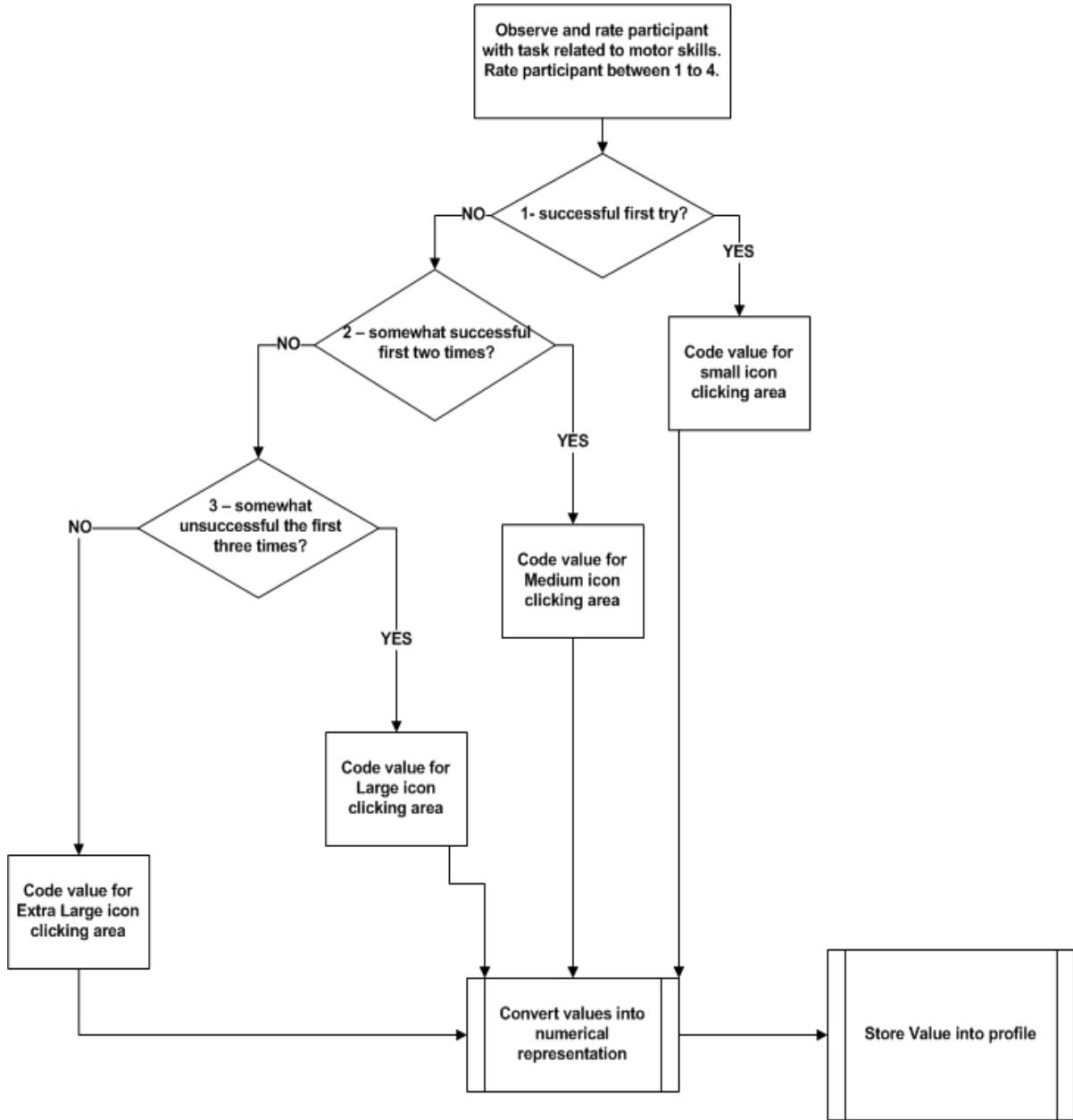


Figure 4.15. Observation profile motor skills parameter process flowchart

### ***Error profile***

Participant data were collected through the system, when participants were administered a set of tasks. The system captured the (vision and motor) errors of the user and stored the information in a database maintained on a server. The errors were then used to develop a profile (collection of preferences) of usage for the participant. The information (Figure 4.16), gathered from the participant's session defined the error detection profile.

The process of surfing and modifying the webpage of the participant was predicated on them reading a requested webpage and then transforming the webpage for the participant, based on parameters that were captured within the error profile of default values. The requested webpage would be captured and stored on the server as "before" and the webpage sent to the participant would be the "after" file. The "before" page would contain standard size fonts and icons as designed by the web designer of the website. The "before" page would be parsed to locate the font elements and values associated with the values located in the profile. Then the fonts and icon elements would be replaced according to the values in the error profile. Next, the webpage would be displayed to the participant.

Once the webpage was displayed, the server would record the movement of the participant while surfing and traversing the webpage. The computer algorithm for determining the values for vision and motor skills for the error profile were managed by scripts within the error detection system. The system keeps track of the number of errors that are made with the participant's current profile skills table (Figure 4.16) in the database and writes the information to the error track tables for font size and motor skills (Figure 4.17). Once the errors are accounted for and the tables are updated, the process continues to monitor and collect errors.

-----  
Date  
Time  
Profile level  
Font size  
Motor skills  
-----

Figure 4.16. Participant current skills table fields in the database supporting the error detection platform

-----  
Username  
Date  
Time  
ErrorID  
Font size  
Motor skills  
Error count  
AvgDistfromTarget  
-----

Figure 4.17. Error track table fields in the database supporting the error detection platform

Figures 4.18 and Figure 4.19 show the process flow of the system capturing the errors and the errors being translated into coded font size and motor skills parameters for the profile.

---

**Introduction** This table explains how the values for the Error Detection profile are created.

---

**Procedure** The steps below show the procedure for creating values in the Error Detection Profile. The system evaluated the participant, based upon errors related to motor skills and vision.

Step	Action								
1	Participant data were collected through system. <b>Result:</b> Benchmark of errors in vision and motor skills.								
2	The information was used to determine the value to code in the Error Detection Profile. <b>Result:</b> <ul style="list-style-type: none"> <li>• Value coded in the font field of the Error Detection Profile.</li> <li>• Value coded in the motor skills field of the Error Detection Profile.</li> </ul>								
3	The system stores the information in a database. <b>Result:</b> <ul style="list-style-type: none"> <li>• Value associated to specific font size.</li> <li>• Value associated to specific icon area size.</li> </ul>								
4	Error Detection profile established. <b>Result:</b> <ul style="list-style-type: none"> <li>• Profile font size is established.</li> <li>• Profile motor skill is established.</li> </ul>								
5	System monitors and tracks according to results. <table border="1" data-bbox="565 1465 1323 1612"> <thead> <tr> <th>If errors in...</th> <th>Then change...</th> </tr> </thead> <tbody> <tr> <td>1 – vision profile</td> <td>Font size</td> </tr> <tr> <td>2 – motor skills profile</td> <td>Icon space</td> </tr> <tr> <td></td> <td></td> </tr> </tbody> </table> <b>Result:</b> <ul style="list-style-type: none"> <li>• New profile font size is established.</li> <li>• New profile motor skill is established.</li> </ul>	If errors in...	Then change...	1 – vision profile	Font size	2 – motor skills profile	Icon space		
If errors in...	Then change...								
1 – vision profile	Font size								
2 – motor skills profile	Icon space								
6	Go to Step 1.								

Figure 4.18. Participant error profile capturing value process

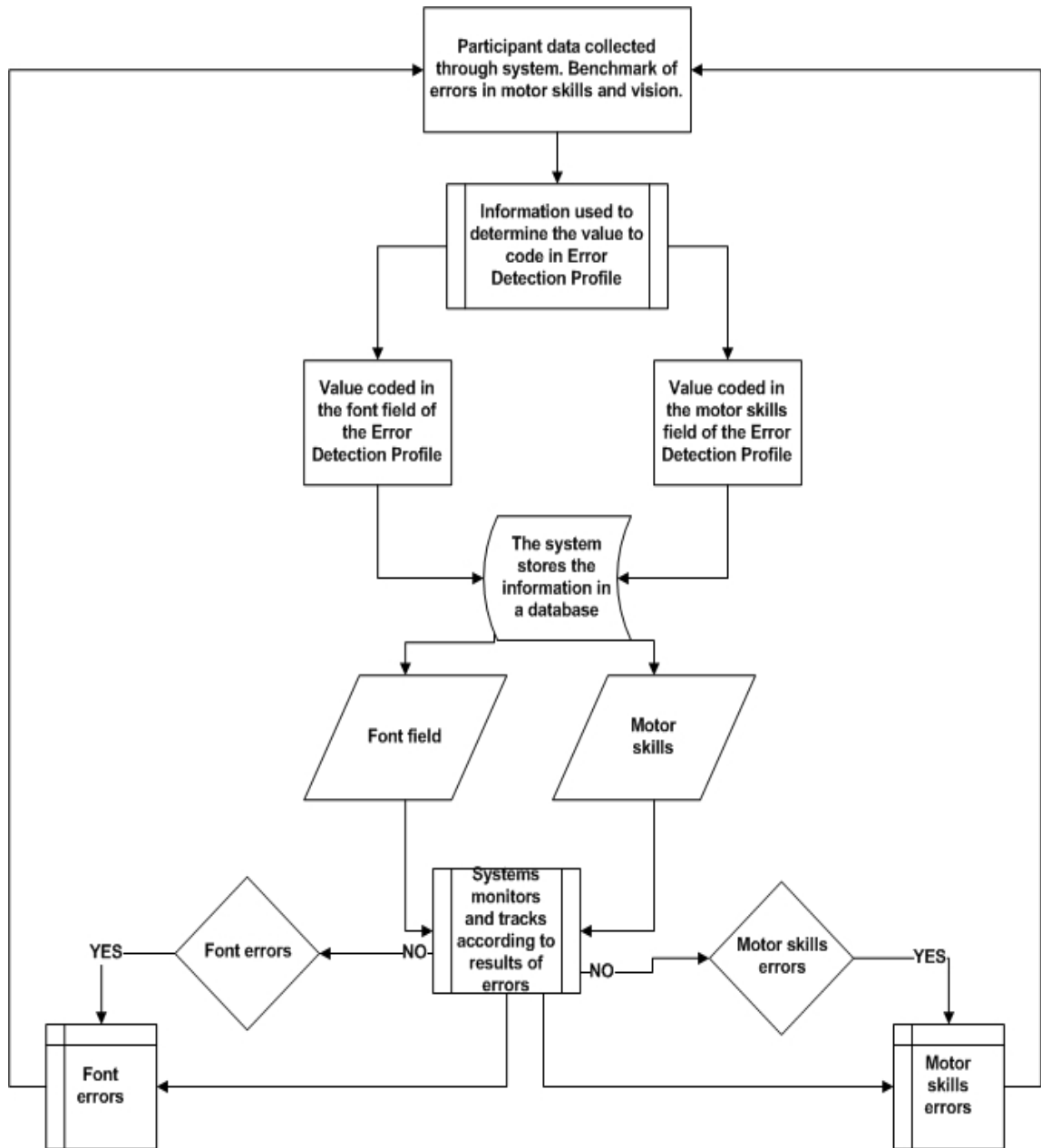


Figure 4.19. Error detection profile for font size and motor skills parameters process

### *Training description*

Prior to the usability experiment, the researcher had an orientation meeting to answer questions and to schedule participants for training. The researcher explained the nature of




the study. On the initial meeting, we sat down with the participant and established a user name, preferably their first name. Then we introduced them to the input devices (keyboard and mouse). We explained to them why we called it a mouse. We explained and demonstrated how to press and release the buttons, how to single and double click. We explained the keyboard functions. We instructed them to practice typing; some typed with their pointers while others typed using the home row. Once they felt comfortable with the keyboard and mouse, logging-on, and logging-off of the computer, we gave them some practice using the keyboard and mouse by letting them play Solitaire and click on some of the cards to get them to practice focusing and clicking. We also had them practice in Paint. We had them click on the icons to change from a brush to a spray can. We had them select different shapes and drag them around to create different shapes. We had them click on icons/shortcuts to Paint and Solitaire to show them how to launch an application. We introduced the browser to them and explained how they could search by typing any keyword. To stimulate interest in the Internet, we had each participant establish an email account. Then we instructed them to send an email to their children and grandchildren.

### ***Task description***

The tasks assigned for each participant in Figure 4.20 displays the informational path that the participants had to take for adequate capture of the main areas of interest (vision and motor skills). Each task was designed to capture the movement and navigation of the webpages that were listed.

The tasks were designed to gather relevant information to establish an efficient profile to help the participant effectively navigate through a webpage. The conditions that determined the outcome were font size and ability to click on an icon successfully (motor

skills). We created a scenario where the participant would visit two specific websites and traverse through the pages by following the steps indicated on the task list. The participants' ability to use the application interface (API) then would be evaluated by how efficiently they performed each task, such as those listed in Figure 4.20.

- Task 1: Please familiarize yourself with what you observe on the screen.
- Look at all of the objects (icons) on the screen.
  - Look at the menu bar (bottom of screen).
  - Notice the start button at the bottom of your screen.
- Task 2: Click (**twice** rapidly) the Internet Explorer Image on your desktop (Screen) to open application.
- Task 3: In window (rectangle bar), type your name and press the return key.
- Task 4: Click on one of the results lines (links).
- Task 5: Once you are done, click on the **home**  or **house** symbol on the top of the menu bar.
- Task 6: At the top of your screen or browser, type in aarp.org
- Task 7: On the right side of the webpage, please **adjust** your font size to your preference if you like
- Task 8: Click on Learning and Technology on the top menu.
- Select or click on computers and technology.
  - Select or click on web lessons.
  - Select or click on Understanding the basics.
  - Read 1<sup>st</sup> paragraph.
- Task 9: Click on Health menu bar.
- Click on physical activity menu on side bar.
  - Click on Working Out.
  - Click on preferred topic to review.
  - Read some of the information.
- Task 10: Click on AARP the Magazine link at the top of menu bar.
- Click on Games in the left hand corner menu.
  - Click on daily crossword puzzle.
  - Click on the box in which the authors name appears in.
  - Select skill level.
  - Solve 1 or 2 entries if you like.
- Task 11: Once you are done, click on the home or house symbol on the top of the menu bar.
- Task 12: At the top of your screen or browser, type in www.nlm.nih.gov
- Task 13: Click on Health Information in the top left corner.
- Click on Medline Plus – Health Information link.
  - Click on Health topics.
  - Click on Eyes and vision heading.
  - Click on Eye object to display information.
  - Click on Home tag in the upper left corner.
- Task 14: Click on Health Information in the top left corner.
- Click on Medline Plus – Health Information link.
  - Click on Health topics.
  - Scroll down on the bottom left side of the screen.
  - Click or select Interactive Health Tutorials.
  - Click or select Back Pain – How to prevent.
  - Click or select Start Self-playing Tutorial.
  - Observe the information displayed.
  - Click the X in the upper right corner to close the window.
- Task 15: Click the home button to return to the homepage

---

Figure 4.20. Task list for usability study (a larger font was used on the website)

**Assumption**

This study assumed that the variables, number of errors, number of mouse clicks, and mouse locations are independent.

The next chapter looks at the results and discussion of our user study.

## CHAPTER 5. RESULTS AND DISCUSSION

The focus of this chapter is to examine and discuss the results of the study.

### **Hypotheses**

The goal of the experiment described in the previous chapter was to examine the use of an error profile in the context of how it compares to some well-known strategies for determining user limitations, namely, self-evaluation (self profile), testing (test profile), and observation of the participants (observation profile). A second goal of the study was to compare how effective these approaches were in predicting the limitations of our participants. To judge effectiveness we examined the errors made by participants while performing a set of tasks.

Hypothesis 1: The use of the self profile (in the software platform described in Chapter 3) will result in more user errors than the use of the test profile.

Our reasoning for Hypothesis 1 was that self-evaluation has generally been seen as ineffective. Hanson (2007) notes that users tend to either overestimate their abilities or underestimate their limitations. We assumed that even simple testing would be superior to the participants' self-evaluation.

Hypothesis 2: The use of the test profile will result in more user errors than the use of the observation profile.

It was our belief that by carefully observing how participants work their way through a sample task, we would be able to create a better view of their capabilities than we would be able to calculate from testing.

Hypothesis 3: The use of the error profile will be statistically equivalent to using the observation profile.

While we expected the use of error detection to be a significant means of identifying participants' limitations, we didn't expect it to be superior to observation. Our interest in using automatic detection of errors is based on the labor intensiveness of observation. The difficulty of performing observation creates problems of scale that automatic methods, such as our error detection method, don't have. We examine the three hypotheses, in the next section.

## **Results**

In our study, the participants desired computer training. They wanted to learn how to use the computer and they wanted to learn how to obtain information via the Internet. Some of the participants had used a computer previously in their occupation, but desired to learn more about accessing information from the Internet. The participants said they "liked" the idea of learning how to use the computer and how to access information. They also were very excited about using email to communicate with loved ones.

Descriptive statistics were used to look at trends in the data and the frequency of errors in task performances. Paired sample statistics were used to look at the correlation of the tests.

### ***Self-evaluations vs. testing***

A comparison of participant performance using a browser, without any intervention, was measured. The results of the performance are shown in (Table 5.1). The mean without profile performance was ( $M = 57.8$ ) with a standard deviation of 13.952. The number of errors made using no profile showed a very high error rate in performance (see Figure 5.1).

The frequency displays the numbers of participants who committed the errors.

Table 5.1. Errors made without profile treatment

N		25
Mean		57.80
Std. Error of Mean		2.790
Std. Deviation		13.952
Skew		-.916
Std. Error of Skew		.464

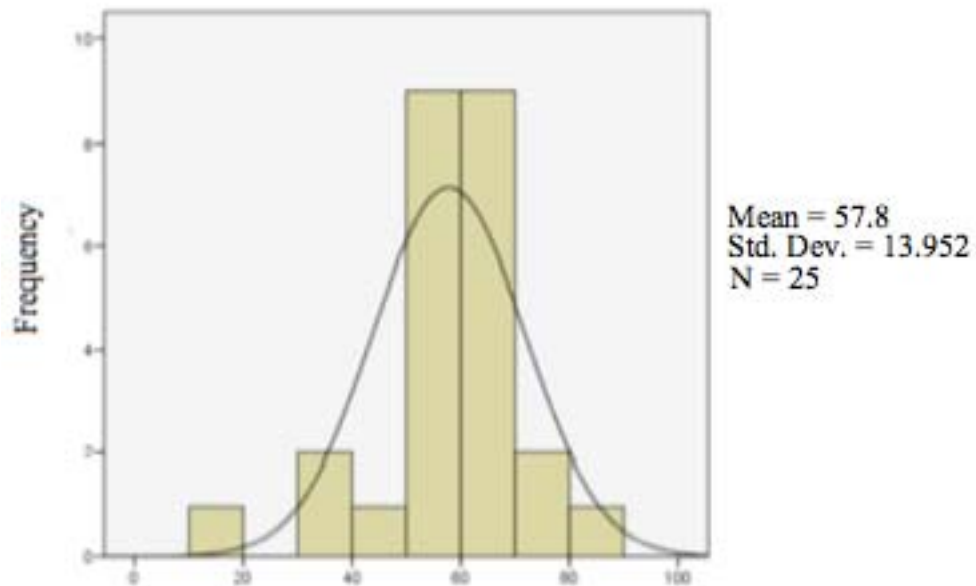


Figure 5.1. Errors made without intervention

We examined the results related to the three hypotheses and looked at some interesting results that compare the profile types. First, we looked at the results achieved between participant performance using the self profile and the test profile. Table 5.2 shows the Analysis of Variance (ANOVA) test results when comparing usage of these two profiles. The main effects are given in Table 5.3.

Table 5.2. ANOVA tests

<b>Effect</b>	<b>F</b>	<b><i>p</i>-value *</b>
<b>Total Self Profile</b>	0.517	<.885
Cognitive	4.334	<.037
Vision	4.945	<.027
Motor Skills	2.795	<.102
<b>Test Profile</b>	1.438	<.234
Cognitive	13.918	<.0001
Vision	0.565	<.851
Motor Skills	1.087	<.426

\*Significant at the .05 cutoff; df=25

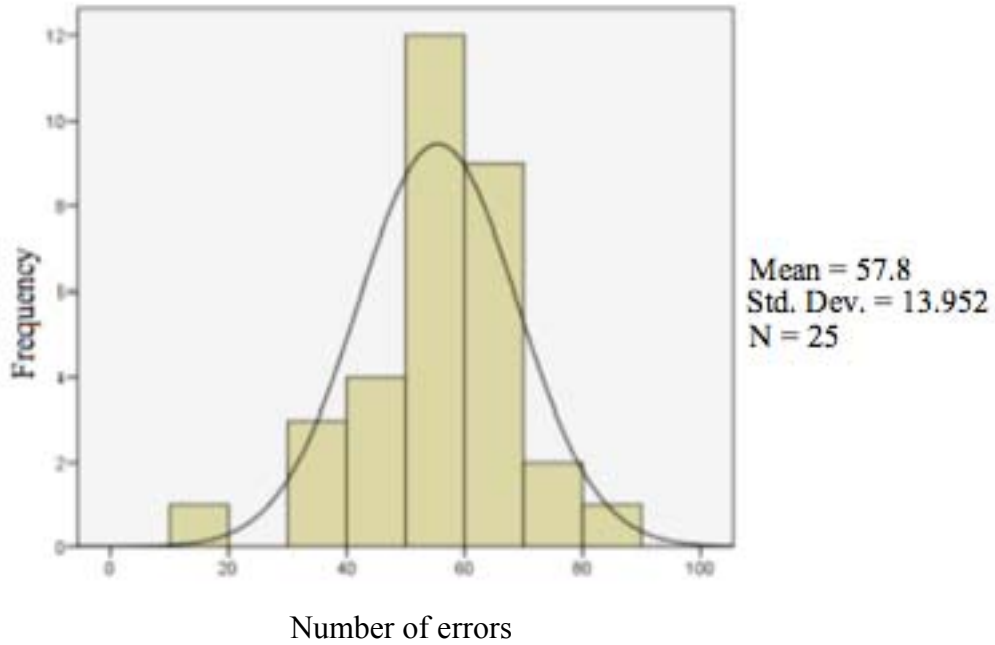
Table 5.3. Feedback condition main effects

<b>Performance Measure</b>	<b>Main Effect *</b>
Cognitive Errors, Self & Test	Self > Test
Vision Errors, Self & Test	Self > Test
Motor Skills Errors, Self & Test	Self > Test

\* X > Y indicates that condition X had a significantly higher time than condition Y at  $p < .05$

While raw errors totals are not by themselves instructive, it is interesting to see the error distribution of the errors for the self profile (Figure 5.2a) and test profile (Figure 5.2b)

a. Number of errors made in the self profile



b. Number of errors made in test profile

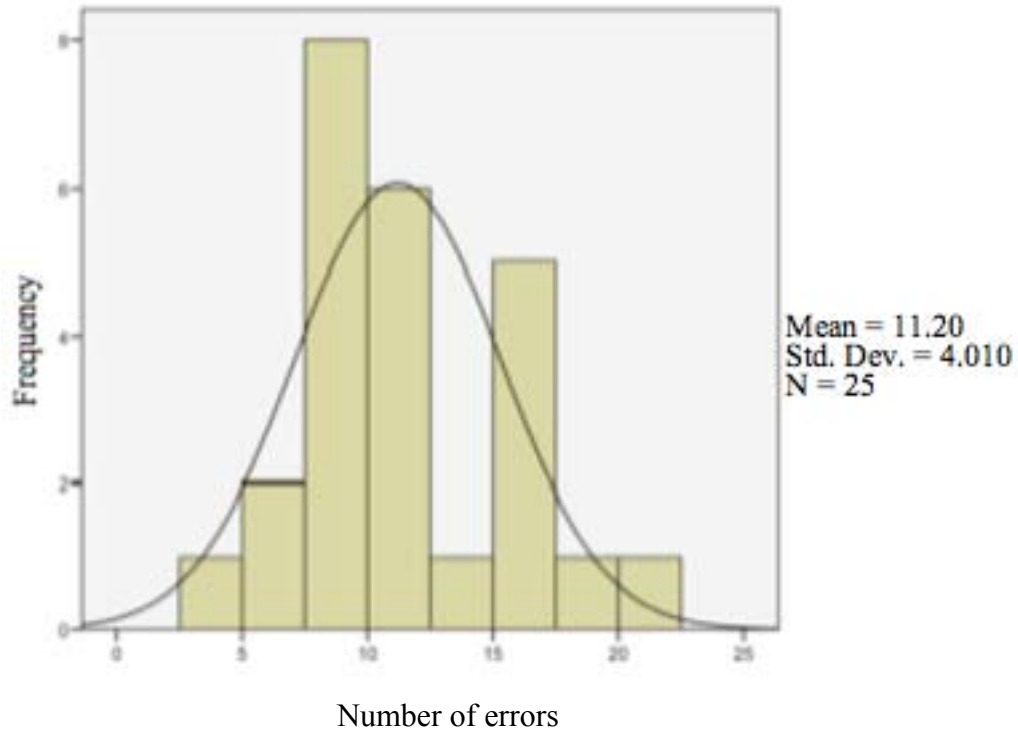


Figure 5.2. Error distribution for the self profile (a) and test profile (b)



The Wilcoxon rank-sum test was used to identify differences in accuracy between participants' self profile and participants' test profile in performance of accessibility of the Internet. The Wilcoxon rank-sum method tested the null hypothesis that the probability of observations from the population (self profile) exceed the observation from the second population (test profile) is less than or equal to 0.5. This analysis indicated significant differences between the two (see Table 5.4). Table 5.5 shows the basic error statistics for the self and test profiles. The paired samples correlation for the two profiles is shown in Table 5.6. Table 5.7 presents the paired samples t-test for errors made.

Table 5.4. Wilcoxon rank-sum results

	Ranks	N	Mean Rank	Sum of Ranks
How Many Errors Were Made in the Test Profile? and	Negative Ranks	25(a)	12.50	312.50
	Positive Ranks	0	.00	.00
How Many Errors Were Made in the Self-Profile?	Ties	0		
	Total	32		

a. How Many Errors Made in the Test Profile < How Many Errors Made in the Self-Profile

Table 5.5. Error means and standard deviation for the self and test profiles

	Self	Test
Mean	57.8	11.20
S. D.	13.95	4.01

Table 5.6. Paired samples correlation

	N	Correlation	P
Errors made using the self profile and the test profile	25	.469	.018

Table 5.7. Paired samples t-test for the self and test profiles

	Paired Difference			t	df	Significance (2 – tailed)
	Mean	S. D.	Std. Error Mean			
Errors made using the self profile and using the test profile	46.6	12.560	2.512	18.551	24	0.000

The next section presents the results for the comparison of the test profile and the observation profile.

***Comparing testing and observation***

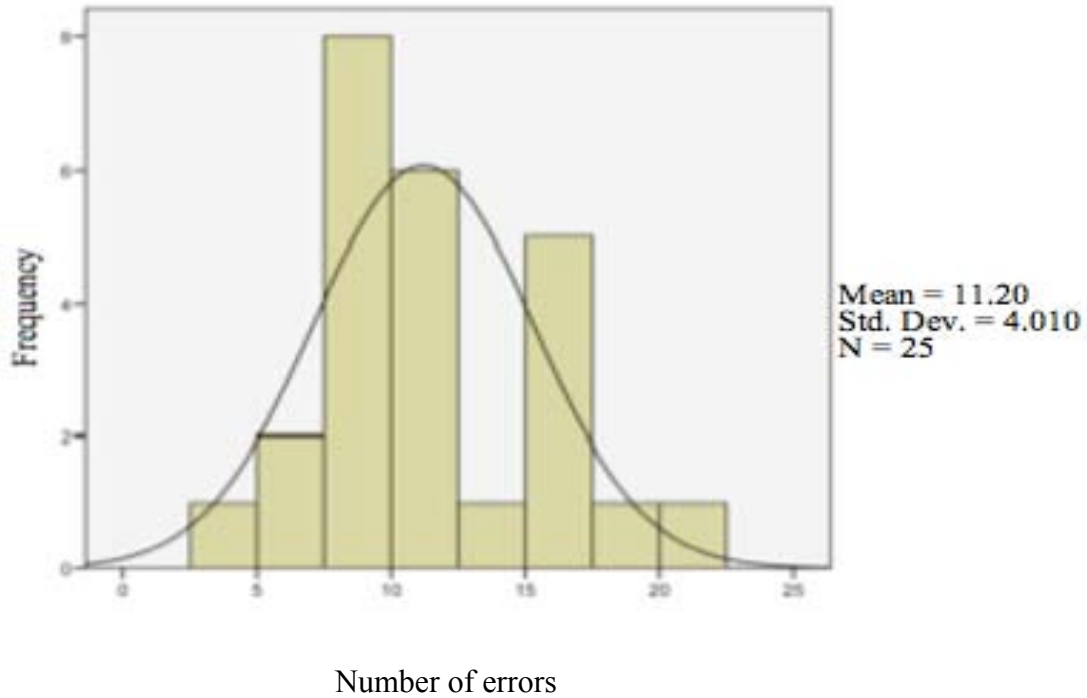
Table 5.8 displays the mean and standard deviation for the errors measured for the test and observation profiles. The observational profile provided an indication that observational measures (M=7.12) errors were more effective because of additional variables that were available during the observational assessment.

Table 5.8. Mean error scores of the performance of the profiles - all profiles

	N	Test Profile		Observational Profile	
		Mean	S.D.	Mean	S.D.
Total errors detected	25	11.20	4.010	7.12	3.621

While raw data doesn't provide very much information, the distribution of the errors for the test and observation profiles are interesting (Figure 5.3).

## a. Test profile errors



## b. Observation profile errors

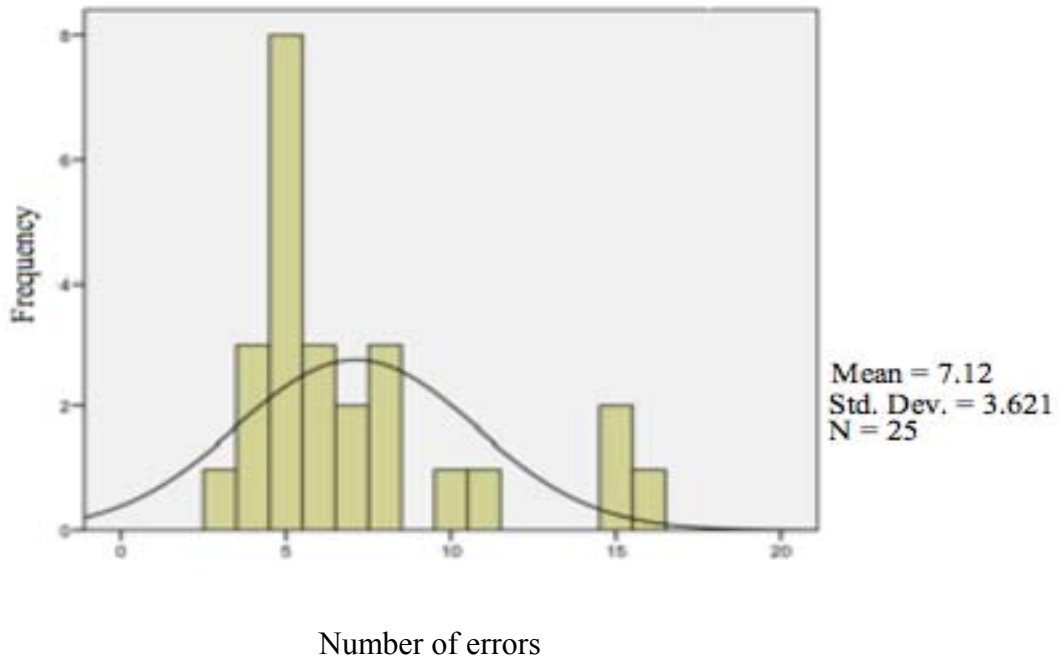


Figure 5.3. Distribution for the errors made using profiles for test (a) and observation (b)

Table 5.9 looks at the correlation between the numbers of errors participants made while using the two profiles. The paired sample differences t-test for the numbers of errors made are shown in Table 5.10.

Table 5.9. Paired samples correlations for test versus observation

	N	Correlation	Sig.
How Many Errors Were Made in Test Profile and How Many Errors Made in Observation Profile	25	.627	.001

Table 5.10. Paired samples t-test for test versus observation

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
How Many Errors Made in Test Profile and How Many Errors Made in Observation Profile	4.080	3.366	.673	2.691	5.469	6.061	24	.000

The next subsection looks at the results for the comparison of the observation profile and the error profile.

#### *Comparing observation and error detection*

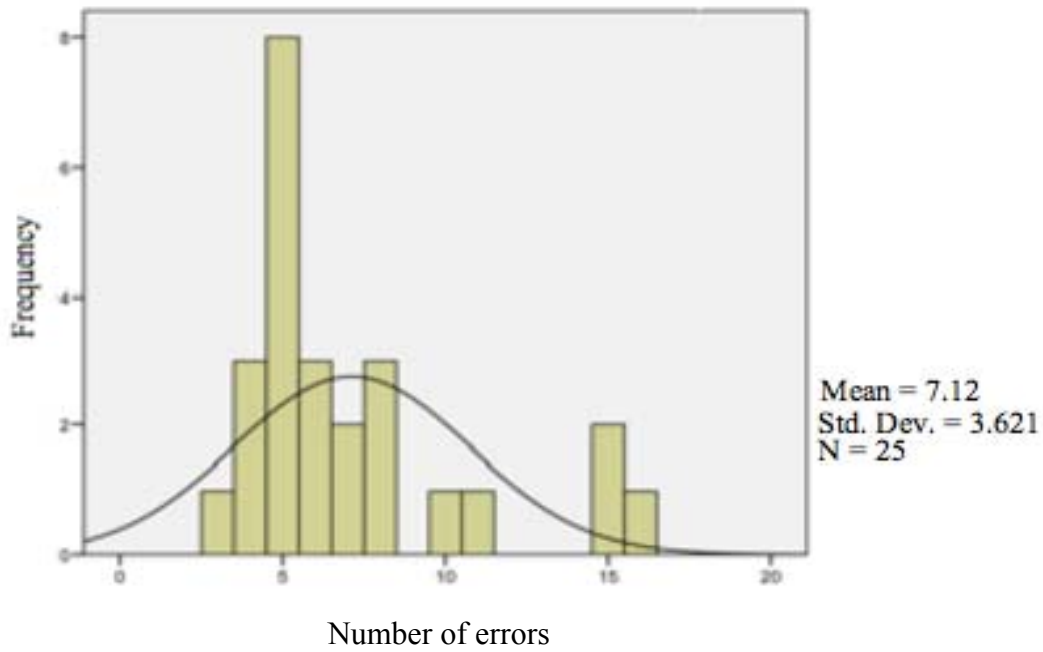
The focus here is to present the results achieved between the observation and error profile. Table 5.11 shows the mean and standard deviation for the two profile error rates.

Table 5.11. Mean error scores of the performance of the profiles - all profiles

	N	Observational Profile		Error Detection Profile	
		Mean	S.D.	Mean	S.D.
Total errors detected	25	7.12	3.621	6.80	4.010

Figure 5.4 shows the distribution of the errors made when using the observation profile (a) and the error profile (b).

a. Observation profile errors



b. Error profile errors

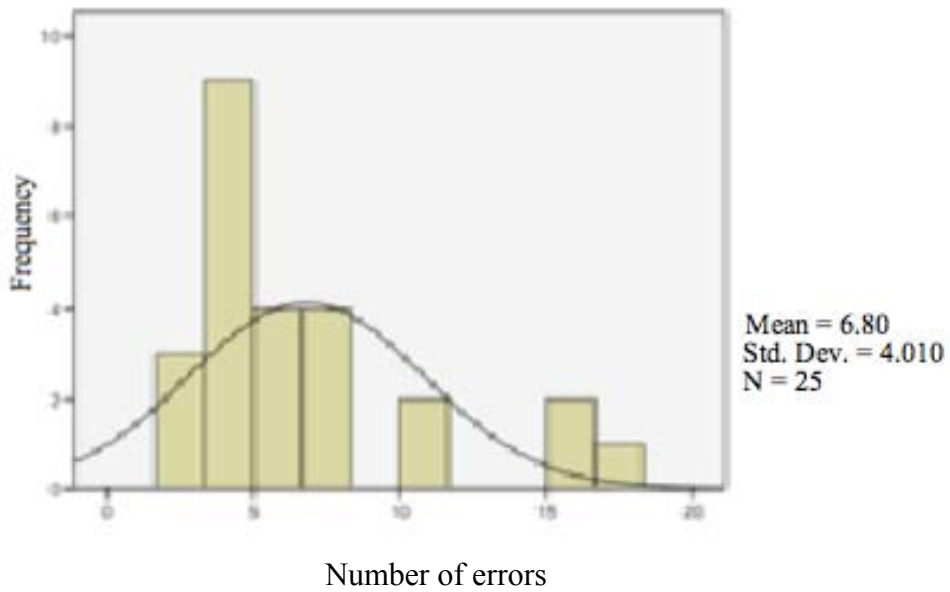


Figure 5.4. Distribution for errors made using the observation profile (a) and the error profile (b)

A scatter plot of the errors for the two profiles is shown in Figure 5.5. The correlation between the errors made when using the two profiles is given in Table 5.12.

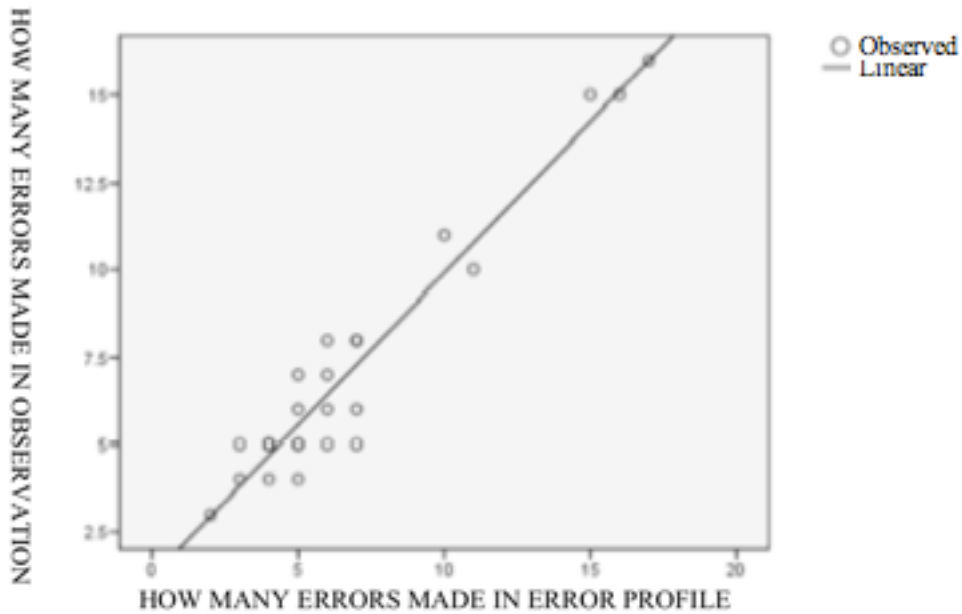


Figure 5.5. Errors made in observation compared to error detection

Table 5.12. Paired samples correlations

	N	Correlation	Sig.
How Many Errors Made in Observation and How Many Errors Made in Error Detection Profile	25	.963	.000

Table 5.13 presents the Paired samples t-test for the difference between the number of errors the participants made when the observation profile was used and the number of errors made the error profile was used.

Table 5.13. Paired samples t-test for observation and error detection profiles

	Paired Differences				t	df	Sig. (2-tailed)	
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower				Upper
How Many Errors Made in Observation Profile – How Many Errors Made in Error Profile	.320	1.108	.222	-.137	.777	1.445	24	.161

The next subsection examines these results in the context of our problem.

### Discussion

The discussion section is broken down into sections paralleling the way that the results section was partitioned. First, we look at the results comparing the use of the self profile versus the test profile.

Performance in the experiment was measured based on the number of errors that participants made while completing the task set.

#### *Hypothesis 1: Self evaluation vs. testing*

Tables 5.5 shows the mean and standard deviation of the errors made for the cases where the webpages were converted using a profile based on self-assessment and testing. The primary result can be found in Table 5.5. The paired samples correlation is in Table 5.6. The paired samples t-test (Table 5.7) shows a significance of  $p=0.000$ . The paired samples t-test assumes that there is a difference between the two samples. The positive mean for the difference (“Errors made using self profile – Errors made using test profile”) indicates that Hypothesis 1 holds and participants made more errors when the self profile was used than when testing was used to construct the test profile.

The main effects from the feedback condition (Table 5.3) indicate that the Hypothesis 1 is supported as well. The correlation between using the two forms of profile creation is low (.469) when you compare the errors the participants made (Table 5.6). The belief that self-evaluation is not very effective has been discussed in the literature (Hanson, 2007).

The results indicate that testing was the more effective of the two approaches for determining the profile variable values. The result also agrees with the expectation that self-assessment is not an effective means of identifying the limitations of older adults.

### ***Hypothesis 2: Testing vs. observation***

The paired samples t-test for “How many errors were made using test profile & How many errors were made using observation profile” is given in Table 5.10. The paired samples t-test assumes that there is a difference between the two samples and a significant result indicates that they are statistically different. Table 5.10 shows  $t=6.061$  with a statistical significance of 0.000. As a result, Hypothesis 2 holds and we can assume that use of the observation profile will result in fewer user errors than use of the test profile. It is interesting to note that while the samples are different, the correlation between the two samples is somewhat higher (.627) than what we saw with self evaluation and testing (.469).

The simple descriptive statistics are given in Table 5.5. The distributions of errors are given in Figure 5.3 for the test profile (Figure 5.3a) and the observation profile (Figure 5.3b), respectively. The graphs are interesting, given the result from Table 5.10, which indicates that observation was the most effective of the two methods and that testing is not an effective means of identifying the limitations of older adults for determining the profile variable values.



Of the two approaches for setting the user profile values, observation performed better, but it is more labor intensive and time consuming to administer to a large number of users. Using a test is more flexible because many people can be given the test by only one individual.

***Hypothesis 3: Observation vs. error detection***

The focus of this thesis was to find an automated means of profile creation that would provide a result statistically equivalent to observation. We have shown that using observation to create user profiles is statistically superior to the other traditional methods (Taylor, Miller, & Nilakanta, 2009).

The problem with observation is that it is very labor intensive. We looked at the use of the errors the participants made to guide the creation of user profiles. It satisfied the criteria that the new approach should be automatic. Detection of errors can be done whenever a user is logged on and using the Error Detection software. But the method would also have to be competitive with observation in order to be useful.

Hypothesis 3 focused on testing the two samples (errors made using an observation profile and errors made using an error profile) to determine if they were statistically equivalent. A paired samples t-test was used (Table 5.13). The paired samples t-test determines if the two samples are different and a significant result shows them as being significantly different. Table 5.13 presents a p value of 0.161, which is not significant. As a result, the two samples cannot be seen as being statistically different and Hypothesis 3 holds.

The basic descriptive statistics are given and show very little difference. More interestingly, Table 5.12 shows a very high correlation (.963), with 0.0 significance for the

two samples. A review of this result has been published in Taylor, Miller, Nilakanta, Sander, et al. (2009).

As a result, the error detection approach provides a dynamic mechanism for determining a user's limitations. The dynamic nature of our result means that it is possible to scale our proposed system (described in Chapter 3) to very large numbers of users.

### **Limitations**

The study had a few limitations:

1. Generalization of the research findings is limited because the research participants were from a small population.
2. The participants could have impairments that were not reported, thus affecting outcomes and measurements.
3. The scope of the research was limited to the usability of Internet services for older adults.
4. Long-term memory and reasoning were not measured.

## CHAPTER 6. CONCLUSIONS AND FUTURE WORK

A user study consisting of 25 older adults was developed and performed to compare the proposed error detection strategy to evaluation strategies based on self assessment, written tests, and one-on-one observation. A server-based platform was developed for the user study. The platform had a user profile that contained a measurement of the user's impairments for motor skills and vision.

The server converted the webpage that the user requested based on the contents of the user profile. The results of the study were promising. Three hypotheses were tested. The first two indicated that observation was superior to self assessment and testing with respect to the user error rates. The third hypothesis compared profiles based on one-on-one observation against profiles based on our error detection strategy. The study showed that there was no statistical difference between the error rates of the results of the observation-based profiles and the error rates of the error detection-based profiles. This is an important result since doing in-depth observations of the potential users is very labor intensive and error detection places the burden only on the computer system.

The result is that the error detection approach can be used to automatically adjust the user's profile as they use the system. In addition, the error detection approach to constructing user profiles scales well. While one-on-one observation is very hard to use with a large number of users, our error detection approach can easily be applied to a large number of users. Moreover, our error detection approach can continually monitor users and react to an older adult's diminishing skills in real time.

There are a number of directions that this work can take in the future. The most immediate and most relevant direction will be to expand the type of errors to include cognitive errors. While this will be difficult, our present results provide a strong basis for this extension.

A more conceptual extension will be to develop a rigorous error model. In the present work we made use of a rather *ad hoc* view of error. Our work would benefit from a more conceptual approach of modeling errors.

Finally, it would be interesting to expand the software platform to include standard graphical (e.g., Java) user interfaces.

## BIBLIOGRAPHY

- Adler, R. (1995). *Older adults and computers: Report of a national survey*. Technical Report for SeniorNet, San Francisco: SeniorNet.
- Alpay L., Verhoef, J., Xie, B., Te'eni, D., & Zwetsloot-Schonk, J.H.M. (2009). Current challenge in consumer health informatics: Bridging the gap between access to information and information understanding. *Biomedical Informatics Insights*, 2,1–10
- Alur, D., Crupi, J., & Malks, D. (2003). *Core J2EE patterns, best practices and design strategies*, 2<sup>nd</sup> Ed. New York: Prentice Hall.
- American Academy of Neurology (AAN). (2003). *Geriatric neurology fellowship core curriculum*. American Academy of Neurology.
- American Psychological Association (APA). (2007). The American Heritage® Dictionary of the English Language. *American Psychological Association* (4th Ed.).
- Anderson, B., & Tracey, K. (2001). The impact (or otherwise) of the Internet on everyday life. *American Behavioral Scientist*, 45(3), 456-475.
- Backman, L., Small, B., Wahlin, A., & Larsson, M. (2000). Cognitive functioning in very old age. In F.I.M. Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition*. Mahwah, NJ: Lawrence Erlbaum.
- Baidya, S. (2008). *EASII: Enhancing accessibility to chemical dynamics simulation with intelligent interface* (Master's thesis, Texas Tech. University). Retrieved from <http://repositories.tdl.org/ttu-ir/handle/2346/21709?show=full>
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.
- Berg, J., Brouwer, W., Deelman, B., Schmidt, W., & Sikken, J. (1998). Memory and learning abilities in everyday life of the elderly. *Tijdschrift Voor Gerontologie En Geriatrie (Deventer)*, 29(3), 130-140.
- Berry, J. (1999). Memory self-efficacy in its social cognitive context. *Social Cognition and Aging*, 69–96.
- Berry, J., West, R., & Dennehey, D. (1989). Reliability and validity of the memory self-efficacy questionnaire. *Developmental Psychology*, 25(5), 701-713.
- Berry, R. (2011). *Older people and the Internet: Towards a “system map” of digital exclusion*. London: The International Longevity Centre.

- Beier, M., & Ackerman, P. (2005). Age, ability, and the role of knowledge on the acquisition of new domain knowledge: Promising results in a real-world learning environment. *Psychology and Aging, (20)*, 341–355.
- Browne, H. (2000). Accessibility and usability of information technology by the elderly. In Univ of Maryland (Eds.), *UU guide: Practical design guidelines for universal usability*. Retrieved from <http://www.otal.umd.edu/UUGuide/hbrowne/>
- Bucar, A., Renold, C., & Henke, M. (1999). How do older net citizens compare with their young counterparts? *CyberPsychology & Behavior, 2(6)*, 505-513.
- Burkhard, M. & Koch, M., (2012). Evaluating touchscreen interfaces of tablet computers for elderly people. In: H. Reiterer & O. Deussen (Eds.), *Mensch & Computer 2012 – Workshopband: interaktiv informiert – allgegenwärtig und allumfassend*. Munich: Oldenbourg Verlag. 53-59.
- Cavanaugh, J., Feldman, J., & Hertzog, C. (1998). Memory beliefs as social cognition: A reconceptualization of what memory questionnaires assess. *Review of General Psychology, 2*, 48-65.
- Charness, N., & Czaja, S. (2005). Adaptation to new technologies. In M.L. Johnson (Ed.), *Cambridge handbook on age and ageing* (pp. 662–69). Cambridge: Cambridge University Press,
- Charness, N., Schumann, C., & Boritz, G., & (1992). Training older adults in word processing: Effects of age, training technique, and computer anxiety. *International Journal of Technology and Aging, 5*, 79-105.
- Crane, D., Pascarello, E., & James, D. (2006). *Ajax in action*. Greenwich, CT: Manning Publications.
- Czaja, S. (2005). The impact of aging on access to technology. *The newsletter of ACM SIGACCESS*. Retrieved from [www.sigaccess.org/community/newsletter/...2005/sep05\\_02.pdf](http://www.sigaccess.org/community/newsletter/...2005/sep05_02.pdf)
- Czaja, S. (1997). Computer technology and the older adult. *Handbook of Human-Computer Interaction, 2*, 797-812.
- Czaja, S. (1996). Aging and the acquisition of computer skills. In W.A. Rogers, A.D. Fisk, & N. Walker (Eds.), *Aging and skilled performance: Advances in theory and Applications* (pp. 201–220). Mahwah, NJ: Lawrence Erlbaum.
- Czaja, S., Fisk, N., Fisk, A., Hertzog, C., Nair, S., Rogers, W., & Sharit, J. (2006). Factors predicting the use of technology: Findings from the Center for Research and

- Education on Aging and Technology Enhancement (CREATE). *Psychology and Aging*, 21(2), 333-352
- Czaja, S., & Lee, C. (2001). The Internet and older adults: Design challenges and opportunities. In N. Charness, D.C. Park, & B.A. Sabel (Eds.), *Communication, technology and aging; Opportunities and challenges for the future* (pp. 60-78). New York: Springer.
- Czaja, S., & Lee, C. (2003). Designing computer systems for older adults. In A. J. Jacko & A. Sears (Eds.), *The human-computer interaction handbook: Fundamentals, evolving Technologies, and emerging application* (pp. 413-427). Mahwah, NJ: Lawrence Erlbaum.
- Czaja, S., & Lee, C. (2007). The impact of aging on access to technology. *Universal access in the information society*. New York: Springer.
- Czaja, S., & Sharit, J. (1993). Age differences in the performance of computer-based work. *Psychology and Aging*, 8(1), 59-67.
- Czaja, S., & Sharit, J. (1998). Ability-performance relationships as a function of age and task experience for a data entry task. *Journal of Experimental Psychology: Applied*, 4, 332-351.
- Czaja, S., & Sharit, J. (1999). Age differences in attitudes toward computers. *Journal of Gerontology*, 53B(5), 329-340.
- Deets, H. (1999). Aging and technology: The convergence of two revolutions. *Cyber Psychology & Behavior*, 2(6), 50-503.
- Demiris, G. (2001). Considerations for the design of an older adults-based clinical monitoring and educational system for older adult patients. *Journal of the American Medical Association*, (8), 468-472.
- Detterman, D., Gabriel, L., & Ruthsatz, J. (2000). Intelligence and mental retardation. In R.J. Sternberg (Ed.), *Handbook of intelligence* (pp. 141-158). Cambridge: Cambridge University Press.
- Devolder, P., & Pressley, M. (1992). Causal attributions and strategy use in relation to memory performance differences in younger and older adults. *Applied Cognitive Psychology*, 6(7), 629-642.
- Dixon, R., Hultsch, D., & Hertzog, C. (1988). The Metamemory in Adulthood (MIA) questionnaire. *Psychopharmacology Bulletin*, 24, 671-688.

- Echt, K., & Morrell, R. (1998). Effect of age and training formats on basic computer skill acquisition in older adults. *Educational Gerontology, 24*, 3-25.
- Elias, P., Elias, M., Robbins, M., & Gage, P. (1987). Acquisition of word-processing skills by younger, middle aged and older adults. *Psychology and Aging, 2*, 340-348.
- Elliot, E., & Lachman, M. (1989). Enhancing memory by modifying control beliefs, attributions, and performance goals in the elderly. *Advances in Psychology, 57*, 339-367 [http://dx.doi.org/10.1016/S0166-4115\(08\)60986-3](http://dx.doi.org/10.1016/S0166-4115(08)60986-3)
- Festervand, T., Meinert, D., & Vitell, S. (2011). Older adults' attitudes toward and adoption of personal computers and computer-based lifestyle assistance. *Journal of Applied Business Research, 10* (2), 13-22.
- Fisk, A., Rogers, W., Charness, N., Czaja, S., & Sharit, J. (2004). *Designing for older adults: Principles and creative human factors approach*. Boca Raton, FL: CRC Press.
- Fisk, A. (1999). Human factors and the older adult. *Ergonomics Design, 7*(1), 8-13.
- Forbes. (1997). Steel versus silicon. *Forbes, 7*, 129-131.
- Garg, V., Camp, L. J., Lorenzen-Huber, L. M., & Connelly, K. (2011, July). *Designing risk communication for older adults*. Symposium on Usable Privacy and Security (SOUPS). Pittsburgh, PA.
- Hannemyr, G. (2003). The Internet is hyperbole: A critical examination of adoption rates. *Information Society, 19*(2), 111-121.
- Hanson, V., Richards, J. T., & Lee C. C. (2007). Web access for older adults: Voice browsing? *Human Computer Interaction, 5*, 904-913.
- Hanson, V. (2001). Web access for elderly citizens. Proceedings of the 2001 EC/NSF *Workshop on Universal Accessibility of Ubiquitous Computing: Providing for the Elderly*. doi:10.1145/564526.564531
- Hartley, A., Hartley, J., & Johnson, S. (1984). The older adult as a computer user. *Aging and Technological Advances, 347-348*.
- Hoffman, D., Novak, T., & Venkatesh, A. (2004). Has the internet become indispensable? *Communication of the ACM, 47*(7), 37-42.
- Hummert, M., Nussbaum, J., & Wiemann, J. (1992). Communication and the elderly. *Communication Research 19*, 413-422.



- Iyer, R. & Eastman J. (2006). The elderly and their attitudes toward the internet: The impact on internet use, purchase, and comparison shopping. *Journal of Marketing Theory and Practice*, 14, 55-66.
- Iyer, V. (2003). *Microstructures of feel, macrostructures of sound: Embodied cognition in West African and African-American music*. (Doctoral Dissertation, U.C. Berkeley).  
retrieved from <http://archive.cnmat.berkeley.edu/People/Vijay/%20THESIS.html>
- Jacko, J. A., Scott, I. U., Barreto, A. B., Bausch, H. S., Chu, J. Y. M., & Fain, W. B. (2001) Iconic visual search strategies: A comparison of computer users with AMD versus computer users with normal vision. Proceedings of the 9th International Conference on Human-Computer Interaction, New Orleans, LA, August 5-10, 423-427.
- Jacko, J., & Sears, A. (Eds). (2003). *The human-computer interaction handbook: Fundamentals, evolving technologies, and emerging applications*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Jay, G., & Willis, S. (1992). Influence of direct computer experience on older adults' attitudes toward computers. *Journal of Gerontology: Psychological Sciences*, 47(B), 250-257.
- Keegan, C., Gross, S., Fisher, L., & Remez, S. (2004). *Boomers at midlife 2004. AARP Life Stage Study, Wave 3*. Washington, DC: AARP.
- Kelley, C., & Charness, N. (1994). Training older and younger computer novices to use a word processor. *Canadian Psychology*, 35(16).
- Kelley, C., & Charness, N. (1995). Issues in training older adults to use computers. *Behavior & Information Technology*, 14 (2).
- Keobane, R., & Nye, J. (1998). Power and interdependence in the information age. *Foreign Affairs*, 77(5), 81-94.
- Kwon, W-S. & Noh, M. (2010). The influence of prior experience and age on mature consumers' perceptions and intentions of internet apparel shopping. *Journal of Fashion Marketing and Management*, 14(3), 335-349.
- Lawson, P. (1999). Achieving universal access to the Internet: An impossible dream? *University of Ottawa, Department of Communications Speaker Series on Communication, Social Justice and the Common Good*. Retrieved from [http://www.piac.ca/consumers/achieving\\_universal\\_access\\_to\\_the\\_internet\\_an\\_impossible\\_dream](http://www.piac.ca/consumers/achieving_universal_access_to_the_internet_an_impossible_dream)

- Lee, B. (2012). Cyber behaviors among seniors. In *Encyclopedia of Cyber Behavior* (pp. 233-241). Hershey, PA: Information Science Reference. doi:10.4018/978-1-4666-0315-8.ch020
- Lenhart, A., Rainie, L., & Lewis, O. (2001). Teenage life online: The rise of the instant-message generation and the Internet's impact on friendships and family relationships. *Pew Internet & American Life Project*. Retrieved from <http://fe01.pewinternet.org/Reports/2005/Teens-and-Technology/03-Basic-Demographics-of-Online-Teens-and-Their-Families/1-Introduction-Demographics.aspx>
- Linden, P. (2010), *Just Java*, 6th Ed. Upper Saddle River, NJ: Prentice-Hall. July 2010.
- Lineweaver, T., & Hertzog, C. (1998). Adult's efficacy and control beliefs regarding memory and aging: Separating general from personal beliefs. *Aging, Neuropsychology, & Cognition*, 5, 264-296.
- Liu, Cheng-Li. (2010). The impact of goods-classification and landmarks for spatial knowledge and goods-finding in the elderly within a 3D virtual store. *Computers in Human Behavior*, 26, (6) 1777-1786.
- Liu, L., Watson, B., & Miyazaki, M.. (1999). VR for the elderly: Quantitative and qualitative differences in performance with a driving simulator. *CyberPsychology & Behavior*, 2(6), 567-576.
- LoPresti, E., Brienza, D., Angelo, J., Gilbertson, L., & Sakai, J. (2002). Neck range of motion and use of computer head controls. *Proceedings of ASSETS 2000: The Fourth International ACM Conference on Assistive Technologies*. (pp. 121-128). Retrieved from <http://www.rehab.research.va.gov/jour/03/40/3/lopresti.html>
- Mackie, R., & Wylie, D. (1988). Factors influencing acceptance of computer-based innovations. In M. Helander (Ed.), *Handbook of human-computer interaction* (pp. 1081-1106). Amsterdam: Elsevier-North Holland.
- Madden, M. (2003). *America's online pursuits: The changing picture of who's online and what they do*. Washington, DC: Pew Internet and American Life Project.
- Madden, M. (2010). Older adults and social media. Pew Internet and American Life Project. Retrieved from <http://pewinternet.org/Reports/2010/Older-Adults-and-Social-Media.aspx>
- Makris, P. (2001, May). Accessibility of Ubiquitous Computing: Providing for the Elderly. *Workshop on Universal Accessibility of Ubiquitous Computing: Providing for the Elderly*. EC/NSF. Retrieved from <http://www.informatik.uni-trier.de/~ley/db/conf/wuauc/wuauc2001.html>

- Mann, J. (2008). *Cisco predicts Internet traffic to double every two years*. Retrieved from <http://www.techspot.com/news/30504-cisco-predicts-internet-traffic-to-double-every-two-years.html>
- Margrett, J. (2007). Personal Communication. Iowa State University, Human Science College, Gerontology Department.
- Mazur, E., Signorella, M., & Hough, M. (2012). Older adults and their Internet behaviors. In Z. Yan (Ed.), *Encyclopedia of cyber behavior* (pp. 608-619). doi:10.4018/978-1-4666-0315-8.ch05
- McDonald, S., Waern, Y., & Cockton, G., Eds. (2000). People and computers XIV: Usability or Else! *Proceedings of HCI 2000*. London: Springer-Verlag.
- McDougall, G. (1995). Memory self-efficacy and strategy use in successful elders. *Educational Gerontology, 21*, 357-373.
- McKenna, K., & Bargh, J. (2000). Plan 9 from cyberspace: The implications of the Internet for personality and social psychology. *Personality and Social Psychology Review, 4*, 57-75.
- Medlock, S., Eslami, S., Askari, M., Sent, D., Buurman, B., De Rooij, S., & Abu-Hanna, A. (2012). Health information seeking behavior of elderly Internet users in the Netherlands. *European Geriatric Medicine, 3*, S90-S91.
- Melenhorst, A., Rogers, W., & Caylor, E. (2001). The use of communication technologies by older adults: Exploring the benefits from the user's perspective. *Proceedings of the Human Factors and Ergonomics Society 46th Annual Meeting*, 221-225.
- Miller, L., & Lachman, M. (1999). The sense of control and cognitive aging: Toward a model of mediational processes. In T. M. Hess & F. Blanchard-Fields (Eds.), *Social cognition and aging* (pp. 17-42). San Diego: Academic Press.
- Mobasher, B., Cooley, R., & Srivastava, J. (2000). Automatic personalization based on Web usage mining. *Communications of the ACM, 43*(8), 142-151.
- Morrell, R., & Echt, K. (1996). Instructional design for older computer users: The influence of cognitive factors. In WA. Rogers, A. D. Fisk, & N. Walker (Eds.), *Aging and skilled performance: Advances in theory and application* (pp. 241-265).
- Morrell, R., & Echt, K. (1997). Designing instructions for computer use by older adults. In A. D. Fisk & W. A. Rogers (Eds.), *Handbook of human factors and the older adult* (pp. 335-361). San Diego: Academic Press.

- Nagao, K., Shirai, Y., & Squire, K. (2001). Semantic annotation and transcoding: making older adults content more accessible. In *Older Adults Engineering, 1070(986X)*, 69-81. doi: 10.1109/93.917973
- Nascimento Ordonez, T., Sanches Yassuda, M., & Cachioni, M. (2011). Elderly online: Effects of a digital inclusion program in cognitive performance. *Archives of Gerontology and Geriatrics, 53(2)*: 216–219. doi: 10.1016/j.archger.2010.11.007
- National Institute on Aging (NIA) & National Library of Medicine (NLM). (2002). *Making your web site senior friendly: A checklist*. Retrieved from <http://www.nlm.nih.gov/pubs/checklist.pdf>
- Negrino, T., & Smith, D. (2007). *JavaScript & Ajax for the web* (6<sup>th</sup> ed.). Berkeley, CA: Peachpit Press.
- Newell, A., Carmichael, A., Gregor, P., & Alm, N. (2003). Information technology for cognitive support. In J. Jacko, and A. Sears (Eds.), *The human-computer interaction handbook : Fundamentals, evolving technologies, and emerging applications* (pp. 464-481). Hillsdale, NJ: Lawrence Erlbaum.
- Newell, A., & Gregor, P. (2001). Accessibility and interfaces for older people – a unique, but many faceted problem. *Proceedings of the 2001 EC/NSF Workshop on Universal Accessibility of Ubiquitous Computing: Providing for the Elderly*. Retrieved from [http://virtual.inesc.pt/wuau01/procs/pdfs/newell\\_final.pdf](http://virtual.inesc.pt/wuau01/procs/pdfs/newell_final.pdf)
- Ogozalek, V. (1994). A comparison of the use of text and multimedia interfaces to provide information to the elderly. *Proceedings of the CHI '94 Conference Companion on Human Factors in Computing Systems*, 203. doi:10.1145/259963.260287
- Park, D. (1992). Applied cognitive aging research. In F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition* (pp. 44-494). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Perry, B. (2004). *Java servlet & JSP cookbook*. Sebastopol, CA: O'Reilly Media.
- Radin, R., Vanderheiden, G., & Lin, M. (1990). A method for evaluating head-control computer input device. *Ergonomics, 35*, 159-175.
- Rizzo, A. (1999). Aging and information technology. *CyberPsychology & Behavior, 2(6)*, 497-499.
- Rogers, W., & Fisk, A. (2000). Human factors, applied cognition, and aging. In F.I.M.Craik & T.A. Salthouse (Eds.), *The handbook of aging and cognition* (2nd ed.) (pp. 559-591). Hillsdale, NJ: Lawrence Erlbaum Associates.

- Rogers, W., Cabrera, E., Walker, N., Gilbert, D., & Fisk, A. (1996). A survey of automatic teller machine usage across the adult life span. *Human Factors*, 38, 1-11.
- Rotter, J. (1966). Generalized expectancies for internal versus external control of reinforcement. *Psychological Monographs*, 80 (Whole No. 609).
- Ryan, E. (1992). Beliefs about memory changes across the adult life span. *Journal of Gerontology*, 47(1), 41-46.
- Ryan, E., & Kwong See, S. (1993). Age-based beliefs about memory changes for self and others across adulthood. *Journal of Gerontology*, 48, 199-201.
- Saba, D., & Mukherjee, A. (2003). Pervasive computing: A paradigm for the 21st century. *IEEE Computer*, 36(3), 25-30.
- Salthouse, T. (1985). Speed of behavior and its implication for cognition. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the Psychology of Aging* (2nd ed.). (pp. 400–426). New York: Van Nostrand Reinhold.
- Salthouse, T. (1991). *Theoretical perspectives on cognitive aging*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Sampller, J. (1998). Redefining industry structure for the information age (Special Issue: Editor's Choice). *Strategic Management Journal*, 19(4) 343-355.
- Sato, D., Kobayashi, M., Takagi, H., Asakawa, C., & Tanaka, J. (2011, October). How voice augmentation supports elderly web users. *Proceedings of the 13th International ACM SIGACCESS Conference on Computers and Accessibility* (pp. 155-162). Dundee, Scotland. doi:10.1145/2049536.2049565
- Sayago, S, Sloan, D., & Blat, J. (2011). Everyday use of computer-mediated communication tools and its evolution over time: An ethnographical study with older people. *Interacting with Computers*, 23(5): 543-554. doi:10.1016/j.intcom.2011.06.001
- Schunk, D. (1994). Self-regulation of self-efficacy and attributions in academic settings. In D. Schunk & B. Zimmerman (Eds.), *Self-regulation of learning and performance: Issues and educational applications* (pp. 75–99). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Sears, A., & Young, M. (2003). Physical disabilities and computing technologies: An analysis of impairments. In J. Jacko and A. Sears (Eds.), *The human-computer interaction handbook: Fundamentals, evolving technologies, and emerging applications* (pp. 482-503). Mahwah, NJ: Lawrence Erlbaum Associates.

- Seeman, P., Guan, H., & Van-Tol, H. (1993). Dopamine D4 receptors elevated in schizophrenia. *Nature*, 365, 441–445.
- Shardanand, U., & Maes, P. (1995). Social information filtering: algorithms for automating “word of mouth.” *Proceedings of the ACM CHI Conference 1995*, Denver, CO. Retrieved from [http://www.sigchi.org/chi95/proceedings/papers/us\\_bdy.htm](http://www.sigchi.org/chi95/proceedings/papers/us_bdy.htm)
- Shneiderman, B. (1998). *Designing the user interface: Strategies for effective human-computer interaction* (3<sup>rd</sup> ed.). Reading, MA: Addison-Wesley.
- Sloan, D., Atkinson, M., Machin, C., & Li, Y. (2010, April). The potential of adaptive interfaces as an accessibility aid for older web users. *Proceedings of 2010 International Cross-Disciplinary Conference on Web Accessibility (W4A)*, Raleigh, NC.
- Smith, M., Sharit, J., & Czaja, S. (1999). Aging, motor control, and the performance of computer mouse tasks. *Human Factors*, 41(3) 389-396.
- Stuart-Hamilton, I. (1999). Intellectual changes in late life. In R.T. Woods (ed.) *Psychological problems in ageing: Assessment, treatment and care* (pp. 27-47). New York: Wiley.
- Taylor, A., Sr., Miller, L., Nilakanta, S., Sander, J., Mitra, S., Sharda, A., & Chama, B. (2009). Using an error detection strategy for improving web accessibility for older adults. *Advances in Computer-Human Interactions (ACHI) 2009*, 375-380. Retrieved from <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4782543>
- Taylor, A., Sr., Miller, L., & Nilakanta, S. (2009). Comparing strategies for evaluating older adults to improve web accessibility. *24th International Conference on Computers and their Applications, CATA 2009*, 13-18.
- Tyler, R. (2002). Is the internet changing social life? It seems the more things change, the more they stay the same. *Journal of Social Issues*, 58(1) 195-205. doi:10.1111/1540-4560.00256
- Uphold, C. R. 2012. Transitional care for older adults: the need for new approaches to support family caregivers. *Journal of Gerontological Geriatric Research*, 1(2):107. doi: 10.4172/jggr.1000e107
- Wagner, N., Hassanein, K., & Head, M. (2010). Computer use by older adults: A multi-disciplinary review. *Computers in Human Behavior*, 26(5), 870–882.
- Walker, N., Millians, J., & Worden, A. (1996). Mouse accelerations and performance of older computer users. In *Proceedings of the Human Factors and Ergonomics Society*

- 40th Annual Meeting (pp. 151 – 154). Santa Monica, CA: Human Factors and Ergonomics Society.
- Watzman, S. (2003). Visual design principles for usable interfaces. In A. J. Jacko & A. Sears (Eds.), *The human-computer interaction handbook: Fundamentals, evolving technologies, and emerging application* (pp. 413-425; pp. 264-284). Mahwah, NJ: Lawrence Erlbaum Associates.
- Weare, C., Loges, W., & Oztas, N. (2007). Email effects on the structure of local associations: A social network analysis. *Social Science Quarterly*, 88(1), 222-243.
- Wilkniss, S., Jones, M., Korol, D., Gold, E., & Manning C. (1997). Age-related differences in an ecologically based study of route learning. *Psychology and Aging*, 12(2), 372-375.
- Wood, E., Rushing, A., Bechtel, L., & Gilbert, J. (2005). Use of computer input devices by older adults. *Journal of Applied Gerontology*, 24(5), 419--438.
- World Wide Web Consortium (W3C). (1999). *Web content accessibility guidelines 1.0*. World Wide. Retrieved from <http://www.w3.org/TR/WCAG10/>
- Zajicek, M. (2001). Supporting older adults at the interface. In C. Stephanidis (Ed.), *Universal access in HCI: Towards an information society for all* (pp. 454-458). Mahwah, NJ: Lawrence Erlbaum Associates.
- Zajicek, M., & Hall, S. (2000). Solutions for older visually impaired people using the Internet. In *Proceedings of HCI 2000* (pp. 299-307). Sunderland, UK.
- Zajicek, M., & Arnold, A. (1999). The 'technology push' and the user tailored information environment. *5th European Research Consortium for Informatics and Mathematics, Workshop on 'User interfaces for all,'* Dagstuhl, Germany. Retrieved from [citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.23.4960](http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.23.4960)
- Zajicek M., & Reeves, C. (1998). An older adult navigation tool for the blind. In *Proceedings of the 3rd ACM/SIGAPH on Assistive Technologies* (pp. 204-406). New York: ACM Press.
- Zandri, E., & Charness, N. (1989). Training older and younger adults to use software. *Educational Gerontology*, 15(6), 11-27.
- Zickuhr, K. (2011). Americans and their gadgets. Pew Research Center's Internet & American Life Project. Retrieved from <http://pewinternet.org/Reports/2010/Gadgets/Report/Desktop-and-Laptop-Computers.aspx>

Ziebland, S. & Wyke, S. (2012), Health and illness in a connected world: How might sharing experiences on the internet affect people's health? *Milbank Quarterly*, 90: 219–249.  
doi: 10.1111/j.1468-0009.2012.00662.x009.2012.00662.x



## APPENDIX A. HUMAN SUBJECTS APPROVAL

### IOWA STATE UNIVERSITY

OF SCIENCE AND TECHNOLOGY

**DATE:** 30 January 2007

**TO:** Alfred Taylor  
213 Atanasoff

**CC:** Dr. Les Miller  
227 Atanasoff

**FROM:** Jan Canny, IRB Administrator  
Office of Research Assurances

**IRB ID:** 06-647

Institutional Review Board  
Office of Research Assurances  
Vice Provost for Research  
1138 Pearson Hall  
Ames, Iowa 50011-2207  
515 294-4566  
FAX 515 294-4267

**Approval Date:** 29 January 2007  
**Date for Continuing Review:** 28 January 2008

The Chair of the Institutional Review Board of Iowa State University has reviewed and approved the protocol entitled: "Error Detection Strategies for Elderly Computer Users." The protocol has been assigned the following ID Number: 06-647. Please refer to this number in all correspondence regarding the protocol.

Your study has been approved from 29 January 2007 to 28 January 2008. The **continuing review date** for this study is no later than **28 January 2008**. Federal regulations require continuing review of ongoing projects. Please submit the form with sufficient time (i.e. three to four weeks) for the IRB to review and approve continuation of the study, prior to the continuing review date.

Failure to complete and submit the continuing review form will result in expiration of IRB approval on the continuing review date and the file will be administratively closed. All research related activities involving the participants **must stop** on the continuing review date, until approval can be re-established, except when necessary to eliminate immediate hazard to research participants. As a courtesy to you, we will send a reminder of the approaching review prior to this date.

Please remember that any **changes in the protocol or consent form** may not be implemented without prior IRB review and approval, using the "Continuing Review and/or Modification" form. Research investigators are expected to comply with the principles of the Belmont Report, and state and federal regulations regarding the involvement of humans in research. These documents are located on the Office of Research Assurances website or available by calling (515) 294-4566, [www.compliance.iastate.edu](http://www.compliance.iastate.edu).

You must promptly report any of the following to the IRB: (1) **all serious and/or unexpected adverse experiences** involving risks to subjects or others; and (2) **any other unanticipated problems involving risks** to subjects or others.

Upon completion of the project, please submit a Project Closure Form to the Office of Research Assurances, 1138 Pearson Hall, to officially close the project.

## APPENDIX B. PARTICIPANT SELF-ASSESSMENT QUESTIONNAIRE

The self-assessment questionnaire given below was given to each participant at the initial meeting. Each participant completed a self-assessment of their limitations and computer skills. The responses from the self-assessment were used to define the parameters in the Self profile. The assessment asks the participant how they rated themselves in the context of using the Internet, their vision, motor skills, and their cognitive abilities. The self-assessment questionnaire results in provided profile parameter values based on their rating.

7. Rate your motor Skills	“motor /mobility”
8. Rate your vision	“font size”
9. Rate your thinking	“thinking/reason”
10. Rate your comprehension	“understanding”
11. Rate your learning	“learning”
6. Rate your memory	“memory”

The answers from the self-assessment questionnaire were the basis for the initial coding of the parameters for the self-assessment profile. The table below explains the process of the participant answering the questionnaire and the answers being translated into coded parameters for the profile.

The font algorithm for self-assessment data was based on self-reported data through a self-assessment questionnaire.

### Self-assessment:

- The value for font size will be set through the response from the user self-assessment questionnaire.
- The rating scale is from 1- poor, 2-below average, 3-average ,4-above average , 5 excellent based upon the Likert scale.
- The rating choices are listed horizontally along the right hand side of the vision severity characteristics.
- Descriptors are listed horizontally for each choice. The descriptors are listed sequentially in terms of severity (of visual assessment), from poor to excellent.
- The numbers attached to each severity are considered part of the scale. The specific number beside each severity name is the numerical rating to be given for that severity. For example, under poor, a numerical rating of 1 - is possible; while under excellent, a numerical rating of 5 is possible.
- For each rating, the participant marked the descriptor that best described their vision.
- Using the severity vision score, the value to set the default profile was determined:
  - Font for poor vision – 18pt to 20pt
  - Font for low vision – 16pt
  - Font for average vision – 12pt (browser default)
  - Font for above average vision – 12pt
  - Font for excellent vision – 12pt

Since before Mosaic, the default font-size value in all major browsers has been set at 12pt. They currently default to 12pt which rasterizes very differently across browsers and platforms to access information. All scalable font-size values operate relative to this inconsistent base rasterization.

(lists.w3c.org/Archives/Public/www-style/1998Dec/0030.html)

### Algorithm:

Browse: (font size)  
 The user requests a page; either suggests or enters a URL.  
 Browse: (font size)  
 Read in URL request by user as string.  
 Search page for font size tabs in webpage.

Write font information to Table error\_track\_fontsize.

Display webpage to user.

Detect errors (how many times the user attempts to launch and traverse through the site).  
(i.e., wrong button, wrong menu, and wrong link.)

Update Table: error\_mouse\_clicks to determine the number of clicks

Participant Name: \_\_\_\_\_

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Approved Date:	27 August 2007
Expiration Date:	28 January 2008
Initial by:	jlc

### Participant Self- Assessment Questionnaire

1. Rate your motor (hand movement) skills ability 1 to 5, (5) being excellent.

1-Poor  2-Below average  3-Average  4-Above average  5-Excellent

2. Rate your vision level 1 to 5, (5) being excellent.

1-Poor  2-Below average  3-Average  4-Above average  5-Excellent

3. Rate your thinking skills 1 to 5, (5) being excellent.

1-Poor  2-Below average  3-Average  4-Above average  5-Excellent

4. Rate your comprehension (understanding) skills 1 to 5, (5) being excellent.

1-Poor  2-Below average  3-Average  4-Above average  5-Excellent

5. Rate your learning skills 1 to 5, (5) being excellent.

1-Poor  2-Below average  3-Average  4-Above average  5-Excellent

6. Rate your memorization skills 1 to 5, (5) being excellent.

1-Poor  2-Below average  3-Average  4-Above average  5-Excellent

7. Rate how you feel about yourself 1 to 5, (5) being excellent.

1-Poor  2-Below average  3-Average  4-Above average  5-Excellent

8. Rate how well you think you can learn to use the computer 1 to 5, (5) being excellent.

1-Poor  2-Below average  3-Average  4-Above average  5-Excellent

## APPENDIX C. PARTICIPANT QUESTIONNAIRE AND TEST

The test questionnaire below was given to each participant at the testing meeting. Each Participant was administered the test questionnaire of their limitations and computer skills. The results from the test questionnaire were used to define the parameters in the test profile. The assessment tested the participant in the context of using the Internet, their vision, motor skills, and their cognitive abilities. The test questionnaire results provided profile parameter values based on their rating. The paper-based tests were given to the participants after the self-assessment. Then numbers of errors were captured during usability testing using the paper-based results of the test questionnaire. As mentioned previously, the values were entered into the test profile. The paper-based test showed the actual capabilities of the participant through the execution of the tasks. The response values from the paper-based test defined the test profile parameters. The results of the test questionnaire were used as parameters in establishing the test profile. These values were derived from how the participant performed on the test questionnaire. The participant was administered the test to measure actual performance in the areas of vision and motor skills. The output or results of the participant answers were used to generate the profile parameters. Each question had a measurement assign to each answer (e.g., question #5, word size). There was a font size associated with each block presented to the participant; **apple = font size 10**, banana=12, orange=14, pear=16, and grape=18. The response to question 8 helped determine the motor skills value. The participant had to accurately place a dot in the middle of the boxes presented. This profile is supplied with parameter information from the test questionnaire.

Test Questionnaire groupings:	Measure:
3. Word Size	Font size
4. Period placement	Motor
5. Matching symbols	Thinking/Reasoning
6. List #	Thinking/Understand
7. List #	Thinking/Understand
<b>8.</b> President	Crystallized Memory

The font algorithm for test profile data was based on test data through the test questionnaire.  
test questionnaire:

- The value for font size will be set through the response from the user test questionnaire.
- The rating scale is from 1- poor, 2-below average, 3-average ,4-above average , 5 excellent based upon the Likert scale.
- The rating choices are listed horizontally along the right hand side of the vision severity characteristics.
- Descriptors are listed horizontally for each choice. The descriptors are listed sequentially in terms of severity (of visual assessment), from poor to excellent.
- The numbers attached to each severity are considered part of the scale. The specific number beside each severity name is the numerical rating to be given for that severity. For example, under poor, a numerical rating of 1 - is possible; while under excellent, a numerical rating of 5 is possible.
- For each rating, the participant marked the descriptor that best described their vision.
- Using the severity vision score, the value to set the default profile was determined:
  - Font for poor vision – 18pt to 20pt
  - Font for low vision – 16pt
  - Font for average vision – 12pt (browser default)
  - Font for above average vision – 12pt

- Font for excellent vision – 12pt

Since before Mosaic, the default font-size value in all major browsers has been set at 12pt. They currently default to 12pt which rasterizes very differently across browsers and platforms to access information. All scalable font-size values operate relative to this inconsistent base rasterization.

([lists.w3c.org/Archives/Public/www-style/1998Dec/0030.html](http://lists.w3c.org/Archives/Public/www-style/1998Dec/0030.html))

Algorithm:

Browse: (font size)

The user requests a page; either suggests or enters a URL.

Browse: (font size)

Read in URL request by user as string.

Search page for font size tabs in webpage.

Write font information to Table error\_track\_fontsize.

Display webpage to user.

Detect errors (how many times the user attempts to launch and traverse through the site).

(i.e., wrong button, wrong menu, wrong link.)

Update Table: error\_mouse\_clicks to determine the number of clicks

The main objective of the participant test was to gather seemingly more accurate measures from the participants. That way we could create a test profile with measured values taken directly from the participants' actions. Questions contained on the test questionnaire varied from checking to see if there were any other possible factors that could affect the outcome of the measurements. Such as, asking the participant if they wore glasses and if they had the glasses on at that time? If the participant wore glasses and did not have them on, we would request them to get them. That way we insured a more accurate assessment of them taking the vision part of the test. We tested their long term memory and reasoning with questions 21 and 22.

Participant Name: \_\_\_\_\_

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Approved Date:	27 August 2007
Expiration Date:	28 January 2008
Initial by: LV	jlc

**Participant Questionnaire**

1. Do you typically wear glasses?

 Yes No

2. Are you wearing glasses now?

 Yes No

3. Do you wear glasses when using the computer?

 Yes No

4. Gender

 Female Male

5. Check the word size that you prefer.

 Apple banana orange pear grape

6. How long have you worked on a computer?

 less than 3 months More than 6 months More than 1 year Never

7. How often do you use a computer?

 Less than Monthly Monthly Weekly Daily None

8. Please place a period . in the middle of each box.



9. Please match the symbols with the corresponding number. Place the number in the object.

1. Star

2. Rectangle

3. Square

4. Circle

5. Triangle



10. Age \_\_\_\_\_

11. Education Level in years \_\_\_\_\_

Grade School  Some High School  "12" High School  "14" Associate Degree

"16" Bachelors degree  "18" Masters degree  PhD

12. How well do you think you can learn computer technology?

Superior  Above average  Average  Fair  With some difficulty

13. Please choose an answer to the statement. Computers are for: \_\_\_\_\_.

Playing games  Solving problems  Shopping on-line  Business

14. Ethnicity

Caucasian  Hispanic  Asian  Indian  African American

15. Prior occupation

Farmer  Professional  Homemaker  Medical  Teacher

16. Last Occupation \_\_\_\_\_

17. Income range

5,000-30,000  30,000-50,000  50,000-70,000  70,000-above

18. Marital Status

Married  Single  Widowed  Divorced

19. How many children do you have?

None  1  2  3  4 or more

20. Rate your health

Excellent  Good  Fair  Poor

21. List the number from highest to lowest.

\_\_\_\_\_  
 23  2  16  eleven  33  31

22. Who was Franklin D. Roosevelt? \_\_\_\_\_



## **APPENDIX D. USABILITY OBSERVATION EVALUATION FORM**

The usability observation evaluation form was used to record and rate behavior and user performance while accessing the Internet. The observation data was gathered when the participants were administered a set of tasks. The number of instances and actions while the participants completed the usability task was recorded, using the observation form. The results were entered into a profile and then used as preferences for the participant while completing usability tasks. The responses from the observational session defined the observation profile. The main objective of the observation of the participant was to collect observable behavior of the participant surfing the web. The usability observation evaluation form was used to collect and record varied characteristics of the interaction of the participant, such as accuracy in moving and clicking the mouse, traversing through a webpage, asking questions, talking out loud, and how efficiently they were accomplishing the tasks. More importantly, we were interested in the way the participant could effectively use their motor skills and see. The results from the Usability Observation Evaluation Form were the basis for the initial coding of the parameters for the observation profile

Algorithm:

Browse: (font size)

The user requests a page, either suggests or enters a URL.

Browse: (font size)

Read in URL request by user as string.

Search page for font size tabs in webpage.

Write font information to Table error\_track\_fontsize.

Display webpage to user.

Detect errors (how many times the user attempts to launch and traverse through the site).

(i.e., wrong button, wrong menu, wrong link.)

Update Table: error\_mouse\_clicks to determine the number of clicks

The main objective of the observation was to gather seemingly more accurate measures from the participants. That way we could create a profile based on measured values taken directly from the participants' actions.

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Expiration Date:	28 January 2008
Initial by:	jlc

Usability Observation Evaluation Form

Task 1: 1. 2. 3. 4. 5. (Rate 1 – 5)

- Read Instruction \_\_\_\_\_
- Screen Response \_\_\_\_\_
- Type \_\_\_\_\_
- Visually scan \_\_\_\_\_
- Non verbal \_\_\_\_\_
- Body Language \_\_\_\_\_
- Questions \_\_\_\_\_
- Talk out loud \_\_\_\_\_

Cognitive:

- Questions
- Talk out loud
- Efficiency
- Effectiveness

Motor Skills:

- mouse movement
- scrolls
- clicks
- access

Vision:

- Prog (aarp)
- 2<sup>nd</sup> site

Task 1: Questions | Non-verbal's | Lean forward | adjust glasses | Other

Steps time

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_
9. \_\_\_\_\_
10. \_\_\_\_\_

Clarify language – Confounding knowledge

Behaviors:

Coding sub-behaviors

- # of clicks \_\_\_\_\_
- Steps to get to desired end \_\_\_\_\_

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Rating fluidity by time and #

- 1| \_\_\_\_\_
- 2| \_\_\_\_\_
- 3| \_\_\_\_\_
- 4| \_\_\_\_\_
- 5| \_\_\_\_\_

Vision =

- body gesture
- leaning forward
- verbal
- non-verbal

## APPENDIX E. TASK LIST FOR USABILITY STUDY

The task list used for each participant represented designed informational path that the participants had to take for adequate capture of the main areas of interest (vision and motor skills). Each task was designed to capture the movement and navigation of the webpages that were listed. The tasks were designed to gather relevant information to establish an efficient profile to help the participant to effectively navigate through a webpage. The conditions that determined the outcome were font size and ability to click on an icon successfully (motor skills). We created a scenario whereas the participant would visit two specific websites and traverse through the pages by following the steps indicated on the task list. The ability of the participant to use the application interface (API) would be evaluated by how efficiently they performed each task listed.

Task 1: Please familiarize yourself with what you observe on the screen.

- Look at all of the objects (icons) on the screen.
- Look at the menu bar (bottom of screen).
- Notice the start button at the bottom of your screen.

Task 2: Click (**twice** rapidly) the Internet Explorer Image on your desktop (Screen) to open application.

Task 3: In window (rectangle bar), type your name and press the return key.

Task 4: Click on one of the results lines (links).

Task 5: Once you are done, click on the **home**  or **house** symbol on the top of the menu bar.

Task 6: At the top of your screen or browser, type in aarp.org

Task 7: On the right side of the webpage, please **adjust** your font size to your preference if you like

Task 8: Click on Learning and Technology on the top menu.

- Select or click on computers and technology.
- Select or click on Web lessons.
- Select or click on Understanding the basics.
- Read 1<sup>st</sup> paragraph.

Task 9: Click on Health menu bar.

- Click on Physical activity menu on side bar.
- Click on Working Out.
- Click on preferred topic to review.
- Read some of the information.

Task 10: Click on AARP the Magazine link at the top of menu bar.

- Click on Games in the left hand corner menu.
- Click on Daily crossword puzzle.
- Click on the box in which the authors name appears.
- Select skill level.
- Solve 1 or 2 entries if you like.

Task 11: Once you are done, click on the home or house symbol on the top of the menu bar.

Task 12: At the top of your screen or browser, type in www.nlm.nih.gov

Task 13: Click on Health Information in the top left corner.

- Click on Medline Plus – Health Information link.
- Click on Health topics.
- Click on Eyes and vision heading.
- Click on Eye object to display information.
- Click on Home tag in the upper left corner.

Task 14: Click on Health Information in the top left corner.

- Click on Medline Plus – Health Information link.
- Click on Health topics.
- Scroll down on the bottom left side of the screen.

- Click or select Interactive Health Tutorials.
- Click or select Back Pain – How to prevent.
- Click or select Start self-playing Tutorial.
- Observe the information displayed.
- Click the X in the upper right corner to close the window.

Task 15: Click the home button to return to the homepage

## APPENDIX F. LETTER OF INFORMATION

The letter of information was administered prior to the participants starting the study.

ISU IRB # 1	06-647
Approved Date:	18 September 2007
Expiration Date:	28 January 2008
Initial by:	jc

**Title of Study:** Error Detect Strategies for Elderly Computer Users

**Investigators:** Principle Investigator: Alfred Taylor

Major Professor: Dr. Les Miller

This is a research study. Please take your time in deciding if you would like to participate. Please feel free to ask questions at any time.

### INTRODUCTION

The purpose of this study is to examine the usability of accessibility to Websites for people over 65. The following questions are to be answered in this research:

1. Are there any structure or layout problem?
2. Is there any navigational problem?
3. Are there any terminology problem?

### DESCRIPTION OF PROCEDURES

If you agree to participate in this study, your participation will last for approximately 60 minutes. You will access the Website via computer. You will navigate to various Websites. You will be given a task list to complete. Also, you will be asked some questions on your experience on navigating through the Website performing the task given. Your mouse movements will be recorded using software. You will be given a participant "self-assessment questionnaire" to complete. Also, you will be asked to take a "number comparison" test that will last approximately 1 ½ minutes. You will be asked to complete a questionnaire that will best describe how you feel. Finally, you will be asked to complete a short questionnaire about your use of computers. You may skip any question that you do not wish to answer or that makes you feel uncomfortable.

### RISKS

There are no foreseeable risks in this study.

### BENEFITS

This survey will not yield a direct benefit to you. However, the knowledge or information gathered in this research will help future research in designing Website usability for people over 65.

**COSTS AND COMPENSATION**

You will not be compensated for participating in this study and there is no cost in participating in this survey.

**PARTICIPANT RIGHTS**

Your participation in this study is completely voluntary and you may refuse to participate or leave the study at any time. If you decide to not participate in the study or leave the study early, it will not result in any penalty or loss of benefits to which you are otherwise entitled. During the testing, if you feel uncomfortable at any time you can quit.

**CONFIDENTIALITY**

Records identifying participants will be kept confidential to the extent permitted by applicable laws and regulations and will not be made publicly available. However, federal government regulatory agencies and the Institutional Review Board (a committee that reviews and approves human subject research studies) may inspect and/or copy your records for quality assurance and data analysis. These records may contain private information. To ensure confidentiality to the extent permitted by law, the following measures will be taken.

There is no identifier in this questionnaire and the participant's identity will be anonymous all throughout the survey. Only the researcher will have access to the data. The data will be entered and kept in a password-protected computer located at the PI's office in the Computer Science department. The questionnaire will be tossed away or shredded after all the information is entered into the computer.

**QUESTIONS OR PROBLEMS**

You are encouraged to ask questions at any time during this study. For further information about the study contact Major professor/ supervising faculty:

Project supervisor:

P.I: Alfred Taylor at 515-294-9937 or email [taylora@iastate.edu](mailto:taylora@iastate.edu)

If you have any questions about the rights of research subjects or research-related injury, please contact the IRB Administrator, (515) 294-4566, [jcs1959@iastate.edu](mailto:jcs1959@iastate.edu), or Diane Ament, Research Compliance Officer (515) 294-3115, [dament@iastate.edu](mailto:dament@iastate.edu).

Thank you very much for your participation.

## APPENDIX G. EDS QUESTIONNAIRES

The questionnaires listed below were system-administered evaluations that the user could take as recommended by the system. These questionnaires were precursors to future capabilities of the Error Detection system that would eliminate human intervention when optimization was necessary for a participant. The system-generated questionnaires were not used in this study, but the architecture was built to add in future research. Each electronic questionnaire measured specific areas (vision, motor skills, current health state, computer skill levels).

### Questionnaire ID: 100

User Name

Rate your motor (hand movement) skills ability 1 to 5, (5) being excellent.

Rate your vision level 1 to 5, (5) being excellent.

Rate your thinking skills 1 to 5, (5) being excellent.

Rate your comprehension (understanding) skills 1 to 5, (5) being excellent.

Rate your learning skills 1 to 5, (5) being excellent.

Rate your memorization skills 1 to 5, (5) being excellent.

Rate how you feel about yourself 1 to 5, (5) being excellent.

Rate how well you think you can learn to use the computer 1 to 5, (5) being excellent.

Rate your health 1 to 5, (5) being excellent.

### Questionnaire ID: 101

User Name

What is your basic computer skill level?

How frequently do you use computers?

Rate your motor (hand movement) abilities 1 to 5, (5) being excellent.

Rate your vision level 1 to 5, (5) being excellent.

Rate your thinking skills 1 to 5, (5) being excellent.

Rate your comprehension (understanding) skills 1 to 5, (5) being excellent.

Rate your learning skills 1 to 5, (5) being excellent.

Rate your memorization skills 1 to 5, (5) being excellent.

Rate how you feel about yourself 1 to 5, (5) being excellent.

Rate how well you think you can learn to use the computer 1 to 5, (5) being excellent.

Rate your health 1 to 5, (5) being excellent.

### Questionnaire ID: 102

User Name

What is your basic computer skill level?

Do you have any eye defects?

How frequently do you use computers?

### Questionnaire ID: 103

User Name

What is your basic computer skill level?

Do you have any eye defects?

How frequently do you use computers?

### Questionnaire ID: 104

User Name

What is your basic computer skill level?



**Questionnaire ID: 105**

User Name

Do you have any eye defect?

**Questionnaire ID: 106**

User Name

Do you have any eye defects?

How frequently do you use computers?

**Questionnaire ID: 107**

User Name

How frequently do you use computers?

Which Websites do you frequently visit?

**Questionnaire ID: 109**

User Name

What is your basic computer skill level?

Do you have any eye defect?

How frequently do you use computers?

Which Websites do you frequently visit?

**Questionnaire ID: 110**

User Name

What is your basic computer skill level?

Do you have any eye defect?

How frequently do you use computers?

Which Websites do you frequently visit?

**Questionnaire ID: 200**

User Name

Word size preference?

What is the reasoning symbol score?

What is the numerical sequence score?

What is the President memory score?

What is the placement value for mobility?

**Questionnaire ID: 210**

User Name

How many numerical comparisons were correct?

How many numerical comparisons were incorrect?

What was the total number of numerical comparisons answered?

What is the approximate R-W/ N-1= score for understanding and thinking?

## **APPENDIX H. ERROR DETECTION SYSTEM STRATEGIES AND ALGORITHMS FOR SYSTEM SUPPORT**

The appendices listed below describe the system strategies and algorithms for system support of the various test and functions.

### **H-1. Strategy for scoring Font size**

The font algorithm for self-assessment data was based on self-reported data through a self-assessment questionnaire.

Self-assessment:

- The value for font size will be set through the response from the user self-assessment questionnaire.
- The rating scale is from 1- poor, 2-below average, 3-average, 4-above average, 5 excellent based upon the Likert scale.
- The rating choices are listed horizontally along the right hand side of the vision severity characteristics.
- Descriptors are listed horizontally for each choice. The descriptors are listed sequentially in terms of severity (of visual assessment), from poor to excellent.
- The numbers attached to each severity are considered part of the scale. The specific number beside each severity name is the numerical rating to be given for that severity. For example, under poor, a numerical rating of 1 - is possible; while under excellent, a numerical rating of 5 is possible.
- For each rating, the participant marked the descriptor that best described their vision.
- Using the severity vision score, the value to set the default profile was determined:
  - Font for poor vision – 18pt to 20pt
  - Font for low vision – 16pt
  - Font for average vision – 12pt (browser default)
  - Font for above average vision – 12pt
  - Font for excellent vision – 12pt

Since before Mosaic, the default font-size value in all major browsers has been set at 12pt. They currently default to 12pt which rasterizes very differently across browsers and platforms to access information. All scalable font-size values operate relative to this inconsistent base rasterization.

([lists.w3c.org/Archives/Public/www-style/1998Dec/0030.html](http://lists.w3c.org/Archives/Public/www-style/1998Dec/0030.html))

Algorithm:

Browse: (font size)

The user requests a page; either suggests or enters a URL.

Browse: (font size)

Read in URL request by user as string.

Search page for font size tabs in webpage.

Write font information to Table error\_track\_fontsize.

Display webpage to user.

Detect errors (how many times the user attempts to launch and traverse through the site).

(i.e., wrong button, wrong menu, wrong link.)

Update Table: error\_mouse\_clicks to determine the number of clicks

### **H-2. Test Profile Font: (Palper Questionnaire) Strategy**

The font algorithm for determining values for the test profile was collected from a participant questionnaire administered to each participant.

1. There were questions addressing font size preference on the participant questionnaire.
2. The question asks which word size that the participant preferred?  
The choices were font size 12; font size 14; font size 16; font size 18; and font size 20;

- Based upon the above choices, the test profile values for font size will be entered into each user's profile. This will be the font size that the user's webpage will display.

Algorithm:

The user requests a page either suggested or enters a URL.  
 Browse: (font size)  
 Read in URL request by user as string.  
 Search page for font size tabs in webpage.  
 Write font information to Table error\_track\_fontsize.  
 Display webpage to user.  
 Detect errors (how many times the user attempts to launch and traverse through the site). (i.e., wrong button, wrong menu, wrong link.)  
 Update Table: error\_mouse\_clicks to determine the number of clicks

### **H-3. Strategy Test Profile Font (System Test) (Users Choice):**

The font algorithm for determining values for the system test profile will be collected from a test script administered to each participant by the system.

- The user default font size will first be established through a font test script on the initial sign-in webpage.
- The user will be given a series of words to replicate in sequence.
- The user has a threshold of a certain number of errors.
- If the user mistypes more than three words wrong then the series of words will increase in size.
- Once the user has success, then that font size is stored into the users' profile.

Algorithm:

The user requests a page either suggested or enters a URL.  
 Browse: (font size)  
 Read in URL request by user as string.  
 Search page for font size tabs in webpage.  
 Write font information to Table error\_track\_fontsize.  
 Display webpage to user.  
 Detect errors (how many times the user attempts to launch and traverse through the site). (i.e., wrong button, wrong menu, wrong link.)  
 Update Table: error\_mouse\_clicks to determine the number of clicks

### **H-4. Strategy Profile Font (System Test)**

- The font algorithm for determining values for the "Error" profile will be collected by a script through detection and periodic system administered test to each participant.
- The user default font size will first be established through a font test script on the initial webpage.
- The user will be given a series of words to replicate in sequence.
- The user has a threshold of a certain number of errors.
- If the user mistypes more than three words, the series of words will increase in size.
- Once the user has success, then that font size is stored into the users' profile.

Algorithm:

Browse: (font size)  
 Read in URL request by user.  
 Search page for font size tab in webpage.  
 Compare found font size with user profile font value.  
 If font size = profile font value  
 Then Do nothing

Else  
 If font size  $\neq$  profile font value  
 Then change font size in webpage to font value.  
 Display webpage  
 Detect errors (how many times the user attempts to launch and traverse through the site). i.e., wrong button, wrong menu, wrong link.  
 Update Table: error\_mouse\_clicks to determine the number of clicks  
 Compare Tables and times with past performance.  
 Change/ask user if they would like to improve performance?  
 Have them take font test again.  
 Detect performance of font size adjustment.

## H-5. Strategy for scoring cognition (System Test) (“Error Profile”)

### H-5.1 Scoring locus of control:

1. The cognition (locus of control) algorithm for determining values for the “test” profile values will be collected from a test script that will administer a Locus of Control test (Rotter, 1966) to each participant by the system. The Locus of Control is a 13-item questionnaire that measures generalized expectancies for internal versus external control of reinforcement. People with an internal locus of control believe their own actions determine the rewards that they obtain, while those with an external locus of control believe that their own behavior does not matter much and that rewards in life are generally outside of their control. Scores range from 0 to 13. A low score indicates an internal control while a high score indicates external control.
2. User login to system server.
3. User is presented with menu.
4. User selects Locus of Control Test.
5. The user is prompted to answer 13 questions to determine locus of control.
6. Once the user completes all of the questions, then the values are stored into the users’ profile.

Algorithm:

User click on answer they prefer.  
 Each answer will be coded

- Internal or external (dependent upon answer)

The fields associated with the locusofcontrol Table are:

- errorID
- Username
- Time
- Answer 1 – 13

Then the fields in curr\_skills are updated:

- Understanding score
- Thinking score

Then:

Return user to homepage after completion of test.

Read in URL request by user.

Parse webpage: ( )

<body> attributes

<basefont> element

<font> element

<div> element

<block> element

<img> element

<display> property

Display webpage

Detect errors (how many times the user attempts to launch and traverse through the page). i.e., wrong button, wrong menu, wrong link.  
 Update Table: error\_mouse\_clicks to determine the number of clicks  
 Write font information to table error\_track\_fontsize.

### **H-5.2 Strategy for scoring Cognitive Test (number comparison test). Paper test (System Test Parameters) (“Error Profile”)**

1. The comparison test is a criterion for convergence or divergence of a series whose terms are real or complex numbers. It determines convergence by comparing the terms of the series in question with those of a series whose convergence properties are known. There are two versions of the comparison test.
2. The spatial and attentional functions that may contribute to calculation.
3. The test updates the number\_comparison\_error\_test Table.
4. This test is for checking processing speed and accuracy
5. The value is store in the number\_comparison\_error\_test table
6. The value is also stored in the error\_cognition\_apititude Table

Algorithm:

User is administered the number comparison test at user training session.  
 The values are then entered per user into create questionnaire under the administration menu.  
 The questionnaire is created with the following fields or questions to load the table with values:  
 How many correct?  
 How many incorrect that was answered?  
 What was the total amount of comparisons completed?  
 The fields in the number\_comparison\_error\_test table are:  
 Username  
 ErrorID  
 Spatial, (integer)  
 Attentional (integer)  
 Perceptual speed (integer)  
 Updates the current\_skills table when in “Error Profile”  
 understandingscore  
 thinkingscore  
 The fields in the error\_cognition\_apititude table are update with values:  
 Username  
 Time  
 ErrorID  
 Fontsize  
 Wellness  
 Confidence  
 Additional (if another parameter is needed)

#### **H-5.2.1 Solution and support scoring.**

A typical formula for this correction is  $R - W/n - 1$ , where R = number right, W= the number wrong, and n= the number of response options for each item.

In order to decrease or increase perception:  
 The webpage must be presented to the user clearly and concisely.  
 Decrease text  
 Enlarge fonts

Minimize large areas of information  
Remove graphics

## H-6. Strategy for scoring motor skills (System Test Parameters) (“Error Profile”)

1. The motor skills algorithm for determining values for the test profile and the “Error Profile” will be collected by a script through detection and periodic system administered test to each participant by the system.
2. Test assesses:
  - \* Fine Motor Precision
  - \* Fine Motor Integration
  - \* Manual Dexterity
3. Composite scores
4. Test covers a broad array of fine and gross motor skills, providing composite scores in three motor areas and one comprehensive measure of overall motor proficiency.
5. Interpretation
  - \* Normative interpretation of subtest and composite scores
  - \* Profile analysis to evaluate an individual’s strengths and weaknesses

The fields in the error\_motor skills table are updated with values:

Username  
Time  
ErrorID  
Fontsize  
Clickcount  
AvgDistfromTarget

Algorithm:

The user default motor skills score is already set “null” based on W3C standards for webpages.

The user will be given a series of boxes to click on.

The user must click on the dot in the middle of the box.

The user has a threshold of one click per box.

Each time the user clicks correctly on each dot the box will give a response to notify the user they have correctly clicked the dot.

If clickcount = 4 do nothing to webpage –don’t update motor skills score

If clickcount = 3 increase page/buttons – update motor skills score to 2

If clickcount = 2 increase page/buttons – update motor skills score to 3

If clickcount = 1 increase page/buttons – update motor skills score to 4

Once the user has completed test, then that motorSkillsScore is stored into the users’ profile curr\_skills fields:

time  
profileLevel  
computerLevel  
fontSize  
fontColor  
\*motor skills score  
Thinking score  
Learning score  
Memory score  
Understanding score  
Mental fatigue score  
White background score

Return user to homepage after completion of test.

Read in URL request by user.

Parse webpage: ()

<body> attributes

<basefont> element

<font> element

<div> element

<block> element

<img> element

<display> property

Display webpage

Detect errors (how many times the user attempts to launch and traverse through the page). i.e., wrong button, wrong menu, wrong link.

Update Table: error\_mouse\_clicks to determine the number of clicks

Write font information to Table error\_track\_fontsize.

## APPENDIX I. EDS RATING SYSTEM

The appendices below describe the rating system for the Error Detection System. The ratings were specifically used for motor skills and vision. Although, other attributes were built into the Error Detection System, we only measured the efficiency of the ability to see clearly and use motor skills.

### K-1. Ratings

Establishing a rating in each category assessed each field. Reviewed "fields" having an assigned number are identified with a "number" to rate the variable in the Table.

The fields encompassing the current skills Table are:

- Time
- ProfileLevel
- ComputerLevel
- FontSize
- FontColor
- Motor Skills Score

The above fields are the most valuable to the current profile and are given a numerical rating. Scoring for each field is primarily based on the presence or absence of a particular attribute, such as number of clicks, the font size within a webpage, the proximity of the mouse pointer and also on the presence, or absence of constant movement. The scoring scheme is as follows:

Has attribute, but not referenced as efficient = 1 (poor)

Has attribute and is referenced as having some efficiency = 2 (below average)

Has attribute and is referenced as having efficiency = 3 (average)

Has attribute and is referenced as having more efficiency = 4 (above average)

Has attribute and is referenced as having the most efficiency = 5 (excellent)

"Referenced" includes such information as detected errors in test (font size, cognition, numeric comparison, motor skills, vision color, and learning).

"Efficiency" includes, but is not limited to, accuracy in clicking (opening and closing), traversing through a webpage and selecting sites.

The skills manager assesses each attribute independently and the value assigned constitutes the final rating. A final score is stored in the current skills Table.

Observational Information attributes include such items as Website design, ease of navigation and information retrieval.



## **APPENDIX J. EDS RATING CRITERIA**

The appendices below describe the rating criteria for the Error Detection System. The criterion was designed to rate self, test, observational and error detection measures.

### **J-1. Ratings**

To facilitate the statistical analysis of performance trends, numeric codes with corresponding descriptions was used. However, to verify some of the ratings, such as font size and motor skills, a different type of code (mouse clicks and proximity of mouse clicks in relation to object) was used.

Mechanisms to ensure the reliability of the rating system:

- Observation strategies.
- Error tracking Tables.
- Database entry of values.
- Paper copy of manual test.
- Standardized testing.

The system parameters in “Error Profile” “current skills “was continuously tested and refined within the relevance of performance success framework for monitoring and evaluation.

Validation process to ensure the reliability of the rating system:

- Consultation by expert in field.
- Major Professor.
- Peer review of methods.
- Replication of administered test.

### **J-2. Rating Categories:**

The following categories will be used to rate the user and system performance:

1. Poor
2. Below average
3. Average
4. Above average
5. Excellent