Usability for the Elderly

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ABSTRACT

Computer usability has advanced significantly thanks to research from Nielson, Schneiderman and the like, yet usability with respect to the elderly is rarely addressed. This is worrying considering the increase in elderly populations and an increase of computer and internet usage within this group. Many elderly are isolated from society and use computer and internet services for social networking and finding important health information. As a person ages they may suffer from age related disabilities affecting their ability to use computer systems. To support our aging population and avoid elderly groups being isolated from society and relevant facilities the challenges of elderly usability must be addressed.

This paper will provide an overview of the ideas and studies relating to elderly usability found within relevant literature, discussing the effects of aging, studies of elderly usability and possible software and hardware solutions. The aim of this is to pool current resources of elderly usability and to discuss areas of consistency and conflict within the literature to improve understanding within the domain.

INTRODUCTION

Computer and internet usage has become common place within our society, no longer are the benefits of computer systems restricted to the experienced and technically knowledgeable. One main cause for this occurrence is improvements in the field of computer usability. The work of Nielson, Schneiderman and others has given great advancements in this field, improving the accessibility of computers and thus allowing a wider audience to benefit from their use. Yet one group, common in all societies that has been excluded from much of the progress in the field of usability is the elderly. This is concerning in view of the significant increase in elderly populations within our society. The world health Organisation predicts that by the year 2020 there will be over a billion people over the age of sixty [Organization, 1997].

As society becomes more computer dependent the need for every member to be able to use a computer increases. Considering most elderly populations are already isolated from society, an inability to use technology could further this social distance. As computers are now common tools for social networking and information searches there is an obvious benefit the elderly could receive from their use.

Yet as a person ages it is common to suffer from multiple age-related disabilities affecting the ability to successfully use a computer. Common disabilities an elderly individual may face are cognitive-, hearing-, vision- and dexterity- related and often in combination with each other.

Within this paper I will overview literature relevant to the field of elderly usability, discussing the effects of aging on usability, relevant studies, findings and suggested solutions given in the texts. Highlighting areas of conflict and consistencies within the literature in an aim to accumulate an overview of the current situation of elderly usability.

EFFECTS OF AGEING

As a person ages they are often affected by age related disabilities, this which may in turn effect their ability to use a computer system. Hanson [Hanson, 2001], Hawthorn [Hawthorn, 2000], Hunter et al. [Hunter et al., 2007] and Becker [Becker, 2004] clearly state the main disabilities an elderly person may face and the effect they have on the usability of computer and internet systems. These significant disability areas are discussed below.

Vision

All the literature (but Becker in particular) observes that as a person ages their overall vision decreases [Becker, 2004]. There is a reduced ability to focus on objects near to the eye as elasticity in the lens decreases. Overall visual acuity also decreases, effecting ones ability to clearly see objects or judge depth. The eye has a decreased sensitivity effecting its ability to adapt to changes in light levels. As a result there is an increased sensitivity to glare. Also, colour perception and contrast discrimination decreases as the eye's lens yellows and thickens.

All papers observe that vision disabilities disadvantage elderly users. Reading small sized text becomes difficult as visual acuity decreases. Also, text placed against low contrast backgrounds or images can become difficult to read as colour discrimination and light sensitivity is

diminished. With the smaller field of view, comparing objects placed far apart can also become difficult. An interesting observation from Hawthorn [Hawthorn, 2000] was that the usual distance from the computer screen to the eye is the range in which bifocals distort. Tri-focals and graduated lenses are a solution to this problem though they are expensive and many elderly cannot afford them. Hawthorn [Hawthorn, 2000] also noticed that due to vision problems, reading heavily italicised or curved fonts can become problematic.

Dexterity and motor skills

Age can cause a decrease in dexterity and motor skills [Hanson, 2001, Hawthorn, 2000, Becker, 2004]. This is a natural part of the aging process, though can be greatly increased by arthritis or tremors. Czaja [Czaja, 1997] notes that arthritis and similar complaints are far more common among the elderly. Due to a reduction in dexterity and fine motor skills positioning the mouse can become difficult, which in turn makes many standard computer interface devices such as buttons, links and scrollbars difficult to use [Hawthorn, 2002].

Cognition

The main areas effected by cognitive disabilities for elderly are attention, concept formation and working memory. Working memory is a specific type of short term memory that is simultaneously held and worked with, Hawthorn discusses this indepth [Hawthorn, 2000].

Hanson [Hanson, 2001] observed that an elderly person would have problems learning unfamiliar domains, forming cognitive models of computer applications and would require longer training times with software. Also elderly are more likely to have navigational problems due to the distractions of visual clutter and irrelevant on-screen information, (such as animations).

Hearing

Hawthorn [Hawthorn, 2000] stated that about 20 percent of people aged between 45 and 54 have a hearing impairment of some sort, and that this increases to 75 percent for ages 75 to 79. There is an overall loss in hearing response to all frequencies, especially high pitches. Seperating specific sounds from background noise and localizing sound becomes more difficult with age.

Although sound is often not utilized within computing, the growth of multimedia on the home computer and internet will create problems with elderly experiencing hearing loss [Hanson, 2001]. Systems using speech technology may cause problems with the elderly, especially if using a female voice, as the higher pitched voice may be hard to hear.

Literacy

This disability is really an extension of cognition disabilities, though Becker [Becker, 2004] observed it as significant enough to mention seperately, suggesting that literacy declines significantly with age due to a decrease in working memory. At the same time the ability to simultaneously read and comprehend decreases also. Becker's work concerns the usability of online health resources. She states that approximately 66 percent of people aged 65 and over have low-health related literacy skills and can have difficulty reading online resources [Becker, 2004]. The significance of this with respect to computer usability is obvious, as most computer applications involve reading.

Table 1. Guidelines for Making Senior-Friendly Web Sites NIA/NLM

Sample Guidelines for Designing Readable Text	
Sans serif typeface	Use font typeface that is not condensed (e.g., Arial, Helvetica) to display information content.
Large font size	Use 1214 point font size to improve legibility of information content.
Sample Guidelines for Presenting Information	
Style	Present information in a clear and familiar way to reduce the number of inferences that must be made.
Simplicity	Write the text in simple language.
Sample Guidelines for Increasing Ease of Navigation	
Help and Contact Information	Provide help information as well as phone numbers for personal contact.
Site Map	Provide a hierarchical, visual model (site map) to show the organization and content of the site.
Menus	Use pull down menus (list of options displayed when mouse is placed over it) sparingly so precise mouse movement is not required.

STUDIES

Chadwick-Dias et al. [Chadwick-Dias et al., 2003], Hanson [Hanson, 2001], Hunter et al. [Hunter et al., 2007] and Becker [Becker, 2004] articles all involved an evaluation.

Becker

Becker [Becker, 2004] evaluated web sites that were likely to be of interest to an elderly individual, for example health or government sites. The testing marked each site against a set of guidelines (see Table 1) defined by the National Institute on Aging and National Library of Medicine (NIA/NLM) [NIA and NLM, 2002]. There were 125 United States websites chosen, these were:

- 25 randomly chosen newspaper sites
- 25 commercial health sites (.com)

- 25 non-commercial health sites (.org)
- 50 state government sites, one per state

The results of the study showed none of the sites received high ratings with respect to usability. Results showed 93 percent of sites made use of small font sizes and 40 percent did not offer text resizing. Almost 40 percent of state sites required homepage navigation by pull down menus and less then 50 percent of .com and .org sites offered help on their homepage. The results relating to literacy were particularly worrying, with some state health sites requiring a graduate degree reading level. 96 percent of newspaper, 92 percent of state and 84 percent of nonprofit sites required a reading level higher than 8th grade (using the United States grade system) and 29 percent required a university level education. This is concerning, cosidering many health organizations suggest using a reading level no higher than 6th grade [Becker, 2004].

Hanson

Hanson's [Hanson, 2001] research was not about critiquing already created websites, but improving the site on the user computer. Hanson evaluated a gateway system built at the IBM T. J. Watson Research Center. The system is designed to alter incoming websites before they are received by the user browser. The user customizes the types of alterations to take place in an easy-to-use menu system. One of the goals of the software is to avoid the user feeling stigmatized for using it, unlike physical devices which can be seen as marking the user. Another aim is to help with multiple disabilities, unlike most current software solutions. Possible customizations include options such as increasing and changing fonts, altering inter-letter spacing, sharpening images, removing background images and adding background colours and magnification.

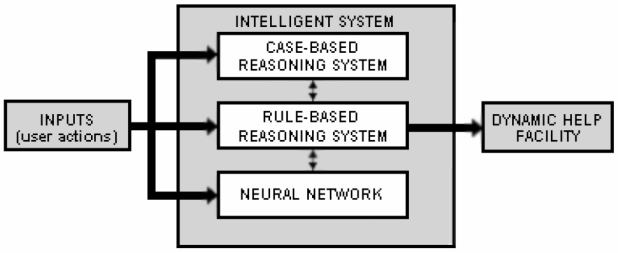
Preliminary investigations found that most users preferred only simple changes. The two most common alterations were increase in font size and removal of images behind text, this is consistent with the NIA/NLM guidelines Becker [Becker, 2004] used.

Hunter et al.

Hunter et al. [Hunter et al., 2007] proposed a new way to improve elderly usability while browsing the internet. The suggested system would learn from a users interaction with a system and would alter it appropriately, for example giving help in needed situations. Essentially this system works in a way similar to Hanson [Hanson, 2001] (who is referenced) but is completely server sided and dynamic. The described system would use a neural network to learn appropriate responses (figure 1).

In order for such a system to be implemented the accuracy of a nerual network system's ability to classify needs to be tested. The evaluation used 20 participants, each were reqested to perform two tasks on the web consisting of five subtasks. An event logger (created by the Mozilla project) kept track of user activity and stored the information in an access database. This data was then split in two, half used for training the neural network the other for testing it. This division, training and testing was performed ten times, the mean classification accuracy was 96 percent. Hunter et al. states this shows that the proposed neural network system can work succesfully classifying user's actions.

Figure 1. An overview of the system suggested by Hunter et al. [Hunter et al., 2007]



In an initial step to discover internet interaction trends with people aged 54 to 86, a study group of elderly users was formed. The participants of this group were chosen by results of a questionnaire on previous experience with the internet and computers. The questionnaire showed that the most commonly used sites by this age group are shopping, email and hobby sites.

Chadwick-Dias et al.

Chadwick-Dias et al. created two evaluations. The first was to learn whether age caused differences in interaction with the internet and whether font size affected performance. Interestingly the evaluations for this paper were the only to try and find young and older adults with similar computer experience, so as to rule out lack of familiarity as the cause of results.

27 participants were used and balanced by age and computer and internet experience. The system they were tested on was an employee/retiree benefits prototype website. Each user interacted with three versions of the site with the text sizes changed using browser text sizing options. The participant had to perform 15 tasks on the test site.

Results showed that older users (aged over 55) had a significantly lower task success rate and took longer to complete these tasks (figure 2). This trend also seemed to increase the further past 55 the user was. Overall text size seemed to have no effect on any age group, though older users were observed to like the larger text more. This is inconsistent with previous work by Becker and Hanson as one of their main suggestions to improve performance was to increase text size. Other interesting findings about elderly users were:

- Older users are often more cautious

- They are more likely to click on non-links
- They had trouble accessing data in large tables
- Had trouble with computer and internet jargon
- Spent longer reading text and instructions
- Had difficulty in knowing their location within a site
- Difficulty scrolling and managing windows
- Difficulty using tabbed navigation systems

The second evaluation was similar to the first, though the website used was improved, taking in to account the findings from the first evaluations. For example links used action words to increase and were displayed in a consistent manner. More objects such as icons and bullets were also made into links.

Results showed a significant increase in usability independent of age. The difference between users aged over 55 and under 55 seemed almost identical to the results of the first study. Though the click speed between the results varied, within the first study older users clicked less than younger, but with the new site design they clicked more often. It is interesting that although older users performed better on the second site, they rated it with a lower preference rating.

HARWARE CONSIDERATIONS

Czaja [Czaja, 1997] in reviewing usability studies found that the mouse was a problem area as, elderly found selecting small targets difficult. This is consistent with the findings of Chadwick-Dias et al. [Chadwick-Dias et al., 2003], Hawthorn [Hawthorn, 2000], Hanson [Hanson, 2001] and Becker [Becker, 2004]. One interesting fact found in the studies was that keyboard performance seemed significantly better than a mouse, allowing the user to be more precise while making less errors.

An area mentioned by Czaja [Czaja, 1997], Hanson [Hanson, 2001], Hawthorn [Hawthorn, 2000], Hunter et al. [Hunter et al., 2007] and Becker [Becker, 2004] was increased sensitivity to glare amongst elderly. This is particularly probelmatic with highly reflective screens such as ATMS screens.

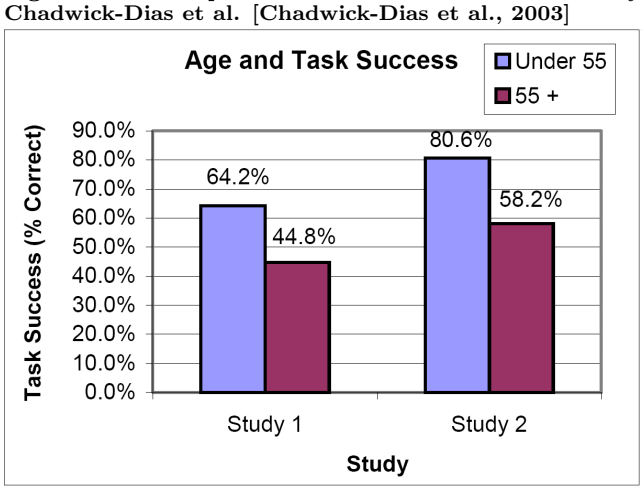
SOFTWARE CONSIDERATIONS

Every article gave suggestions to software design. The main suggestions observed were:

Using large text size

All groups commented on the size of text. Hawthorn [Hawthorn, 2000] suggested 12 to 14 point font. The only to disagree with its importance with respect to usability was Chadwick-Dias et al. [Chadwick-Dias et al., 2003]. Their findings contradicted suggestions of text size importance by all other groups. Though Chadwick-Dias et al. did suggest that the improvement from the increased text size may have been off set by the additional scrolling needed to read all the text. It is disscussed that testing again on larger displays may bare different results.

Figure 2. Participant success over the two studies by Chadwick-Dias et al. [Chadwick-Dias et al., 2003]



Minimize working memory demands

Placing minmal demands on working memory is advised by all the texts and Czaja [Czaja, 1997] notes that this is consistent with cognitive aging literature. Creating an easy navigation system helps minimize working memory needs and Hanson [Hanson, 2001] suggests that added visual clutter, animation and redundant text makes navigation harder.

Software performance

Becker [Becker, 2004] was the only to mention this. Becker suggests the NIA/NLM guidelines suggestion of a 10 second maximum download time on 56 kbps connections. As of 2004 over 80 percent of edlerly internet users where home users and approximately 50 percent use 56 kbps connections [Becker, 2004].

Clear and consistent links

This was mentioned in most of the papers, but was discussed most by Chadwick-Dias et al. [Chadwick-Dias et al., 2003]. Chadwick-Dias et al. suggested creating links that use action words and displaying them in a consistent manner, such as consistent underlining and colouring helps distinguish links form normal text. They also suggest that links should display information on mouse over and that bullets and icons should be links where possible. This should make a site navigation more obvious and therefore easier.

Minimize irrelevent and complex text

This is related to minimizing working memory. Chadwick-Dias et al. [Chadwick-Dias et al., 2003] noticed older users spent longer reading text, so avoidance of unecessary text should improve performance. Also since literacy decreases with age, using complex language shold be avoided. These observations are reflected in the

guidelines suggested by Czaja [Czaja, 1997] and Becker [Becker, 2004].

Use procedures and operations consistent with other applications

This is suggested by Czaja [Czaja, 1997] and is consistent with Hawthorn [Hawthorn, 2000]. Hawthorn describes automated processes, where a commonly used process becomes automatic and takes minimal mental strain. The example given is changing a gear on a car, at first the action is dificult but soon becomes natural and effortless. If there is consistency across applications in operations and procedures there is less an individual has to learn and therefore less of a cognitive load.

SUMMARY

These articles discussed and evaluated areas and ideas within elderly usability. Czaja [Czaja, 1997] and Hawthorn [Hawthorn, 2000] overviewed previous ideas to create guidelines and approaches to improving research and design to try achieve "intergenerational fairness" [Hawthorn, 2000]. Hanson's [Hanson, 2001] approach to improving usability involoved altering website design in between server and client, this offered all websites to be customized for the users needs. Hunter et al. [Hunter et al., 2007] carried on some of the ideas of Hanson's suggesting a server sided tool that adapts websites automatically. Becker [Becker, 2004] utilized NIA/NLM [NIA and NLM, 2002] and accessed the current state of internet services with respect to elderly usability with poor results. The work of Chadwick-Dias et al. [Chadwick-Dias et al., 2003] conflicted with general ideas of elderly usability, testing webiste design. Finding that text size did not make a difference in performance disagreed and questioned a lot of previous work in this area, as increased text size is almost always placed in guidelines for elderly usability [NIA and NLM, 2002] [Czaja, 1997] [Becker, 2004].

FUTURE WORK

Hunter et al. [Hunter et al., 2007] suggested a fully implemented neural network tool could be very benificial to elderly usability. Having a server sided tool that made design decisions based on the individual user means the elderly would not have to make more effort (for exmple install more software) to efficiently use websites. Though in the case of a misclassification by the neural network system how a user would cope may be an area of concern.

Chadwick-Dias et al. [Chadwick-Dias et al., 2003] suggests this topic would benefit from more long term studies. Becker believes more research needs to go into text sizes and performance. This is needed as there are conflicts between the assumption that bigger text is better and the results of Chadwick-Dias et als studies [Chadwick-Dias et al., 2003]. Hanson discusses future work on keyboard correction. The keyboard was barely talked about within these articles though an improvement in performance without specialized hardware would be benificial. I personally believe that future work needs to be in long term research and the creation of a set of universal design guidelines that include elderly usability.

REFERENCES

Becker, S. A. (2004). A study of web usability for older adults seeking online health resources. *ACM Trans. Comput.-Hum. Interact.*, 11(4):387–406.

Chadwick-Dias, A., McNulty, M., and Tullis, T. (2003). Web usability and age: how design changes can improve performance. In *CUU '03: Proceedings of the 2003 conference on Universal usability*, pages 30–37, New York, NY, USA. ACM.

Czaja, S. J. (1997). Computer technology and the older adult. *Handbook of Human-Computer Interaction*, pages 797–810.

Hanson, V. L. (2001). Web access for elderly citizens. In *WUAUC'01: Proceedings of the 2001 EC/NSF workshop on Universal accessibility of ubiquitous computing*, pages 14–18, New York, NY, USA. ACM.

Hawthorn, D. (2000). Possible implications of aging for interface designers. 12.

Hawthorn, D. (2002). How universal is good design for older users? *SIGCAPH Comput. Phys. Handicap.*, (73-74):38–45.

Hunter, A., Sayers, H., and McDaid, L. (2007,). An evolvable computer interface for elderly users. *Workshop "Supporting Human Memory with Interactive Systems", HCI Conference.*

NIA and NLM (2002). Making your web site senior-friendly: A checklist. national institute on aging and national library of medicine. http://www.nlm.nih.gov/pubs/checklist.pdf.

Organization, W. H. (1997). Press release who/69. Available at http://www.who.ch/press/1997/pr97-69.htm.