A Study of Web Usability for Older Adults Seeking Online Health Resources

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The Web offers older adult users immediate access to health resources that might not otherwise be available. Older adult users, however, may encounter Web barriers associated with normal aging and lower education. The National Institute on Aging Web guidelines were used to assess the usability of 125 Web sites offering health resources. Performance, translation, and reading complexity were also assessed. Results showed that many of the sampled sites were not senior-friendly. Only 12% of the sites offered a Spanish version, many containing nontranslated text. Approximately a third of sampled sites required a college education to comprehend extracted health information.

1. INTRODUCTION

The Internet provides an extraordinary opportunity for older adults who are sixty years or older to access online health information. It has become an important resource for those who suffer from chronic illness, are homebound, or live in rural or remote areas, because they may have difficulty accessing health information through traditional channels. Providing online health resources, however, does not guarantee that older adults will be successful at accessing or understanding the information they seek. Web sites that do not meet the online needs of targeted users may pose virtual barriers that prevent these information seekers from attaining their goals.

The older adult population in the U.S. is one of the largest groups of users benefiting from online access to health-related resources. It is well known that the older adult population continues to grow at a very rapid pace, as baby boomers age and life expectancy increases. Since 1990, the number of Americans sixty-five or older has more than tripled. Older adults will comprise about 20% of the total population by 2030, which is twice more than the percentage of 2000 [Administration on Aging 2002]. Minority adults will represent 25.4% of the older adult population by 2030; furthermore, they will grow by 219% between 1999 and 2030 [Kinsella and Velkoff 2001]. Older adults are also the fastest growing online population with a 25% surge in Internet usage in the last year. As of October 2003, adults sixty-five and older represented 7% of the online U.S. population [Greenspan 2003].

Internet usage has become increasingly appealing to older adults given that many are frequently isolated with large amounts of discretionary time. A Seniornet study [1998] discovered that a major incentive for older adults to own a computer is to obtain information about health care and medical conditions. Fox and Fallows [2003] identified searching for health information as one of the most popular online activities performed by adults, following email and searches for product and service information. They also discovered that 80% of adult Web users have searched online for at least one major health topic. Many of these adult users are surfing the Web for healthcare information to learn about symptoms, diagnosis, prescriptions, surgery, or recovery. Others are online to seek or offer support to those users with similar health conditions.

An important aspect of the older adult population, when compared to its younger adult counterpart, is the proportion having some type of disability. According to the Administration on Aging [2002], 44.5% of older adults ages 65–69 have a disability and this increases to 73.6% for those 80 years or older. Chronic disabilities include arthritis, hearing impairments, cataracts, hypertension, heart disease, and diabetes, among others. As such, older adult users have a strong likelihood of benefiting from online health information that may otherwise be difficult to obtain.

Unlike younger adult users, there are physiological factors due to the normal aging process affecting older adult use of the Web. The normal aging process, including vision, cognition, and physical impairments, has an impact on Web usability when designs are not senior-friendly. Web design issues, such as fonts, colors, graphics, background images, navigation, search mechanism, and others may prevent older adult users from taking advantage of online health resources. Web designs may pose reading comprehension barriers by not accounting for visual acuity, cognitive abilities, and education levels of the older adult population, all of which may have an effect on health literacy [Davis et al. 1998]. Health literacy is the degree to which older adults have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions [Healthy People 2010, 2000]. For the ethnic elderly who have low English proficiency, nontranslated information content may be difficult or impossible to comprehend. The performance of a Web site may also play a role in obtaining health resources, as those older adults relying

Table I. Guidelines for Making Senior-Friendly Web Sites [NIA/NLM 2002]

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 12–14 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.

on slower network access speeds may become frustrated with lengthy page download times and leave the site.

The U.S. National Institute on Aging (NIA) in conjunction with the U.S. National Library of Medicine (NLM) [2002] has readily acknowledged Web usability issues for older adults and the need for addressing them. They have published guidelines for designing senior-friendly sites that are based on scientific findings from research in aging, cognition, and human factors. (Refer to Morrell et al. [2004] for a compilation of research findings.) These guidelines, illustrated in Table I, provide information on how to improve the design and information content of Web pages for older adults. The overall objective is to eliminate barriers to Web use based on vision, cognition, and physical impairments due to the normal aging process.

Because of usability recommendations by Nielsen [1999], Schneiderman [1998], and other experts, today's Web sites have improved user interfaces that meet the online needs of many younger adult users. Their designs, however, do not necessarily take into account the needs of older adults in terms of normal aging, English proficiency, and reading comprehension skills. Many Web sites still use 8–10 point font sizes, for example, for links appearing at the bottom of pages. Others use mouseover technology for displaying the contents of pull-down menus, thus requiring precision mouse movement to navigate the site. Mouseover technology triggers an event, such as a link changing color, images appearing, or menu lists expanded, when the user places the mouse over these objects. These and other design impediments make it difficult, if not impossible, for older adults to utilize the site fully. The NIA/NLM research-based guidelines provide a much-needed framework for addressing online design barriers facing older adult users.

A sample of 125 Web sites offering health resources was studied in order to evaluate Web designs in meeting the needs of older adult users. Section 2 briefly describes the normal aging process as well as health literacy of the older adult population in the U.S. Section 3 presents the data gathered to assess adherence to NIA/NLM and other usability guidelines. Section 4 summarizes

the usability findings as they relate to design, performance, translations, and reading complexity of the sampled sites. Section 4 concludes the article and identifies future research opportunities.

2. AGING FACTORS AND WEB DESIGN

As adults age, their vision, cognition, and physical skills decline, with an impact on their ability to perform many tasks [Salthouse 1991]. Older adult reading comprehension is affected by cognitive changes associated with normal aging; as well as his or her education level and language proficiency [Qualls et al. 2001]. As such, vision, cognition, motor skills, and literacy all play a role in the usability of a Web site by older adults.

2.1 Vision

The aging eye has a reduced ability to focus on close objects due to a reduction in the elasticity in the lens. In addition, there is a decline in visual acuity affecting the ability to see objects clearly. The lens of the eye yellows and thickens, impacting color perception. There is decreased light sensitivity affecting adaptation to changes in light levels, and increased sensitivity to glare from light reflecting or shining into the eye. Depth perception is reduced, making it more difficult to judge the distance of an object [American Foundation for the Blind 2004].

Together, these vision changes affect the use of a Web site in terms of legibility, reading speed, comprehension, navigation, searches, and visual distractions [Charness 2001]. For many older adult users, eye fatigue and strain occur even with corrective lenses due to Web design factors such as font size, font style and type, foreground and background colors, patterned background images, and animation [Echt 2002].

The NIA/NLM guidelines recommend that sufficiently large font sizes be used to accommodate aging vision when designing Web content. Other recommendations, not addressed in this study, include the use of sans serif font styles (e.g., Arial, Helvetica), elimination of patterned background images and the use of highly contrasting foreground and background colors (e.g., black text on an off-white background).

2.2 Cognition

Strong et al. [2001] identify problem solving, working memory, attention, and concept formation as the cognitive issues influencing an older adult's use of Web features. Working memory entails temporarily holding and manipulating information while engaging in a variety of cognitive tasks [Baddeley 1986; Strong et al. 2001 p. 263]. An older adult's performance on working memory tasks declines with age [Holt and Morrell 2002], and he or she has a reduced ability to discern details in the presence of distracting information. As a result, complex navigation schemas, poorly designed search capabilities, and cluttered Web pages all negatively affect the older adult's online experience.

To address cognition issues, NIA/NLM guidelines recommend a site map feature to show how the site is organized. It also specifies that help and contact

information be made available to provide additional resources for those who need them. Other recommendations not included in this study are design consistency across pages and appropriately labeled links to promote ease of navigation for the older adult user.

2.3 Motor Skills

Older adults have decreased motor coordination so that it becomes difficult to move and click a mouse, scroll down a Web page [Hawthorne 2000], or click on standard-size links [Ellis and Kurniawan 2000]. An older adult typically takes longer to complete a movement than younger adults [Chadwick-Dias et al. 2003], and their movements tend to be less smooth and less coordinated [Seidler and Stelmach 1996]. Due to a reduction in fine motor skills, cursor positioning of the mouse is difficult for older adults, especially when interacting with small objects [Chaparro et al. 1999; Walker et al. 1996; Worden et al. 1997].

The NIA/NLM guidelines recommend that the Web design take into account physical impairments by using single mouse clicks to access information and judiciously using mouseover technology. The guidelines also specify large buttons to minimize precise mouse movements needed to activate them. This study focuses on mouseover technology required to navigate a Web site.

2.4 Literacy

For older adults, the Internet is transforming health care by providing extensive information regarding the diagnosis, treatment, and medication of diseases. There are numerous Web sites offering access to unparalleled amounts of health information with older adults potentially being major beneficiaries. As a result, more seniors are getting online to search for health or medical information. There has been a 25% increase from 2000 to 2003 in the number of online seniors performing health-related searches [Fox 2004, p. 6].

Many older adults face impediments to utilizing the wealth of online information; it is estimated that approximately 66% of adults age 65 and older have low-health literacy skills [National Work Group on Literacy and Health 1998]. Health care organizations have been vocal about the adult literacy problem in the U.S. associated with misaligned written material and user comprehension skills [Berkman et al. 2004; Nielsen-Bohlman et al. 2004]. The American Academy of Family Physician's [2002] health education program recommends writing content at a seventh-grade or lower reading level. The National Work Group on Literacy and Health [1998] recommends a fifth-grade reading level. The University of Utah's Health Sciences Center [1997] states that an average adult typically reads one to two grade levels below their last grade completed and, recommends a sixth-grade reading level. Doak et al. [1996] recommend a fifth-grade reading level for adults sixty-five and over.

Age can have an impact on literacy in that comprehension of written material progressively declines [Wickens and Holland 1999]. Reductions in older adult working memory capacity have been correlated with decreased performance on language comprehension tasks [Kemper and Mitzner 2001; Xiao et al.

2003]. Researchers have found that literacy declines dramatically with age, even after making adjustments for education level and cognitive impairment [Gazmararian et al. 1999]. They have also found that a negative association between literacy skills and age appears to increase after age sixty-five [Kirsch et al. 1993]. As one ages, it becomes more difficult to simultaneously remember and process new information and to comprehend text [Craik and Salthouse 2000].

The NIA/NLM guidelines for senior-friendly Web sites specify that information should be presented clearly, using active voice, and in simple language. The guidelines do not specify a targeted reading grade level, though they recommend a familiar and positive writing style.

3. USABILITY STUDY

A usability study assessed 125 Web sites for potential usability barriers facing older adult users. Twenty-five online newspapers were randomly selected from each geographic region in the United States. These newspapers were affiliated with the following states: Arizona, Delaware, Florida, Hawaii, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Missouri, Minnesota, New Mexico, New York, Oregon, Pennsylvania, Rhode Island, Tennessee, Texas, Utah, Washington, Wisconsin, New Hampshire, Nevada, and North Carolina. Twenty-five commercial (.com) and twenty-five nonprofit (.org) Web sites were selected from online searches using health conditions (e.g., stroke, diabetes, cancer, heart disease, lung, arthritis) typically associated with aging. In addition, several Web sites offering a broad range of health content (e.g., Mayoclinic.org, WebMD.com) were included in the study. Each of the 50 state government Web sites was included in the study.

A rater, knowledgeable with the NIA/NLM and homepage guidelines, completed the usability assessment for each of the 125 Web sites. Both usability and performance data were recorded on a checklist containing the NIA/NLM and homepage guidelines used in this study. Translation data was recorded on a second checklist containing English barriers associated with Spanish versions of sampled Web sites.

The focus of Web site usability was on accessing health resources made available on state, commercial, and nonprofit Web sites. Each Web site was assessed in terms of design, performance, translation, and literacy barriers. The NIA/NLM guidelines primarily focused on design issues. These guidelines do not specify acceptable download times nor appropriate reading grade levels for written content. As such, Web usability and health literacy guidelines were used to support these components of the assessment process. The homepage was the basis for this study, as it is the portal to all resources made available on the site. Nielsen and Tahir [2002] point out that the homepage is the most important page on a Web site because users view it more than any other page. Its design often determines whether a user will stay or leave the site.

Each homepage design was evaluated in terms of potential usability barriers based on pull-down menus, font sizes, and vertical page length as well as missing site map, help, and contact and privacy information. The download

Table II. Percentage of Sampled Web Sites with Usability Issue

Usability Issue	Problem	State (.gov)	Commercial (.com)	Nonprofit (.org)	Newspaper (.com)
Pull-down menus	Precise movement of the mouse may be physically challenging.	38%	12%	24%	8%
Small font size	Font size is difficult to read when it is smaller than 12 point.	84%	100%	96%	100%
Screen is 3 or more pages	Lengthy page requires memory recall of Web content.	10%	20%	4%	72%
No help feature	A question not supported by help feature may render the site inaccessible.	36%	52%	64%	48%
No contact us	No means of personal contact makes it difficult to obtain additional information.	14%	52%	4%	48%
No privacy statement	The user may mistrust the site when the use of personal information is unknown.	8%	36%	44%	40%
No site map	Complex sites may be difficult to navigate with no visual relationship among pages.	44%	88%	68%	56%

time for each homepage was simulated using a 56.6 kps (kilobytes-per-second) network access speed in order to assess usability from a performance perspective. For Spanish versions of sampled Web sites, English content was assessed as a potential barrier for older adults with low or no English proficiency. The reading complexity of each site was assessed in terms of reading grade level in order to identify possible literacy barriers to the effective use of online health resources.

The design, performance, and translation assessments included 125 sites as follows: 50 state government (.gov) Web sites, 50 commercial (.com) Web sites composed of 25 health-related sites and 25 online newspapers, and 25 nonprofit (.org) health-related Web sites.

The health literacy assessment included 99 sites inclusive of all four categories. Only 24 online newspapers were part of the literacy assessment, as one newspaper did not have health information currently available to its readers. Twenty-five of the state sites were part of the literacy study, as not all e-government sites provided health-related resources with a sufficiently large text sample. All 50 profit and nonprofit health-related Web sites were included in the literacy assessment.

3.1 Design

Table II summarizes the usability findings for sampled sites included in the study. The usability issues listed in the table, with the exception of privacy, are based on guidelines put forth by NIA/NLM. The privacy issue was added to the study because of growing concerns regarding personal information gathered while visiting Web sites.

Table III. Percent of Web Sites with Text Resizing Enabled

Internet Explorer Text Resizing	State (.gov)	Profit (.com)	Nonprofit (.org)	Newspapers (.com)
All content resized	24%	16%	20%	36%
Some content resized	36%	44%	40%	28%
No content resized	40%	40%	40%	36%

Pull-down Menus.   Mouseover technology requires precise movement of the mouse in order to highlight and select a menu item from the pull-down list. Aging factors, such as arthritis, loss of hand and finger dexterity, and unsteady hands, can play a role in impaired control over a mouse [Charness and Holley 2001]. As a result, older adults may find using a mouse difficult, if not impossible, due to aging and a decline in motor coordination.

State sites had the highest percentage of pull-down menus with almost 40% of the homepages requiring their use to navigate the site. Online newspapers and commercial health sites had the lowest rate, with only 8% and 12%, respectively, requiring mouse technology to navigate the site.

Font Size.[1]   Numerous studies show that font size should be 12-point or larger to accommodate aging vision [Bernard et al. 2001; Chisnell et al. 2004; Nielsen and Coyne 2002; Tullis et al. 1995]. Small font sizes on a Web page affect the readability of information content, especially for those with low vision. Many homepages rely on small font sizes to fit links and other objects in the peripheral area of the page. Bottom links, such as "help", "privacy policy", and "contact us", are often displayed using 8, 9, or 10-point font sizes.

This NIA/NLM guideline had the highest rate of noncompliance by all sampled sites. Only 16% of state and 4% of nonprofit homepages used 12-point or larger font size on all content. None of the dot com homepages, including both commercial and newspapers sites, used sufficiently large font sizes to display all content.

One could argue that font size is no longer a usability issue given that browsers offer a text-resizing feature. To validate this point, each of the 125 Web sites was checked for the enablement of text resizing in the Internet Explorer 6.0 browser environment (text resizing is available under the VIEW menu). The results are presented in Table III. Approximately 40% of all Web sites did not enable this feature, so small font sizes did not change to larger ones. Many of the sites resized the text body while peripheral links remained constant. Thirty-six percent of online newspapers did resize homepage content to a larger font, improving legibility. In addition, about one-fifth of both commercial and nonprofit health sites, as well as one-fourth of state sites, resized all homepage content.

Screen Length.   In general, Nielsen [1996] points out that only 10% of users scroll beyond content that is currently visible on a screen page. Therefore, the targeted user may miss important information that requires extensive

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[1]The NIA/NLM guidelines recommend 12 to 14-point font size for body text. Our study included all homepage content in the assessment of font size because of the readability impact of small text in the peripheral areas of a Web page.

scrolling. More importantly for older adult users, a lengthy homepage impacts memory recall of the contents at the top of the page and increases the amount of vertical scrolling required to get to the bottom of the page. In addition, it becomes more difficult for older adults to recover from navigation errors [Mead et al. 1999].

Almost two-thirds of the newspaper homepages were three or more vertical screen-pages when using a 15-inch monitor screen. One online newspaper required the user to scroll through ten screen-pages to reach the bottom content. About one-fifth of the commercial sites required extensive scrolling to reach the bottom of the homepage. In general, nonprofit and state government homepages were shorter in length than the other sites. Only 4% of nonprofit and 10% of state homepages required lengthy scrolling.

Help Feature.   Holt and Morrell [2002 p. 125] identify help as an important part of making "elder-friendly" page content. A help feature promotes technical and contextual assistance necessary to minimize long searches on a Web site. State government sites were more senior-friendly than those in other categories in terms of providing help services. Approximately two-thirds of the state homepages offered help support; whereas, less than 50% of commercial (.com) and nonprofit (.org) sites provided help on their homepages.

Contact Us.   Although there is little research that addresses the usability of a site specifically in terms of contact information, it is a recommendation put forth in the NIA/NLM guidelines for promoting senior-friendly sites. This feature offers an opportunity for an older adult to email or phone a person associated with the site to obtain additional information. A significant number of e-government and nonprofit health sites provided a homepage email link with contact information, though this was not the case for the dot com sites. Almost 50% of these commercial sites did not provide a mechanism on the homepage for accessing contact information.

Privacy Statement.   Privacy is an ongoing issue for many online users including older adults. Many fear that online companies will not keep the user's personal information private. A recent study by the Pew Internet research group found that 89% of Internet users seeking health information were concerned that a Web site might sell or give away data about their online activities [Fox and Fallows 2003 p. 33]. Though only a small percentage of the government sites did not have privacy statements on their homepages, this was not the case for profit and nonprofit sites. Approximately 40% of these sites failed to offer a privacy notice on the homepage.

Site Map.   Site maps offer navigational support in terms of showing the overall schema of the Web site. They are useful in helping older adult users understand the relationship of a Web page with other pages as well as showing how to move quickly from one page to another [Westerman et al. 1995]. More than 50% of the state sites provided site map support, unlike commercial sites with only 12% offering site map features on their homepages. Online newspapers and nonprofit sites were more usable than commercial ones, because over a third had site map features on their homepages.

Table IV.   Performance Times for Sampled Web Sites (Percentages are Cumulative)

Download Data in Seconds	State (.gov)	Profit (.com)	Nonprofit (.org)	Newspapers (.com)
Median download time	22	21	24	40
Minimum download time	10	6	7	4
Maximum download time	54	42	81	167
Percent of sites download < 10	3	14	4	4
Percent of sites download < 30	16	71	61	22
Percent of sites download < 60	76	100	91	78

3.2 Performance

Rose et al. [1999 p. 6] uncovered six common technical impediments to using the Internet by studying trade articles published from 1994 to 1999. One of these problems was download delays associated with Web pages. Many usability experts agree on minimizing download time otherwise users leave the Web site and often do not return. Download time is typically measured as the number of seconds required to complete the download of all Web objects on a page. The National Cancer Institute (NCI) Web usability guidelines state that users wait about 10 seconds for a page to download before losing interest [Koyanl et al. 2004]. The NCI guidelines cite previous work by Miller [1968] and Schneiderman [1984] with recommendations that computers respond to simple user entries within two seconds. Nielsen and Tahir [2002] in their study on homepage designs also recommend a ten-second maximum download time.

A performance assessment of sampled homepages, measured in download seconds, was included in this study because of the number of older adults who use dial-up Internet access. A 2002 Pew Internet research group study on "wired seniors" found that 81% of online seniors (65 or older) accessed the Internet exclusively from home [Fox 2002]. According to Nielsen//NetRatings (www.nielsen-netratings.com), 53.26% of home users connect to the Internet using 56.6 kps modems [Greenspan 2003]. From this data, it is inferred that about half the older adult users rely on slower Internet access speed when downloading Web pages.

Performance data associated with homepages of the sampled sites were obtained using Microsoft FrontPage® *estimated time to download* feature. Web developers typically use this feature to evaluate the impact on download time when adding or removing Web objects to a page (e.g., graphic or icon files). Within the FrontPage development environment, the feature allows the developer to select a connection speed for a specified Web page. Eighty-four percent of the sampled Web sites enabled this feature, generating an estimated download time for a 56.6 kps network connection speed. The performance data for these sites are summarized in Table IV.

The median download times for state e-government, commercial, and nonprofit homepages were slightly over 20 seconds, which is twice the ten-second recommendation. Online newspapers required almost double this median time with 40 seconds. An online newspaper held the record for longest download time of approximately 2.8 minutes. More than 20% of both state and newspaper sites required a minute or longer to download the homepage. The percentage of

Table V. Percent of Translated Versions with English Content

Description of Translation Issue	State (.gov)	Profit (.com)	Nonprofit (.org)	Newspaper (.com)
Links at the top of the page are in English.	20%	0%	14%	50%
Links in the navigation bar are in English.	40%	50%	57%	50%
Links at the bottom of the page are in English.	60%	50%	57%	0%
Broken link navigates to an error page in English.	40%	0%	14%	0%
Buttons are in English.	80%	50%	57%	50%
Icons, symbols, acronyms, abbreviations are in English.	40%	0%	14%	0%
Title (or logo) is in English.	40%	50%	86%	50%
Text at the top of the page is in English.	20%	0%	43%	0%
Text body is not fully translated.	40%	0%	14%	50%
The text in the menu box is in English.	40%	0%	71%	50%

homepages that downloaded in fewer than 10 seconds was 4% or less for state, nonprofit, and newspaper sites. Fourteen percent of the profit sites downloaded within the recommended timeframe.

3.3 Translation

Ethnic older adults, who do not have strong English proficiency, may find English-only health resources inaccessible. Unfortunately, only a small percentage of the state and commercial sites provided translated versions to meet the needs of this targeted group of users.[2]

Ten percent of the state sites and 4% of both profit and newspaper sites supplied a Spanish version. A larger percentage of nonprofit sites offered a translated version when compared to the other categories. Approximately one-third provided Spanish pages. There were only two out of the 50 dot com sites supporting Spanish versions. Therefore, they are not included in the discussion on translation barriers (though the data are shown in Table V).

If was found that many of the translated sites had usability barriers due to English content. Most of these barriers, summarized in Table V, are the result of English text embedded in the Spanish pages. A major usability problem with both state and nonprofit sites was the high percentage of nontranslated buttons and links on Spanish pages. Eighty percent of the state sites and almost 60% of nonprofit sites had button labels in English. For most of the nonprofit sites, the information content in the body of the page was in Spanish, though this was not the case for the government sites. Forty percent of the state government sites had English text appearing in the body of the translated Web page.

English content in navigational components of the Web page poses a significant impediment to effective use of a site by non-English speaking users. The nonprofit sites had a high rate of English content in navigational objects on translated pages. More than two-thirds had English text in menu objects, and approximately 60% had English text in both the navigational sidebar and links

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[2]Web sites linking to external language translation services were not included in this study. A moderate level of English proficiency is required to use these services.

Table VI. Reading Complexity of Sampled Web Sites

	Minimum				Maximum				Median			
	State	Profit	Nonprofit	News	State	Profit	Nonprofit	News	State	Profit	Nonprofit	News
ARI	7.7	7.9	7.0	8.1	17.9	14.8	15.3	14.7	11.4	11.6	10.9	11.8
Kincaid	8.2	8.9	7.0	8.7	17.5	14.9	15.5	14.3	12.3	11.8	11.5	11.8
Approximate grade level	8	8-9	7	8-9	Graduate level	College level	College level	College level	11-12	12	11	12
Sentence length[3]	12.3	14.4	13.2	16.1	24.2	23.2	26.1	25.2	17.6	18.5	17.3	19.5

appearing at the bottom of the page. The government sites had less English content appearing in navigational components compared to the nonprofit sites, though the content was still high. Sixty-percent of state sites had English links appearing at the bottom of the translated page.

Another usability barrier occurred when a link on the translated site navigated to an error page with only English content. Forty percent of the state sites and 14% of the nonprofit sites had broken links on translated pages that navigated to English error pages.

3.4 Reading Complexity

Reading complexity is an important usability issue for sites offering health resources. When reading comprehension requirements of a site are misaligned with the reading comprehension skills of targeted users, the consequences can be severe. Those who are getting online to self-diagnose or self-treat may misinterpret the information provided by the health resource, especially when reading complexity is high.

Twenty-five of the state government sites were part of the literacy study, as some state e-government sites did not provide either health-related content readily accessible by older adults, or a sufficiently large sample of health data. Twenty-four online newspapers were part of the study, as there was insufficient health content on one of the sampled sites. Therefore, the sample size for the literacy component of this study was 99 Web sites.

Reading complexity was assessed by extracting health-related material from each of the sampled sites. Health-related content included diseases, diagnosis, treatments, diet, long-term care, medications, and Medicare information. The average sample size was 155 sentences and 2439 words. For each text sample, the Automated Readability Index (ARI) [Kincaid et al. 1975] and the Kincaid Index [Kincaid and McDaniel 1974] were calculated. In addition, the average sentence length for each sample was recorded. The results, summarized by category in Table VI, show the reading complexity metrics and average sentence lengths associated with the extracted text.

The ARI metric takes into account the number of characters, words, and sentences in the sampled text in order to produce an estimated reading grade level. Unlike the Kincaid metric, it does not use syllable counts when calculating the reading grade level associated with information content. The Kincaid

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[3]The average sentence length is calculated as the average of all the average sentence length data recorded for a particular site category. The average sentence length was recorded for each sample in a category.

Table VII. Percentage of Web Sites in Each Grade Level Range

ARI Grade Level	State (.gov)	Profit (.com)	Nonprofit (.org)	Newspaper (.com)
≤8	8%	8%	16%	4%
9 ≤ 12	64%	60%	52%	71%
>12	28%	32%	32%	25%

readability index, often applied to technical documents, takes into account the number of syllables, words, and sentences in calculating reading complexity. Unlike the ARI metric, it does not use character count data in calculating its index value.

The ARI and Kincaid metrics produced the same median grade level for the commercial and nonprofit Web sites and varied by less than one grade level for the state Web sites. In general, the results show that the median reading levels of 11th to 12th grade are far beyond the recommendations made by many health organizations.

The average sentence length is also a reflection of reading complexity, though it does not take into account word complexity. A sentence with 12–15 words, for example, would be appropriate for an 8th-grade reading level. The median average sentence lengths reflect a reading grade requirement beyond the 6th grade.

The minimum grade level for all sampled sites was the nonprofit site, www.familydoctor.org, with a reading level of 7th grade. The maximum reading grade level was associated with health-related content extracted from a state site. The content required a graduate degree (18th-grade reading level) to comprehend it.

Table VII is a compilation of the number of sampled sites within each grade level range. The table shows that 96% of the newspaper sites, 92% of the state and profit sites, and 84% of the nonprofit sites required reading comprehension capabilities higher than 8th grade. Approximately 29% of all sampled sites required a college education (greater than 12th grade) to comprehend health-related information provided on the sites.

4. SUMMARY OF FINDINGS

4.1 Design Issues

None of the categories attained high ratings for usability in terms of enforcing the NIA/NLM design guidelines. About 93% of all sampled sites used a small font size on homepage content, negatively affecting readability for many senior users. In addition, approximately 40% of all sampled sites did not allow for text resizing of homepage content using the browser feature. For those who have an unsteady hand, the use of pull-down menus on approximately 24% of sampled sites poses a usability barrier in terms of site navigation. From a cognitive perspective, lengthy homepages require memory recall for content at the top and bottom of the homepage. Almost two-thirds of online newspapers require older adult users to scroll through an extended homepage. The lack of help and site map features may pose barriers for older adults, particularly those who are new to the Internet, as they may require technical or contextual assistance

when using a site. Fifty percent or less of the sampled Web sites provided these features.

Based on the guidelines put forth by NIA/NLM, state government Web sites were more senior-friendly than the other sites in the sample set. Other than using pull-down menus to navigate the site, state e-government had a higher level of compliance with the guidelines compared to commercial and nonprofit sites. Nonprofit sites had the highest compliance for homepage length and contact information: only 4% did not comply. In general, the commercial sites were not senior-friendly in terms of providing help, contact, site maps, or privacy features on homepages. Online newspapers were the least senior-friendly of the sampled sites, as shown by the high percentage of sites that did not comply with each recommended guideline.

4.2 Performance

Over 80% of older adults are home Internet users and approximately 50% are using 56.6 kps connectivity. This is significant given that the median download time for each category was at least double the ten-second guideline. The median download time for online newspapers was four times the recommended guideline. The lengthy download times associated with homepages in each category could be an impediment for older adults trying to access health resources. Users may not wait for a homepage to download, preventing them from completing their health maintenance objectives in using the Web.

4.3 Translation

Translated versions of Web sites providing health information will become increasingly important as more adults with low or no English proficiency get online. With the rapid growth rate of aging adults, including those from ethnic populations, translated sites will provide much needed health resources to those who may not otherwise be able to access them.

Unfortunately, only 12% of the sampled Web sites offered a translated version. Of those offering a Spanish version, English text in the translated pages could be a problem to site accessibility by non-English speaking users. English appeared most commonly in links, menus, and button labels, affecting the navigability of the site by targeted users. Another language impediment was the broken links on the translated sites, navigating to an English error page.

4.4 Reading Complexity

The misalignment of reading comprehension requirements of the sampled sites and the reading comprehension skills of older adult users could be an obstacle to the effective use of health-related information. Many health organizations suggest writing health content at a 6th-grade reading level in order to reach a broad audience. A lower reading grade level associated with health content would minimize the threat of misinterpretation by older adult users. This is not only because of aging and cognition, but also because of the education level of many older adults.

Though there were Web sites from all categories that offered written content at 7th to 9th-grade reading levels, many required a high school education. Approximately 30% of all sites required higher than a high school education to comprehend online health resources. Given the literacy skills of many older adults and the decline of reading comprehension associated with aging, there appears to be literacy barriers associated with all categories in the study.

5. CONCLUSION AND FUTURE RESEARCH

The NIA/NLM guidelines provided a framework for the design assessment carried out as part of this study. These guidelines are based on past usability research with older adult subjects. Morrell et al. [2004] compiled these research results, which became the foundation for the development of the NIA/NLM guidelines. As such, these guidelines are a significant step forward in eliminating Web barriers that challenge many older adult users.

Though these and other guidelines have been put forth to promote Web usability, there are still those who are not aware of the impact poor Web design has on older adult users. Section 508 (www.section508.gov), an amendment to the 1973 Rehabilitation Act, was enacted to eliminate information technology barriers for those with vision, audio, or physical disabilities. Because of this initiative, there have been significant strides in making Web design accessible to a broad group of users. A similar initiative could promote senior-friendly Web design, inclusive of translation and literacy, in order to meet the online needs of an ever-increasing aging population.

The impetus for this study is the growing number of older adults going online to access health resources. Given that older adults seek online health information more than any other age group [U.S. Department of Commerce 1999, 2002], the Web could be highly influential in maintaining senior health. Existing usability barriers, however, may prevent senior users from taking full advantage of Web health resources.

The U.S. Census (www.census.gov) reports that in the last decade there has been nearly a 50% surge in Americans speaking a language other than English at home. Many are "linguistically isolated" because of low English proficiency. The Web offers a unique opportunity to connect this fast-growing user group to online health resources through translated versions of English sites. Site versions must be fully translated—otherwise, English content may preclude the ethnic elderly from accessing and comprehending these resources.

The results of this study show that improvements to Web design are needed in order to accommodate vision, cognition, and motor skills of older adult users. None of the site categories attained high ratings for overall usability in terms of senior-friendliness. Almost all of the sites used small-point font sizes for some Web content, negatively affecting the readability of the site. About one-fourth required the use of mouse technology to navigate the site, which poses a usability barrier for those who have unsteady hands. In addition, a large number of sites did not provide help or site map support. The median download times for all categories were over twice the recommended guideline, requiring lengthy wait times for downloading pages. Only a small number of sites offered

a Spanish version many of which contained English text, thus posing a barrier for those with low English proficiency. Approximately a third of all sites required higher than a high school education to comprehend sampled health information. This is significant, given that health organizations recommend a 6th-grade reading level to promote comprehension of health content.

A limitation of this study is that navigational schemas associated with the sampled Web sites were not assessed for potential impact on older adult users. The study was limited to assessing the use of pull-down menus on the homepage, which does not take into account navigational requirements when traversing from one Web page to another. Past research has shown that the navigational schema does affect Web site usability by older adults [Mead et al. 1997] and so it would be important to include this aspect of older adult usability in future studies.

In order to promote the design of senior-friendly sites, future research needs to enhance the existing NIA/NLM guidelines. Many of the guidelines lack specific details necessary for the elimination of usability barriers for older adults by improving Web design. Though the guidelines specify a site map, for example, there is little guidance on the effective design of a site map. Site map guidelines require supplemental instructions on effective visual presentation of page and content relationships.

The current NIA/NLM guidelines recommend larger font sizes for the text body. However, the impact of font sizes on readability needs further study given that many text objects appear in a small font on the periphery of a page. In addition, it is unknown whether font size affects ease-of-use and understandability of the design layout when small font sizes are used on links, menu items, and button labels.

Additional research is needed on the structure of help content when taking into account the online needs of older adults. Many sites offer a "FAQs" feature; yet, they fail to organize the questions and answers to promote ease-of-use and fast searches. Others fail to update them regularly by eliminating less frequently asked or obsolete questions. Interactive or online help features may require the use of Web technologies (e.g., chat features) that could be unfamiliar to older adults or require extensive typing, which may be difficult for those with unsteady hands. As such, older adults may resist using customized help features.

Usability guidelines specify a homepage less than four screen-pages in length in order to improve recall of top and bottom contents. Future research should study the impact on older adult usability when homepages are reduced in vertical length, but have added complexity due to an increase in the number of navigational objects on shortened pages.

Future research should also address usability from the perspective of the ethnic elderly, given their growing use of the Internet. Many would benefit from language-accessible health resources on state, commercial, and nonprofit sites. Often, local health service information is only attainable on state government Web sites. Commercial and nonprofit Web sites (e.g., WebMD.com, Mayoclinic.org) provide a wealth of health resources that cannot be readily obtained through traditional channels. From this perspective, Web design

guidelines are needed to promote effective, bidirectional communication. The usability objective is to offer native language searches and email capabilities. In return, the Web site would provide information content fully translated in a native language.

Reading complexity requires further study in order to eliminate usability barriers associated with comprehending online content. An older adult may stop using Web resources due to reading complexity, perpetuating the isolation in which he or she lives. Perhaps worse, an ailing, older user may misuse information for self-diagnosis and treatment. Usability guidelines are needed to identify appropriate reading grade levels for targeted users. Guidelines on how to write online content are also needed to eliminate literacy barriers facing many older adult users.

Reading grade level is only one aspect of measuring reading complexity. Sentence structure variables, prepositional density (loosely defined as the number of facts in a sentence), and passive versus active voice, need further study to assess the impact on older adult reading comprehension. Future research would address these variables with the objective of providing additional guidelines for making content more comprehensible by older adult users.

Lastly, the need for future research on reading variables and their relationships with other variables became apparent during this study. The NIA/NLM guidelines recommend writing content using an active voice. To assess adherence to this guideline, the number of passive sentences was recorded for each sample in the study. (The data is not presented in this article). The data was difficult to interpret given that content written at a low reading grade level did not necessarily contain a low number of passive sentences. The content from a state site at an 8th grade reading level had 28% passive sentences; while another state site at a 10th-grade reading level had 5% passive voice sentences.

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