

A systematic approach to the development of research-based web design guidelines for older people

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Abstract This paper presents a systematic approach to the development of a set of research-based ageing-centred web design guidelines (SilverWeb Guidelines). The approach included an initial extensive literature review in the area of human–computer interaction and ageing, the development of an initial set of guidelines based on the reviewed literature, a card sorting exercise for their classification, an affinity diagramming exercise for the reduction and further finalisation of the guidelines, and finally a set of heuristic evaluations for the validation and test of robustness of the guidelines. The 38 final guidelines are grouped into eleven distinct categories (target design, use of graphics, navigation, browser window features, content layout design, links, user cognitive design, use of colour and background, text design, search engine, user feedback and support).

Keywords Research-based guidelines · Ageing · Web usability · Accessibility

Introduction

Brouwer-Janse et al. [5] have advocated that the twenty first century will see one of the greatest

demographic movements and cultural shifts in history caused by the ageing world population. The global number of elderly people by 2020 is expected to exceed one billion, and there will be more older people throughout countries in the developed world than ever before [49, 70]. For example, in the UK, it is expected that by 2020, there will be 25.2 million people who will be over 50 years old compared with 19.3 m in 1999 [11]. About 70% of the western world will live past 65 years [74]. The trend for North America is similar, where the average life expectancy today is over 76 years [70].

As older adults progress through the natural ageing process, they experience some degenerative effects of ageing, which can include diminished vision, varying degrees of hearing loss, psychomotor impairments, as well as reduced attention, memory and learning abilities. These affect the way older computer users interact with the World Wide Web (Web).

There is a vast amount of research in the area of ageing and technology, which Zajicek [81] has found is often difficult to access by new designers of systems for older people because it requires the designer to first wade through the vast amounts of detail before they can understand how the knowledge applies to their domain.

In order to address this issue, this paper presents a systematic approach that resulted in the development of the SilverWeb Guidelines (a set of research based web design guidelines for older people). The work presented in this paper is the output of a 3 year project. The adopted process involved gathering published studies related to web design and older people, obtaining individual guidelines from them and defining higher order categories of guidelines and in the end

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verifying the usefulness of those guidelines with the target user group. The initial findings of this work have been published in the past as a poster at the CHI 2005 conference [82] and as a full paper at the ASSETS 2005 [40] conference. This paper extends previous work by providing the full details of the final guidelines.

The following sections present a synopsis of the issues that relate to web and ageing. Then, the paper continues with the adopted research approach and findings, and concludes with a detailed discussion of the results and with recommendations for future research in this area.

Ageing population and the web

People over 60 today are among one of the fastest growing groups of web users [48, 54]. In a February 2004 survey [14] 22% of Americans age 65 or older reported having access to the Internet. That survey also showed that wired older people are often as enthusiastic as younger users in the major online activities. Despite the misconception that some have, the web is not exclusively used by young people anymore.

This is an encouraging sign, as Internet and email access can have a positive effect on the quality of life and well being of older people. For example, Eilers [13] found that older people who used computers thought they had more social interaction, memory enhancement and mental stimulation.

The Internet is also helpful in improving the quality of life even when independent living is not practical. McConatha et al. [47] investigated the effects of providing 14 Philadelphia nursing home residents between the ages of 59 and 89 years with personal computers and access to the Internet. After 6 months of using the computer and Internet facilities, it was found, after re-testing, that the group scored significantly lower on depression and significantly higher on cognitive ability. They concluded that “using the Internet allowed the elderly participants to keep their minds active and help combat depression...[and that these]...health benefits became apparent almost immediately” (p 240).

Czaja et al. [9] found that many of the restrictions and social isolation problems that elderly people face on a daily basis could be alleviated through the use of computers and online technologies. Lawhorn et al. [41] suggest that email and Internet use among older people encourages socialisation and a sharing of experiences amongst their fellow peer groups. Similarly, Furlong [17] investigated whether communicating with others through SeniorNet, a computer network, could

improve the lives of older people, and found that SeniorNet functioned as an effective emotional support system, especially for nursing home residents.

Ageing-related functional impairments and their impacts on web interaction

Vision is the most common physiological change associated with ageing, especially in studies of the use of computer-related technology, including the web. A third of people aged over 65 have a visual decline condition [58, 74]. After the age of 55 years, many older people will experience vision changes, including presbyopia, a loss in near vision [10], reduced field of vision [23], and reduction in the ability to view objects in fine detail or clearly from a distance [74]. Older people will also experience a decline in contrast sensitivity, as well as reduced colour sensitivity, particularly in the blue and green range [24].

Ageing-related visual declines can make reading text on a computer monitor an arduous task. Not only is it difficult for such users to read characters that are too small, but also the standard white web page background can prevent such users from seeing the contents of a page clearly even if the text size has been optimised [43].

The use of sound to complement visual information can potentially resolve some problems related to ageing-related visual impairments. However, many older people have problems with their hearing, often at higher frequency. Figures have indicated that 20% of people between 45 and 54 years have some forms of hearing impairment and this figure rises to 75% for people between 75 and 79 years of age [15, 37]. In older people there is a reduced ability to detect high pitched sounds [61, 67], to localise sound [37] and to follow conversations in noisy surroundings [23]. Thus, the benefits of audio output can be lost. Moreover, some of them use computers in a noisy environment such as in computer centres of elderly organisations or libraries, where sound outputs are considered disruptive or would be unheard.

Psychomotor abilities also show a decline with age [23]. Older people’s response times increase when they perform more complex motor tasks [42, 71], even more in tasks with a variety of choices [23, 75]. Older people when compared to younger people perform poorly when they try to track a target [35], make more sub-movements when using a mouse to track an item [78], and experience an increase in cursor positioning problems if the target size is small such as in the case of links or buttons [7].

Attention is the ability to focus and remember information which may have to be processed simultaneously [74]. Older people experience more difficulties in trying to focus and maintain attention on activities over long periods of time, or require quick and continuous scanning [75]. Research has also shown that the ability to sustain divided attention in the performance of tasks declines with age, particularly in complex tasks [22].

Similarly, memory is a key performance factor in all cognitive tasks, which includes learning, planning, perception, decision-making, prioritising and creativity [26]. Human memory is rarely perfect, even for younger people [68]. However, it is generally accepted that there is a decline in cognitive performance with age [80], a decline in the ability to transfer items from working memory into short term memory [63], and the cognitive processing of visual information [29]. Episodic memory (memory for specific events) and procedural memory (memory for how we carry out tasks) [28] also decline.

Even though each of the individual functional impairments described above might not result in a perceptible difference in older people's user experience, the cumulative effect of various impairments can make web interaction more difficult for older people. This combination of impairments may also result in "knock on effects," e.g., the cognitive effort required to do sensory processing overloads the mental resources required for engaging in deeper, interpretive processing of the information.

Meyer et al. [48] also suggested that these physical and psychological changes are responsible for the hesitation of older people using the web. These physical and psychological changes include a decline in working memory, which was evidenced from the problems older web users had remembering which pages they had seen, or how they arrived at the current page. Increased age was associated with fine movements, which could affect the use of scroll bars or image maps. However, research has shown cognitive adaptability in older people when appropriate training was provided, even for complex tasks. Older people are able to navigate the web quite well when the sites are properly designed. In summary, the study suggests that with proper design and training, older people should be able to use the web as effectively as their younger counterparts.

Unfortunately, in a study evaluating 25 web sites targeted to older people [20], some web sites still failed to adhere to guidelines that would help older persons with reduced vision such as providing large and highly contrasted text. As many as 95% of those sites also

failed to provide backward and forward navigation aids, which would have impeded the use of the web by older people with reduced spatial ability. In a similar study, Becker [3] used the National Institute on aging web guidelines [54] to assess the usability of 125 health related web sites. Results showed that many of the sampled sites were not senior-friendly (for example, about 93% of all sampled sites used a small font size on homepage content).

Need for making web sites accessible to older persons

Legislation in many countries has been tightened to ensure that big corporate, government and organisation bodies make sure that people with disabilities are not discriminated against and are provided the same level of access and rights to goods and services as everyone else. For example, in the UK, since October 2004, offering services on the web without addressing accessibility concerns will leave the offending organisation liable under the Disability Discrimination Act [12]. In the US, the Americans with Disabilities Act [1] and the Section 508 Rehabilitation Act Amendment [19] requirements provide similar sanctions.

It is important to recognise that in addition to the legal requirements, there are strong business drivers for providing accessible web sites that benefit not only elderly and disabled people, but all site visitors. These are improved site usability, support for low literacy levels and cultural sensitive design, improved site efficiency, as well as opening an organisation's market up to a truly diverse clientele, which includes all members of the population [34].

Stroud [73] also asserts that the older adult population owns 75% of all financial assets and controls 50% of consumer spending power, and as such they can be an important e-commerce group. A report of the UK Government Department of Trade and Industry [11] also supports this finding, stating that, in relation to elderly people using information communication technology, businesses do not appear "to be aware of the potential market opportunities, or if they are aware to feel that it is worthy of attention" [11]. Keates et al. [36] also support this claim and have stated that industry is continuing to produce products primarily aimed at the younger population. Finally, Stephanidis [72] advocates that by creating accessible web sites, organisations are promoting socially responsible behaviour, which apart from providing good publicity for the organisation, will also enable the organisation to be perceived as an employer of choice and therefore will attract a more diverse workforce.

In addition to the business drivers and legislative requirements for having accessible web sites, the Internet is becoming an increasingly vital tool in an information rich society.

Consequently, there is an increasing call for web sites to cater more for older visitors. Taking the needs of older people into account can address the current attitude that many older people have in ‘shying away’ from the web. By making the Internet accessible to older adults, web designers are opening the doors to provide many new opportunities to this group and in the process might also facilitate easier access for people with disabilities.

One of the reasons often cited for the tendency of older people to shy away from the web is the lack of understanding from web developers that older people have different needs from their younger counterparts, concerning both the reasons for which older people use the web and the way in which older users interact with it (mostly due to ageing-related functional impairments) [38].

To address the needs of senior web users, it is necessary to adopt a universal design approach to web design. Web developers need to remember that older adults are users of the web, and should become aware and sensitive to their web needs. This can be facilitated in a number of ways, for example through training and the availability of guidelines and tools.

Web design guidelines

Universal design or design for all has been described as the philosophy in design that recognises, values and accommodates the broadest possible range of human abilities, skills, requirements and preferences in the product and supporting environments to suit the broadest possible end user population [72].

A key step in helping web designers to implement universal web design is to provide them with web usability and accessibility guidelines.

The epitome of web accessibility guidelines is perhaps the World Wide Web Consortium’s Web Content Accessibility Guidelines (WCAG version 1.0—with version 2.0 looming in the horizon) [76]. Section 508 of

the Telecommunication Act [59] is another set of accessibility guidelines that is widely used in the USA. Various other countries also published their own web accessibility guidelines, most of them are based on the WCAG 1.0 [77]. In addition, a number of other organizations have also provided standards and guidance on how to design accessible interactive systems [31–33, 53]. Finally, although there are other sets of guidelines that address issues of web and ageing (e.g., [52, 54]) they are often limited in scope (e.g., addressing only health related web sites) or the methodology through which they were obtained is unclear or not backed up with literature.

There have been a number of attempts to translate usability guidelines that were intended for user interfaces (e.g., Nielsen’s heuristics) into web design guidelines, but none is as well-received as the WCAG.

In general, there are two streams of sources of usability guidelines: academia (i.e., theory-driven guidelines) and industry (i.e., guidelines derived from practical experiences). These two streams, unavoidably, have produced many overlaps, where some guidelines that aim to highlight the same problem were phrased differently or have different focus.

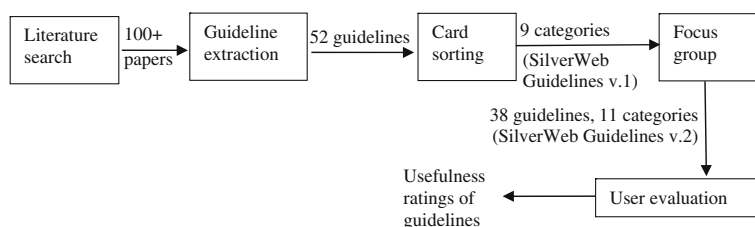
Another thing that is often overlooked is the application of a systematic methodology in the development and validation of these guidelines. This paper demonstrates one such systematic approach.

The study

Initial guideline development

The purpose of this study is to use a systematic approach to guidelines development that involves: gathering various published studies that proposed web design guidelines for older people (both industrial and academic papers), removing any overlaps, categorising them in a meaningful way (using the established clustering methods of card sorting and affinity diagram) and verifying the usefulness of those guidelines with the target user group (older web users). The process is depicted in Fig. 1.

Fig. 1 Processes adopted for the elaboration of the final set of guidelines



Similar methodologies to the ones used in this paper have been used in the past by others [64, 65] for the development of ergonomic criteria.

This study started with an extensive literature review of over 100 academic papers on the areas of HCI and ageing, consisting of collecting and reviewing age-related publications that were published in the key HCI or gerontology journals (e.g., *ToCHI*, *Interacting with Computers*, *Behaviour and Information Technology*, *International Journal of HCI*, *International Journal of HCS*, *Applied Gerontology*, etc.) and conferences (*CHI*, *British HCI*). Additional papers that were cited by these papers and were considered as providing either additional verification of the authors' observations or new insights were also reviewed. A pre-determined format was used to extract information and summaries of these publications.

From the extensive literature review an initial set of 52 guidelines was established (called *SilverWeb Guidelines Version 1.0*). The guidelines were categorised by their impact on ageing-related functional impairments, more specifically into ones related to: vision (decline in static acuity, dynamic acuity, contrast sensitivity, colour sensitivity, sensitivity to glare, decrease in visual field, and decrease in processing visual information), psychomotor abilities, attention (declines in selective and divided attention), memory and learning, intelligence and expertise.

Care was taken so that each guideline was supported with at least one published piece of literature/study. Each guideline was also further supported with explanations and good and bad examples.

Card sorting

A card sorting exercise was then employed as a means to further improve the categorisation of the initial guidelines.

Card sorting is a quick, inexpensive and reliable categorisation method for finding patterns of how participants would organise content by sorting cards depicting various concepts into several categories [46]. Fuccella and Pizzolato [16] have stated that for web design card sorting can help designers better understand the user's view of how information on the web site should be organized.

Card sorting can help resolve disagreements on groupings and categories by identifying trends and insights in the way people group and label content [62].

Other studies have used a similar approach to categorise concepts from HCI domains (e.g., *Mobile-HCI* [50]).

In this study, the card sorting exercise was conducted with a group of 40 postgraduate computing students who were taking a compulsory module in human–computer interaction and design and a compulsory web design (e-commerce) module. Through their course, these students have been exposed to the topics of usability, accessibility and universal design, and have been involved in web design related projects.

Participants were given a set of 3 × 5 in. index cards containing the initial 52 guidelines, each with a short description, and were asked to group related guidelines, sort these guidelines into categories and provide category headings for these groups.

The individual results of the card sorting sessions were then inputted into EZSort, a freely downloadable cluster analysis software application from IBM [30]. EZSort produced a tree diagram depicting the 52 guidelines grouped distinctly into 9 categories.

The cluster analysis identified pairs of guidelines were often grouped together by participants in the card sorting exercise (Table 1).

It also revealed guidelines which were not placed together in the same group by any of the 40 participants. For example, the guideline “The font size should be 1–4 point” was never placed in the same group as “Avoid pull down menus”, “Provide a site map”, “Do not have a deep hierarchy”, “Provide fewer choices to the user” and “Support user control and freedom”.

The analysis also showed that the guidelines are grouped into nine distinct categories (Table 2).

Focus group

The final groups produced through the card sorting exercise was then given to a focus group consisting of five participants (PhD Research Students, Researchers and Academics all experts in the domain of HCI).

Focus groups bring together a cross section of stakeholders in the form of a discussion group [44]. They are a quick, cheap and useful method for requirements gathering and can rapidly bring a wide variety of views to the surface, and often their results are based on a consensus among participants [45]. The key goal of a focus group is to establish a collective view by a process of discussion [44].

The affinity diagramming technique (Fig. 2) was used within the focus group. Affinity diagramming is a categorisation method, similar to card sorting, where participants sort various concepts into several groupings and categories [27]. This technique has been described as a powerful method to understand and group information [18], and is used by teams of participants who are asked to organise large amounts of

Table 1 Guidelines grouped together by the majority of participants

Guideline	Closely related to guideline	Users Grouping guidelines together (%)
Links should be clearly named	Links should be in a bulleted list	90
Links should not be tightly clustered	Links should be clearly named	70
Links should be in a bulleted list	Links should not be tightly clustered	80
There should be differentiation between visited and unvisited links	There should be no link with the same name that goes to a different page	70
The font size should be 1–4 point	The font type should sans serif (i.e., Helvetica, Arial)	92.5
Avoid fancy fonts	The font type should sans serif (i.e., Helvetica, Arial)	82.5
Avoid fancy fonts	The font size should be 1–4 point	82.5
There should be high contrast between the foreground and the background	Background should not be white	80
Blue green tones should be avoided	Colours should be used conservatively	70
Content should not all be in colour alone	Coloured text on coloured background should be avoided	70
Pop up/animated advertisements should be avoided	Multiple overlapping windows should be avoided	57.5
Screen layout should be simple, clear and consistent	Consistent layout should be present	65
Support recognition rather than recall	Reduce the demand on working memory	70

data according to their natural relationships between each other [45]. Unlike card sorting which is done individually, affinity diagrams are constructed collectively by a group of stakeholders.

The 52 guidelines from the card sorting session were printed onto yellow post-it notes and stuck onto the wall into the nine categories produced by the EZSort cluster analysis.

The focus group members iteratively reviewed the guidelines within each category, as well as moved, removed or merged any guidelines from their initial position. This resulted in a new smaller set of 38 guidelines in 11 distinct categories (SilverWeb Guidelines Version 2.0). Through discussion, the focus group agreed on category headings for each category.

Final guidelines

Table 3 presents the final guidelines, with the “Evidence” column providing some representative literature in support of each guideline. Due to space limitations, the full list of references is not included, but can be obtained from the authors.

Heuristic evaluation

To investigate the validity of the new set of guidelines and the effectiveness of the adopted systematic guideline development approach, heuristic evaluations using both sets of guidelines (SilverWeb Guidelines Version 1.0 and Version 2.0) were conducted on two web sites targeted for older persons: <http://www.nsclc.org> and <http://www.elderhostel.org>, whose screenshots

are presented in Figures 3 and 4. These two specific web sites were chosen because they were used in the past in other evaluation studies that looked at the usability of web sites for older people. Also, the two pages are very different from each other in layout, colour use, navigation, and various other aspects covered by the guidelines, thus giving a nice spread of issues that could enable to fully explore the degree of usefulness of the developed guidelines.

Heuristic evaluation is an expert-based usability inspection method [55]. The main purpose of using heuristic evaluation was to identify any problems that may occur when using the new set of guidelines. The key aim of the evaluations was to test the meaning and understanding of the new set of guidelines and thus identify potential ambiguities for the guidelines users.

Six participants (under 40 years old) were recruited for this exercise, consisting of researchers and research students with at least 2 years experience in the domain of HCI.

The sequence of web sites and guidelines the participants reviewed were balanced. The participants worked through the heuristic evaluation sheets provided and evaluated whether the site’s design met a guideline or not by selecting “Yes”, “No” or “NA” on the heuristic evaluation sheets, providing comments if necessary. The NSCLC web site was rated very consistently using both guidelines (71% of the version 2.0 and 67% of version 1.0 SilverWeb guidelines were rated identically across all participants). Seven of the 9 Version 2.0 guidelines were answered unanimously by the participants while only 12 out of 23 equivalent Version 1.0 guidelines were answered unanimously.

Table 2 Nine distinct categories identified by the cluster analysis

Category	Guideline
Category 1	Links should not be tightly clustered Links should be clearly named Links should be in a bulleted list There should be differentiation between visited and unvisited links
Category 2	There should be no link with the same name that goes to a different page Extra and bolder search cues should be provided Do not have a deep hierarchy Provide location of the current page Provide a site map Clear navigation should be provided
Category 3	Support user control and freedom An online help tutorial should be provided Error messages should be simple and easy to follow Search engines should cater for spelling errors
Category 4	Provide larger targets Support user control and freedom Provide ample time to read information Support recognition than recall Reduce the demand on working memory There should be confirmation of target capture The older adult should not be expected to double click Older adults should not be expected to detect small changes
Category 5	Avoid fancy fonts The font size should be 1–4 point The font type should be sans-serif (i.e., Helvetica, Arial) There should be spacing between the lines There should be short line lengths and left justified text Text should have clear large headings
Category 6	Main body of the text should be in sentence case and not all capital letters Avoid irrelevant information on the screen Language should be simple and clear Information should be grouped into meaningful categories Important information should be highlighted Information should be concentrated mainly in the center
Category 7	Avoid busy backgrounds There should be no rapid shifts in brightness between the screens There should be high contrast between the foreground and background Background should not be pure white Blue green tones should be avoided Colours should be used conservatively Content should not all be in colour alone Coloured text on coloured background should be avoided
Category 8	Avoid moving text Avoid pull down menus Avoid scroll bars Pop up/animated advertisements should be avoided
Category 9	Multiple overlapping windows should be avoided Screen layout should be simple, clear and consistent Consistent layout should be present Icons should be simple and meaningful Images should have alt tags Graphics should be relevant and not for decoration. No animation should be present

For the Elderhostel web site, using Version 2.0 SilverWeb guidelines again provided very similar compliance points with a variance of only two points between the lowest and highest ratings. In addition, the participants using the Version 2.0 guidelines had answered 71% of the guidelines unanimously. The heuristic evaluation results using Version 1.0, on the

other hand, show a difference of 19 points between the lowest and the highest compliance points. Additionally, only 40% of the guidelines were evaluated in the same way by participants using the Version 1.0 guidelines. Eight out of 9 Version 2.0 guidelines were evaluated in exactly the same way by participants, compared to only 8 out of 23 equivalent Version 1.0 guidelines.



Fig. 2 Affinity diagram output

Based on the above results, it can safely be concluded that Version 2.0 is more robust than Version 1.0 guidelines. A post-evaluation questionnaire also indicated that Version 2.0 guidelines were perceived as more informative and more logically structured than Version 1.0 guidelines.

User evaluation of the guidelines

Finally, 16 older web users (average age = 59.2 years, SD = 3.81, six males and ten females, average Internet experience = 3.4 years) participated in a controlled experiment to evaluate the usefulness of the SilverWeb guidelines version 2.0. To provide a context for evaluation, the two web sites used in the heuristic evaluation were presented to each participant. Each participant rated these two web sites using the 38 guidelines to help them think about each guideline in more depth. An experimenter was at hand to explain the meaning of any guidelines that the participant was unclear about. The whole session was videotaped for later observation.

Upon completion of the web site rating exercises, the participants were asked to rate the usefulness of each guideline from “one” (useless) to “five” (very useful) and to provide some justification for their ratings. Table 4 lists the averages of these ratings and the justifications of those ratings. The comments from these participants were transcribed by four experienced transcribers in real-time, resolving differences through a group discussion, assisted with videotape replays when necessary.

Before leaving, the participants were given an opportunity to provide any additional guidelines that they felt were important but were not already included in our set. This exercise was an attempt to get a first indication of any additional guidelines not captured in the literature.

Only few participants took this opportunity, possibly because the rating exercise was quite long. Some proposed guidelines that were already covered by the existing set, albeit phrased slightly differently. The participants were asked for clarifications when necessary. The guidelines proposed include:

- Enable users to change font size as some users have worse sight than others.
- Information should not be duplicated in the same page—it is a waste of space.
- Page should remain the same each time it is revisited (note: the participant referred to advanced pages whose image changes every time the page is refreshed or revisited).
- Include multilingual facility for non-English speakers (note: this was suggested by a participant whose first language is not English).
- Search facility should be placed in a noticeable place as some users prefer to search than to browse.
- Inform users of the most appropriate screen resolution. Provide multiple presentations for various screen resolutions, e.g., for large and small monitors.
- Do not use spacing too liberally—it is a waste of space (note: the participant referred to the blank space in <http://www.nslc.org>. This suggested guideline is interesting as it contradicts H9.3.)
- Provide a printer-friendly version.

These suggestions are currently being reviewed, investigating whether some of these should be incorporated in later versions of our guidelines.

Discussion

The paper sets out to employ a systematic approach to the development of a set of guidelines that can help web designers minimize accessibility and usability barriers in web pages targeted for older people. This systematic approach started with a literature-based study to produce an initial set of guidelines that were fully backed by published manuscripts. The initial set was very detailed and comprehensive, but the guidelines were not arranged in any meaningful order. The card sorting exercise performed managed to organize the guidelines into meaningful structure, resulting in nine categories.

This initial set still consisted of a relatively large number of guidelines (52). Past studies found that guidelines sets that contain too many guidelines or guidelines that are potentially too long, general and not too specific might actually prevent adherence by web

Table 3 SilverWeb guidelines (Version 2.0)

Guideline	Evidence	Explanation
<i>H1. Target design</i>		
H1.1 Provide larger targets	[23, 79]	To aid with detection and capture of targets, i.e., buttons, they should be clearly visible
H1.2 There should be clear confirmation of target capture, which should be visible to older adults who should not be expected to detect small changes	[23, 78]	It is difficult for older adults to detect smaller movements. So for example, things like mouse over should not be present. Additionally, as older users are cautious in their movements, it will help if they get good feedback from their actions. This could be the screen status changing, i.e., a link has been selected and thus a new page
H1.3 The older adult should not be expected to double click	[23]	Older adults have slower hand movement therefore it is best that they should only have to single click
<i>H2. Use of graphics</i>		
H2.1 Graphics should be relevant and not for decoration. No animation should be present	[23, 39]	Irrelevant graphics will only distract the reader and make it more difficult for them to read the information they want
H2.2 Images should have alt tags	[57]	If an image is not clear, it will help to read what it is about
H2.3 Icons should be simple and meaningful	[8, 23]	Simple and meaningful icons will be easier to discriminate
<i>H3. Navigation</i>		
H3.1 Extra and bolder navigation cues should be provided	[23, 37]	This is so that the reader can see and identify in advance a target location. It will help better scanning as well
H3.2 Clear navigation should be provided	[4, 76]	This will aid in readability and also help older adults to visualise the structure of information
H3.3 Provide location of the current page	[8]	To reduce complexity and to help the user in orientation, it is best to provide a path that sets out how they got to the current page
H3.4 Avoid pull down menus	[25]	It will be difficult for the older adult to coordinate scrolling down the menu and clicking at the same time due to slower hand movements
H3.5 Do not have a deep hierarchy and group information into meaningful categories	[4, 8, 56, 76]	Grouping the categories of information will help the reader in searching and locating what they are looking for more quickly and will help them scan the page. However, deep hierarchies should be avoided as it will take the reader longer to get to the information they want and will slow them down
<i>H4. Browser window features</i>		
H4.1 Avoid scroll bars	[23]	Scrolling will most probably be required on a long page. This should be avoided because it will be difficult for the older user to scroll down the page and try to read and find the information that they are looking for
H4.2 Provide only one open window eg. pop up/animated advertisements or multiple overlapping windows should be avoided	[4, 23]	Readers will become distracted with multiple overlapping windows or pop up/animated advertisements due to so many separate focal points being present, which will be distracting and difficult for the reader to follow
<i>H5. Content layout design</i>		
H5.1 Language should be simple and clear	[76]	The language should be natural, simple and relevant to the user and should not contain any technical jargon
H5.2 Avoid irrelevant information on the screen	[8]	The content of the page should really be minimised to the most relevant information to make it easier for the reader to find what they are looking for

Table 3 continued

Guideline	Evidence	Explanation
H5.3 Important information should be highlighted	[8]	To help the older adult identify the relevant from irrelevant information, important information should be highlighted in a way that will not distract them further. For example, bold text will be better than presenting the information in a scrolling marquee
H5.4 Information should be concentrated mainly in the centre	[6]	To detect a target it needs to be stronger and located in the centre. Any main information that is located on the periphery of the interface will not be seen at first
H5.5 Screen layout, navigation and terminology used should be simple, clear and consistent	[23, 69]	It is important to avoid complexity and provide a simple screen layout where possible. Therefore there should be consistency between terminology used, navigation etc. Simple screen layout will also aid readability, whereas a cluttered look will distract the reader and make it difficult to identify targets
<i>H6. Links</i>		
H6.1 There should be differentiation between visited and unvisited links	[57]	The reader should be able to clearly see which links have been visited and which have not
H6.2 Links should be clearly named and no link with the same name should go to a different page	[76]	Clearly named links will enhance readability and will help the reader identify the areas they may want to visit. Additionally links with the same name going to a different page will confuse the older adult who may lose track of which page they have visited and which they have not
H6.3 Links should be in a bulleted list and not tightly clustered	[4, 57]	Links in the form of bullet points will aid the reader's visibility and help with clarity. Additionally clustered links will make it more difficult for the reader to identify the links they want to view
<i>H7. User cognitive design</i>		
H7.1 Provide ample time to read information	[39]	Older readers require a longer time to recognise characters and therefore it is best to let them read at their own pace
H7.2 Reduce the demand on working memory by supporting recognition rather than recall and provide fewer choices to the user	[23, 55, 75]	As older adults have a decline in short term memory it is important that they can offload information onto the interface itself. Therefore facilitate older adults to recognise material rather than requiring them to strain their memory in trying to remember where they found an item. Additionally the more choices presented to the user will slow the response and reaction time of the user, as older users' tend to be more cautious in their approach
<i>H8. Use of colour and background</i>		
H8.1 Colours should be used conservatively	[69]	Too much colour can be distracting and can make it difficult to see text properly
H8.2 Blue green tones should be avoided	[23]	It is difficult to detect the colours in this range therefore it is best to avoid their use
H8.3 Background screens should not be pure white or change rapidly in brightness between screens. Also, a high contrast between the foreground and background should exist, for example, coloured text on coloured backgrounds should be avoided	[4, 7, 23, 57, 76]	There should be consistency between the screens on a site and all should be the same in terms of their background colour. This is because it will be difficult for the user to adapt to changes in brightness between the screens. Additionally it is best to have an off white background as opposed to a pure white one to avoid glare. Finally a high contrast between the foreground and background will aid the visibility of the text and make it more readable to the user
H8.4 Content should not all be in colour alone (colour here is denoted by all colours other than black and white)	[76]	It is important that the content of the page is mostly available without colour to aid reading

Table 3 continued

Guideline	Evidence	Explanation
<i>H9. Text design</i>		
H9.1 Avoid moving text	[39]	Readers will have great difficulty following moving text. For example scrolling text should be avoided. Any information that is important should be displayed in some other way to attract attention
H9.2 Text should be left justified and text lines should be short in length	[51]	Shorter lines as opposed to a long page full of text will help with better readability as well as not tire the reader. It will be easier for them to scan for the information they are looking for
H9.3 There should be spacing between the lines	[2]	This will help the reader identify the beginning of the next line. A paragraph with text close together will not help with readability
H9.4 Main body of the text should be in sentence case and not all capital letters	[57]	Having text in all capitals will only make it illegible for the reader
H9.5 Text should have clear large headings	[21]	This is so that it can help with reading and allow the reader to search for information on the page more efficiently
H9.6 Use sans serif type font i.e., Helvetica, Arial of 1–4 point size. Avoid other fancy font types	[23, 51]	It is difficult for older users to see small font therefore this font size and font type should aid visibility and readability as the font style is simple and clear. Fancy fonts reduce the readability of text and make it more difficult to see and read
<i>H10. Search engine</i>		
H10.1 Search engines should cater for spelling errors	[57]	Older adults may not spell something correctly due to keyboard typing errors. Therefore any feedback they receive should be meaningful and provide instructions on how to recover or rectify from the error made
<i>H11. User feedback and support</i>		
H11.1 Provide a site map	[4]	A site map will enable the reader to see what is available to them and will assist to identify what is relevant to them and what is not
H11.2 An online help tutorial should be provided	[8, 25, 55]	It will help the older adult if there are instructions provided on eg. how to use the site. This will better prepare them and may also reduce the amount of errors made
H11.3 Support user control and freedom	[55]	Older users tend to slow down after errors, so it will be best if there is a way out for them, i.e., they have come across a page and are not sure how to get back. Things like a homepage button or even 'forward' and 'previous' links can help them
H11.4 Error messages should be simple and easy to follow	[55]	Older users tend to slow down after making errors. It is important not to slow them down even more by providing an unfriendly message, which does not help them at all

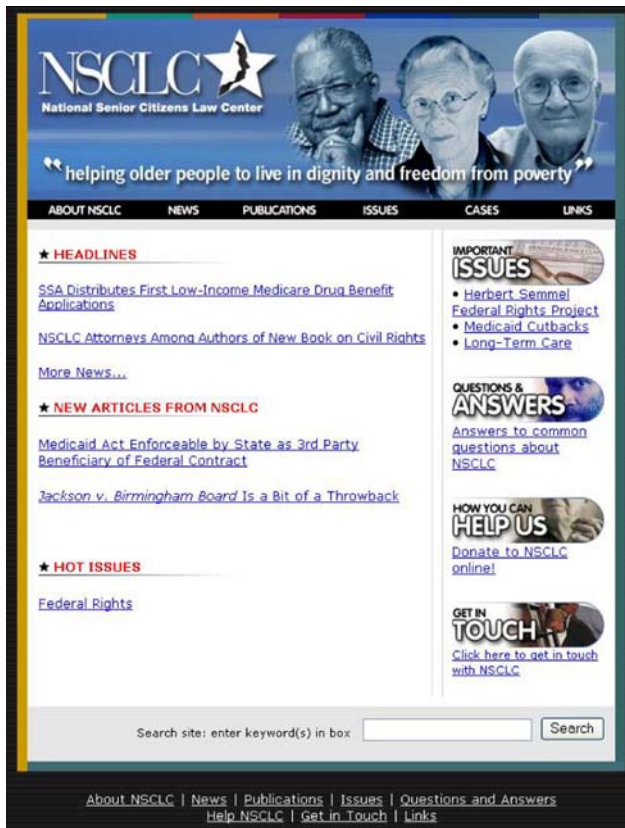


Fig. 3 Screenshot of <http://www.nslc.org>

designers, as they are more open to interpretation [66] and require the designer to first wade through the vast amounts of detail before they can understand how the knowledge applies to their domain [81].

Fig. 4 Screenshot of <http://www.elderhostel.org>



Therefore, a focus group exercise with affinity diagramming was performed to investigate whether it was possible to reduce the number of guidelines without affecting their comprehensiveness. The initial set was shrunk into 38 guidelines and 11 categories (SilverWeb Guidelines Version 2.0). The heuristics evaluation with five experts confirmed that Version 2.0 guidelines are more robust and perceived most positively.

Robertson [60] suggested that it is important to ensure that guidelines are organised, useful and meaningful for the users of the product. To this purpose, 16 older web users were involved in an experiment of usefulness measurement of these guidelines. In general, the participants rated the guidelines quite positively. There was only one guideline that was rated a “one” by one participant. As past studies have revealed that older people can often be overly positive when asked to rate, justifications were requested for the provided ratings, thereby minimizing the possibility of overrating.

One side product of the user evaluation was the finding that older participants were not familiar with some terminology, and some had not been exposed to some of the features proposed in the guidelines. There were also cases where older participants were not aware of the difference between several guidelines. Finally there was one odd case where a participant suggested a guideline that contradicts the existing guideline (although upon elaboration, the participant further explained that white space is good but not when used excessively). These three cases might not

Table 4 Guidelines' usefulness ratings and their justification (taken from [40])

Guidelines	Mean	Justification
H1.1. Provide larger targets	4.75	Important for those with motor and visual impairments
H1.2. There should be clear confirmation of target capture, which should be visible to older adults who should not be expected to detect small changes	4.25	Important for those with motor and visual impairments. Very useful as users need to know whether their actions were successful
H1.3. Older adult should not be expected to double click	4.875	Important for those with motor impairments—difficult to keep the mouse still enough to double click, although following hyperlinks, the common activity in web browsing usually does not require double-clicking
H2.1. Graphics should be relevant and not for decoration. No animation should be present	4	Important for those with cognitive impairments. Older users often get annoyed with animation. Animation also distracts users
H2.2. Images should have alt tags	3	Essential for users with visual impairment relying on non-visual browsers (note: only very few users understand what this guideline means)
H2.3. Icons should be simple and meaningful	3.75	Icons are generally not used in web design. No point in having complex icons in a web page as those with visual impairment will not be able to see the detail and work out its meaning
H3.1. Extra and bolder navigation cues should be provided	3.75	Helps users know where they are (note: it was observed that the participants were confused on the difference between guidelines H3.1.1, H3.2 and H3.3.).
H3.2. Clear navigation should be provided	4	Helps users move smoothly through the pages of the web site. Users would get frustrated if they could not find what they are looking for and they would probably just not bother using the web site
H3.3. Provide location of the current page	4	It is important for users to know their current location in the web site
H3.4. Avoid pull down menus	4.25	Important for those with motor, visual and cognitive impairments. Older users are more likely to have hand problems that make manoeuvring a mouse difficult. Disagree, pull-down menus save space
H3.5. Do not use a deep hierarchy and group information into meaningful categories	4.25	Improves content clarity and minimise density of the web site. Helps users find relevant information quickly
H4.1. Avoid scroll bars	3.375	Horizontal scrollbars are easier to avoid, however, vertical scrollbars are generally displayed in browser. Older users are more likely to have hand problems that make manoeuvring a mouse to the scrollbar difficult. The information that has to be accessed after scrolling is likely to be missed
H4.2. Provide only one open window	4	Multiple windows may cause confusion. Minimise distraction
H5.1. Language should be simple and clear	4.25	Increased readability. Important as older users would have problem understanding complex language
H5.2. Avoid irrelevant information on the screen	4.5	Reduced page density and increased comprehension. It is always important to keep a page simple
H5.3. Important information should be highlighted	4.25	Reduce browsing time by highlighting important information. Helps draw attention to it
H5.4. Information should be concentrated mainly in the centre	4.375	That particular area of the screen places emphasis on information. Important as otherwise users may not notice the information
H5.5. Screen layout, navigation and terminology used should be simple, clear and consistent	3.875	This guideline is too general. Important as once users know their way around a page, they should not have to start working it out all over again just because a different layout template is used
H6.1. There should be differentiation between visited and unvisited links	4.625	Important for those with cognitive (particularly memory) impairments. Helps users not to remember which links they had visited
H6.2. Links should be clearly named and no link with the same name should go to a different page	4.25	Reduces confusion
H6.3. Links should be in a bulleted list and not tightly clustered	4.25	Enhanced readability and legibility. Makes links stand out
H7.1. Provide ample time to read information	4.75	Helps users have enough time to understand information presented. Very important as older users read more slowly (than younger users)

Table 4 continued

Guidelines	Mean	Justification
H7.2. Reduce the demand on working memory by supporting recognition rather than recall and provide fewer choices to the user	3.5	Important for those with cognitive (memory) impairments
H8.1. Colours should be used conservatively	3.75	Important for those with visual impairments. Too many colours would require constant refocusing
H8.2. Blue and green tones should be avoided	3.5	Important for elderly users only when these two colours are used in close proximity. These two are difficult to see as text colours
H8.3. Background screens should not be pure white or change rapidly in brightness between screens. A high contrast between the foreground and background should exist	4	Enhanced readability and legibility. Negative contrast is preferred
H8.4. Content should not all be in colour alone (colour here is denoted by all colours other than black and white)	3.125	Important for those with visual impairments
H9.1. Avoid moving text	4.625	Reduces confusion. Older users are more likely to have problems reading moving text
H9.2. Text should be left justified and text lines should be short in length	4	Increases readability. Older users are used to reading left justified text so it is easier to read left justified text
H9.3. There should be spacing between the lines	4.125	Not consistent with standard design principle. Improves readability
H9.4. Main body of the text should be in sentence case and not all capital letters	4.25	Consistent with standard format. Improves readability
H9.5. Text should have clear large headings	4.25	Important for those with visual and cognitive impairments. Improves readability
H9.6. Use san serif type font i.e., Helvetica, Arial of 1–4 point size	4.25	Increased readability, important for people with visual impairments
H10.1. Search engines should cater for spelling errors	3.75	Users who misspell words should be provided with the right spelling, instead of their search showing no result. Older users have problems spelling long words. Worsened eyesight might also cause more spelling mistakes as the users cannot easily see what they are typing
H11.1. Provide a site map	3.125	Gives users a clear and accurate overview of the site. (note: some users never saw or use a sitemap so didn't know what it was good for)
H11.2. An online help tutorial should be provided	3.625	Gives users detailed instructions about how to use the site. It would only be useful when it is user-friendly (most of them are not). It could be used to teach users how to use a site as many older users have limited experience with web browsing
H11.3. Support user control and freedom	4	It is good to give users control of how desired information should be presented, e.g., changing font size. Important as user needs to feel in control
H11.4. Error messages should be simple and easy to follow	3.625	The error message must be clear so that users do not repeat the same errors. It is useless to have error messages that are only useful for a computer expert as most of the time the expert is not there with the user

have a severe implication as these guidelines were intended for use by web designers. However, if a user-centred design method is to be adopted, the occurrence of these three cases might pose a problem, as older participants might not fully understand the implication of a certain guideline or disagree with the given guidelines. This also highlights the importance of ensuring that guideline users understood the guidelines as they were intended, and that the target user group addressed by the guidelines had been consulted. In general, it is necessary to ensure that guideline validation involves users of various backgrounds and needs, as it is more likely for users who are not

“typical” web users to flag out flaws that are not apparent for “common” users.

Conclusion

The study described in this paper presented the development of a manageable and robust set of guidelines for designing and evaluating ageing-friendly web sites. The guidelines were supported by published literature and had been exposed to several stages of expert and user validations, which should provide some assurance of their validity to their prospective users.

There are inevitably some limitations of the present study. For example, the guidelines address issues related to how to make the user-interface of web sites accessible to older persons. It does not provide guidelines related to motivating or training older persons to use the web in the first place. These issues, although crucial in web usage by older persons, are outside the scope of this study.

The first follow-up study is to hand-in this set of guidelines to web designers to ensure their understanding and to seek suggestions on how to phrase the guidelines in a way more easily comprehensible by web designers.

A comparison study of evaluations using the proposed guidelines and other existing guidelines with a range of web sites targeted for older people would further confirm the usefulness of this set of guidelines. Another possible extension to this study is to compare web sites designed with and without adherence to the proposed guidelines to investigate the effect of implementing these guidelines for ensuring the accessibility and usability of web sites for older users. It will be also interesting to investigate whether adopting these guidelines improves the usability of the web sites for everyone (not just older persons), in line with the universal design principle.

There is a need to further ensure that the guidelines, once published, remain vital and in use by designers. This issue is currently addressed through the development of a tool that can guide web developers in applying the guidelines. One possible scenario would be for this tool to provide examples of good and bad practices for each guideline. This will be particularly helpful for novice designers or designers who are not aware of the needs of older web users. The tool could also automatically test some of the guidelines.

It is planned to release regular revisions to the guidelines, and the proposed tool could provide a user-friendly facility for automatic updating of the guidelines database.

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