

Industry attitudes and behaviour towards web
accessibility in general and age-related change in
particular and the validation of a virtual third-age
simulator for web accessibility training for students and
professionals

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Abstract

While the need for web accessibility for people with disabilities is widely accepted, the same visibility does not apply to the accessibility needs of older adults. This research initially explored developer behaviour in terms of how they presented accessibility on their websites as well as their own accessibility practices in terms of presentation of accessibility statements, the mention of accessibility as a selling point to potential clients and homepage accessibility of company websites. Following from this starting point the research focused in on web accessibility for ageing in particular.

A questionnaire was developed to explore the differences between developer views of general accessibility and accessibility for older people. The questionnaire findings indicated that ageing is not seen as an accessibility issue by a majority of developers. Awareness of ageing accessibility documentation was also very low, highlighting the need for raising awareness of accessibility practices for ageing.

Current age-related documentation developed by the Web Accessibility Initiative was then examined and critiqued. The findings show a tension between the machine-centric Web Content Accessibility Guidelines 2.0 (WCAG 2.0) and the needs of older people. Examination of guidelines when compared to research-derived findings reveal that the Assistive Technology (AT) centric structure of the documentation does not appropriately highlight accessibility practices in a context that matches the observed behaviour of older people. The documentation also fails to appropriately address the psycho-social ramifications of how older people choose to interact with technology as well as how they identify themselves in relation to any conditions they have which may be considered disabling.

The need for a novel, engaging and awareness-raising tool resulted in the development of what is essentially a "Virtual third-age simulator". This ageing simulator is the first to combine multiple impairments in an active simulation and uses eye-tracking technology to increase the fidelity of conditions resulting in

partial sightedness. It also allows for developers to view their own web content in addition to the lessons provided using the simulations presented in the software. The simulator was then validated in terms of its ability to raise awareness as well as its ability to affect web industry professionals' intentions towards accessible practices that benefit older people.

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1. Introduction

The demographic of the World's population is changing with the over sixties rapidly increasing as a percentage of population. As people work longer and society becomes more enmeshed in technology, it is crucial that older people remain able to use technology in order to work and live independently. However, there is very real concern that as people age, they will become disengaged from technology as a result of the ageing process (UK Cabinet Office 2004, Damodaran, Olphert 2010). While the need for web accessibility for people with disabilities is widely understood, it is often still lacking in practice despite legal requirements and developer and designer commitment to accessible development. Standards bodies such as the W3C (World Wide Web Consortium) and the BSI Group (British Standards Institution) affirm that older people have accessibility needs as a result of age-related capability change. These organisations also offer guidance both in their main guidelines as well as in supporting initiatives such as the WAI-AGE Project (Web Accessibility Initiative), however, these supporting documents are unnoticed by many working in industry.

Exacerbating the low profile of ageing as a barrier to accessing the web, is the nature of WCAG 2.0 (Web Content Accessibility Guidelines) which focuses on integrating Assistive Technologies (ATs) such as screen readers at the highest (A) level. Additionally the guidelines are often working in isolation – meeting the needs of one access barrier rather than barriers created by multiple impairments which is often more the experience of people experiencing age-related capability change. Older people also rarely use ATs, either due to a lack of awareness or the steep learning curve associated with leveraging such technologies as well as sociological factors that will be explored in the literature review. Additionally, the elements of the guidelines that are generally more useful to older people such as contrast settings, link purpose and visual presentation have a lower priority and risk being overlooked by designers and developers pressured to meet deadline and budget requirements.

It is imperative to bring the discussion of web accessibility for older people into a position of higher prominence. While the need for accessible design is accepted within the accessibility community and standards bodies alike there is currently a gap concerning mainstream industry views and practices towards ageing and accessibility. Similarly a gap of how to address the lack of awareness of the accessibility needs of older people in industry exists. This thesis explores the state of current developer practice and attitudes to web accessibility in general and for older people in particular and presents a simulator aimed at first raising awareness among students and professionals and then teaching students and training web professionals alike about the accessibility needs of older people. The thesis statement informing the following research is that simulation is an effective medium for an awareness-raising and teaching tool for highlighting the need for accessible design of older people for web professionals and students alike. In support of the above, four main questions are explored in the following document:

1. Are there differences between web development companies' publicly-stated attitudes regarding accessibility and actual practice?
2. How is accessibility in general and for older adults in particular viewed by web developers?
3. How useful are WCAG 2.0 guidelines for developers with regard to ageing?
4. How can knowledge of web accessibility barriers and design techniques benefitting older people be increased?

The exploration of these questions provide context and justification of the need for specialised training and awareness raising of the accessibility needs of older people that is presented in the thesis statement.

The remainder of the thesis is broken down as follows:

Chapter 2

Chapter 2 explores the current state of research with regard to web accessibility practices, guidelines and accessibility challenges in general and for older people specifically. A survey of existing developer accessibility tools and aids is also presented. Age-related changes affecting access to the web are discussed and the

current state of research regarding meeting such needs is surveyed. Finally, methods for teaching accessible design for ageing and the case for multi-media and simulation-based methods for teaching and awareness-raising are presented both in general and in specific to older people.

Chapter 3

Chapter 3 examines the first of the research questions, namely the development practices of developers, in particular, whether development companies see accessibility as a selling point, whether their stated commitment to accessibility affects the accessibility of their own homepages and whether conformance icons and accessibility statements have any effect on the accessibility of their homepages. The following hypotheses are presented and analysed in this chapter:

H1: The presence of the mention of accessibility as a selling point on the developer site will increase the accessibility (that can be checked with automated tools) of the site.

H2: The presence of an accessibility statement will increase the accessibility (that can be checked with automated tools) of the homepage.

This contribution to knowledge presented in this chapter is accomplished by a survey of 100 company homepages in terms of their compliance with accessibility standards as well as examining whether companies mentioned accessibility as a provided service or as part of their company ethos.

Chapter 4

Chapter 4 builds on the picture of web accessibility practices and contributes to knowledge by examining the second of the research questions through a questionnaire study of developers about their attitudes toward accessibility and ageing. The questionnaire examined the following areas:

1. Whether industry professionals view general accessibility guidelines as relevant.
2. Whether industry professionals are aware of accessibility guidelines for older people.
3. Whether industry professionals view ageing in terms of accessibility.

In support of the questions above, five hypotheses are presented and analysed in this chapter:

H1: Experience will increase the likelihood that professionals view ageing as an accessibility issue.

H2: Age will increase the likelihood that professionals view ageing as an accessibility issue.

H3: Experience will increase the awareness of age-specific guidelines.

H4: Job role affects the perception of ageing as an accessibility issue (i.e. front line vs. project management).

H5: Gender affects the perception of ageing as an accessibility issue.

The level of awareness of age-specific guidelines is also explored.

Chapter 5

Chapter 5 examines the third research question regarding the usefulness of WCAG 2.0 guidelines for developers with regard to ageing and critiques the current state of accessibility guidelines (WCAG 2.0) in terms of how ageing is presented as an accessibility barrier within the structure of the guidelines and how this contributes to the lack of awareness to accessibility for ageing. The guidelines most pertinent to the accessibility needs of older people tend to be obscured due to their placement at level AA or AAA meaning that they risk being overlooked by developers aiming to meet Level A (the lowest level of conformance) by their placement within the level system. The guidelines are examined in turn with the accessibility needs of older people in mind and recommendations of their Level of importance relative to the needs of older people are presented.

Chapter 6

Chapter 6 takes the results of the previous three chapters and presents the justification of the methodology of a learning platform highlighting the needs of older people and describes the simulator developed in order to answer the fourth research question regarding how knowledge of web accessibility barriers and design techniques benefitting older people can be increased. The chapter also

presents a solution to the need to re-prioritise the accessibility requirements for older people presented in Chapter 5 so that they are not obscured by the guidelines in the form of the lesson content of the simulator. The level of the educational content is also discussed and takes into account information gathered in chapter 4 concerning the need to target project managers in particular for awareness-raising. As a result of the need to provide generalised content as well as the need to prioritise awareness-raising, simulation is presented as the best medium for meeting these objectives.

The architecture of the simulator along with the novel use of eye-tracking for simulation of visual impairment is presented. Each simulation is explained in detail.

Chapter 7

Chapter 7 presents the validation methodology of the software in terms of simulation fidelity. The validation involved four doctors and a teacher testing the software in turn using a think-aloud protocol. The responses of the medical professionals to the fidelity of the simulator as well as the identification of any other bugs or barriers are also presented, along with the changes made to the software developed in response to the validation.

Chapter 8

Chapter 8 presents the evaluation of the simulator in terms of its success in raising awareness of the accessibility needs of older people and examines the presented solution to the fourth research question concerning how knowledge of accessibility barriers affecting older people and design techniques can be increased. The methodology, design, implementation and results of the evaluation were examined in turn.

In particular, this chapter examines the following:

1. Do web professionals see web accessibility requirements as linked solely to the current generation?
2. How do web professionals rate their awareness of web accessibility for older adults?

In support of the two questions above, five hypotheses are presented and analysed in this chapter:

H1: Using the simulator can affect the attitude that accessibility for ageing is restricted to the current cohort of older people.

H2: Use of the simulator can raise the awareness that ageing can create accessibility barriers.

H3: Use of the simulator can raise awareness of age-specific good design practice.

H4: Use of the simulator can raise awareness of age-specific guidelines.

H5: Use of the simulator can increase confidence in implementing age-friendly websites.

The results are discussed and additional qualitative data is presented.

Chapter 9

Chapter 9 presents a final discussion of the results of the exploration of the four research questions that informed the thesis statement as well as possible avenues for future research are presented.

2. Background

2.1 Accessibility

The W3C defines accessibility as ensuring, "that people with disabilities can perceive, understand, navigate and interact with the Web, and that they can contribute to the Web" (Web Accessibility Initiative 2005a). Older people with changing capabilities are also seen as beneficiaries of accessibility practices and are included in the above definition (Web Accessibility Initiative 2005a).

Enshrined in the UN Charter of Human Rights is the right to "receive and impart information and ideas through any media and regardless of frontiers" (UN Commission on Human Rights 1948). While a wealth of guidelines and tools exist to help developers improve accessibility, compliance is still lacking even in government websites (Lazar et al. 2013, Nurmela, Pirhonen & Salminen 2013, Jaeger, Matteson 2009). This lack of accessibility has persisted at state level despite the creation of the UN Convention on the Rights of Persons with Disabilities which urges member states to take appropriate measures to identify and eliminate obstacles and barriers to accessibility (UN Web Services Section 2006).

The W3C has taken the lead on standards with the WAI (Web Accessibility Initiative) and since its creation in 1998, has introduced two sets of recommendations for web accessibility: the Web Content Accessibility Guidelines (WCAG 1.0) in 1999 and the WCAG 2.0 in 2008. The W3C has also issued guidelines targeting Developers of Authoring tools (ATAG 1.0) in 2000, User Agents (UAAG 1.0) in 2002 and is working on recommendations for Rich Internet Content (WAI-ARIA) (W3C - Web Accessibility Initiative 2011). The Web Accessibility code of Practice (BSI 8878), introduced in the UK in 2010 does not issue guidelines but provides information about how to commission accessible websites and gives steps on how to embed accessibility-focused processes in a project through the creation of accessibility "champions" who will consider accessibility throughout the life-cycle of a product from initial conception to post-launch maintenance (British Standards Institution 2010). The rationale for such an approach over guidelines is that accessibility needs

to be embedded within a process and occupy the context of the real world and as such, the emphasis is on the user experience rather than conformance to guidelines (Cooper et al. 2012).

Progress regarding state-level compliance has been made, particularly in developed countries in terms of introducing laws requiring compliance with web accessibility. In the UK, the Equality Act of 2010 requires that "reasonable adjustments" are made to ensure that services are provided to people with disabilities (legislation.gov.uk 2010). However, while the Equality Act extends beyond public-sector websites, "reasonable adjustments" for web accessibility is not defined leaving a great deal of room for interpretation. In the USA, Section 508 provides explicitly-stated structure by addressing electronic and information technologies specifically in law and providing guidelines (which are essentially a subset of the WCAG) for conformance (Section508.gov 1998). Unfortunately the legal obligation extends only to Federal Agencies and those companies under contract to such agencies. For American consumers, the 2010 Twenty-first Century Communications and Video Accessibility Act has created legal requirements to ensure captioning on the web as well as accessibility requirements for broadband users and Internet services built into smart phones (Open Congress 2010). In the EU, the European Commission is currently drafting the European Accessibility Act, which will include ICT (European Commission 2013). However, like Section 508, the European Accessibility Act is limited to public sector websites. While legislation has not eliminated inaccessible governmental websites, such measures have had a demonstrable impact on accessibility, and countries with anti-discrimination laws have government websites that are more accessible (Goodwin et al. 2011).

Organisations that provide support for people with disabilities also have a role in driving web accessibility by defining what is and what is not accessible as well as raising awareness of accessibility barriers faced by the people they work to support. In the UK, The Royal National Institute of Blind People (RNIB) provides guidance on accessible web design, accessibility testing, standards and also offers courses on

web accessibility (2013). The RNIB also works with companies by providing auditing and accreditation services (Royal National Institute of Blind People 2011). Similarly, Age UK provides freely-available research about web surfing habits of older people and the barriers they face (Age Concern 2009).

Unfortunately, standards bodies, legislation and the involvement of organisations that promote accessibility for people with disabilities have not eliminated such accessibility barriers. Such organisations have, however, provided the means to take legal recourse. RNIB took legal action against BMI Baby in 2012 for failing to provide an accessible booking service. The lawsuit resulted in BMI deciding to work with RNIB in an effort to settle the ongoing proceedings (Royal National Institute of Blind People 2012). Other cases have also been brought against companies in the United States where both CNN and Netflix have had lawsuits brought against them for failing to provide captions for all of their content (Egelko 2012, National Association of the Deaf 2012). Even though such challenges can bring positive change, the reactive nature of accessibility implementation in response to legal challenges underlines the continuing need for accessibility lobbying (Wentz, Jaeger & Lazar 2011). While some organisations have responded by creating separate accessible versions of their websites, Wentz et al. have argued that separate websites have reduced capabilities, time lags between launch of the inaccessible and accessible versions or worse still "accessibility upon request" and underline the persistence of inequality (2011). This concern has been borne out; a usability study of the Facebook mobile and desktop interfaces by blind screen reader users found that the more accessible mobile interface had fewer features than the desktop version (Wentz, Lazar 2011).

Compounding the problem is the trend for established websites to get worse over time with regard to the number of accessibility flaws. As sites continually update, accessibility errors not present in the original design appear on the site (Lazar, Greenidge 2006, Olalere, Lazar 2011). The addition of more complex, but aesthetically pleasing website components and rich content is also leading towards

increasing accessibility barriers (Hackett, Parmanto & Zeng 2005). This rush to embrace technological change may also have a greater negative effect on accessibility than can be offset by advocacy, training and support (Thompson 2009). More recent research found that while some accessibility indicators such as descriptive and relevant ALT tags for images had improved over time, keyboard navigation accessibility had declined and dynamic menus and Flash content have had a growing negative impact on accessibility (Thompson 2009). Even traditionally more compliant sectors such as universities are not exempt from accessibility failings with a survey of 100 universities around the world finding only two institutions with no detected Priority One-Three accessibility flaws and only 36 were free from Priority One (Must fix) errors (Kane et al. 2007).

While legislation and advocacy have helped, there is significant work remaining to ensure equal access for people with disabilities. In one Northern Ireland study, 85% of the 25 council homepages tested did not meet minimum accessibility standards (Paris 2006). In the United States a similar, but more recent study, of 100 government site homepages points to the persistence of the problem of inaccessibility. Over 90% of the pages tested had accessibility errors which were easily solvable, such as mislabelled forms, missing ALT tags, missing skip navigation and missing keyboard equivalents for mouse-over actions (Olalere, Lazar 2011). A recent Finnish study found similar results for Finnish ministry portals where none of the 108 pages tested conformed at Level A – WAI's minimum standard for accessibility (Nurmela, Pirhonen & Salminen 2013). Looking globally, a UN study found that while developed nations have fewer accessibility barriers than developing nations, all evaluated member states had accessibility barriers in government websites primarily relating to HTML errors (Goodwin et al. 2011).

As many countries lack legislation that extends beyond government websites, companies as a whole are less compliant, with fewer than 20% of American Fortune 100 homepages being free from Priority One (minimum standard) accessibility flaws (Loiacono 2004). Recent accessibility study figures do show improvement with

larger companies having fewer accessibility barriers present on their sites than reported in studies in 2004, however, over 40% of such organisations were still seen to be below an accepted threshold of accessibility (Lorca, Andréas & Martínez 2012). Ironically, a 2007 study found that among the 20% of the high street websites tested that had an accessibility statement, many of these statements themselves were difficult to find, or in other words, inaccessible (Parker 2007). So, even where the importance of accessibility is acknowledged, a separation between principle and practice still exists.

Longitudinal data also supports the continued inaccessibility of web content with only marginal improvement. A follow-up study of Canadian Universities found that the majority (over 70%) of universities tested still have WCAG 1.0 priority 1 errors. While that is a reduction from over 80% much improvement is still needed in order for these sites to comply with basic web accessibility guidelines (Zap, Montgomerie 2013). Similar results were seen on Maryland State government websites, where web page compliance had improved only slightly in the three years between analyses and most pages still had accessibility barriers (Lazar et al. 2013). Promisingly, more modern template pages had fewer accessibility errors present than non-template pages (Lazar et al. 2013). However, if these improvements were to continue at the same pace as demonstrated in the two studies above, years would pass before even a majority of sites would be accessible at the most basic WCAG 2.0 conformance Level A.

While these studies are targeted by institution type, the data can be generalised to create a picture of a still widely inaccessible web that has changed little from 2004 when Lazar found over 70% of websites examined in his study not conforming to the WCAG (Lazar, Dudley-Sponaugle & Greenidge 2004). In fact, a recent snapshot of the 1000 most popular websites (as determined by Alexa.com) found that WCAG 2.0 conformance errors were present in 95% of websites with missing ALT tags and labels for forms being the most common errors (de Santana, de Paula 2013). Even where companies have accessibility statements and a stated aim to conform to

guidelines, these guidelines appear to be only partially understood. For example, the Ebay accessibility statement, which is buried in an Ebay Inc. page rather than the main ebay.co.uk site (eBay Inc 2013a), discusses commitment to accessibility for all and cites accessibility to pertain to vision, hearing and impairments relating to dexterity. While the stated commitment appears to be comprehensive, the help page for accessing Ebay has information pertinent only to screen reader users (eBay Inc 2013b).

2.1.1 Developer practice

If legislation and guidelines have not been effective in changing organisational behaviour, what then is the state of accessibility practice and attitudes at the level of individual developers and other web professionals? As the people at the sharp-end of website production, developers and designers are often responsible for ensuring accessibility is a part of the final 'product' (Lazar, Dudley-Sponaugle & Greenidge 2004). While testing is quite common among both professional and informal developers, one survey found that most professional testing appears to be casual, with accessibility (mean on a five-point Likert scale of 2.75) ranking below usability (mean 4.33) and cross-platform compatibility (mean 3.75) as a priority (Rosson, Ballin & Rode 2005). Even for IBM developers with experience of accessibility, designing, testing and finding workarounds were seen as the most difficult aspects of accessibility with testing seen the most time-consuming aspect of accessibility (Trewin et al. 2010) which could potentially lead to accessibility simply being ignored even where there is awareness. Unfortunately, recent research about developer attitudes in developed nations is sparse, leaving a gap for updated research on developer attitudes.

There also appears to be a disconnect between awareness of accessibility guidelines and practice. One Brazilian study found that while 45% of web-related professionals were aware of screen readers for blind users, they had no knowledge of how to make web pages compatible with such technology (Freire, Russo & Fortes 2008). Similar findings were made in South Africa, where although 83% of

developers surveyed in one study agreed with the importance of accessibility for people with visual impairments and blindness, 63% of respondents of the same survey did not believe that their own websites were accessible for the visually impaired (Venter, Lotriet 2009). Another study found that 67% of Ugandan developer respondents reported a lack of awareness of Accessibility Guidelines (Baguma et al. 2007). Lazar found similar inconsistencies in his survey, with a majority of American respondents, finding that of 138 developer respondents who said they were familiar with software tools for accessibility checking, only 98 indicated that their web site was accessible (2004). Similar findings have been reported elsewhere: the Disability Rights Commission Formal Investigation (2004) found that of SMEs (Small to Medium Enterprises) only 29% took accessibility "into account" while building a website although 69% were "aware of accessibility as an issue". Although this gap is much smaller in large organisations, 97% acknowledged awareness of accessibility as an issue with 68% taking accessibility into account during a build, there still remains a significant number of large organisations that did not to take accessibility into account (Disability Rights Commission 2004). Crucially, developers themselves have indicated a need for more education about accessibility with a recent stakeholder survey finding 85% of developers wanting more advanced accessibility training with many wanting more information about the functional limitations of disabilities and the use of assistive devices (Lopes, Van Isacker & Carriço 2010). Organisational change with regards to web accessibility does not come easy. A study of the webmaster attitudes to the implementation of Section 508 on American e-government sites found that most sites did not conform to Section 508 and that managerial attitude to Section 508 compliance was very important in determining whether attempts to make sites accessible were actually made (Jaeger, Matteson 2009).

2.1.2 Developer tools and guidelines

Where developers are aware of guidelines and are willing to create accessible sites, what tools are available to help them? There are a number of freely available tools designed to aid developers in creating standards-compliant web sites. Validators

for Hypertext Markup Language and Cascading Style Sheets (i.e. HTML and CSS) are common and allow for automated validation of mark-up compliance (World Wide Web Consortium 2009, World Wide Web Consortium 2012a) on which many assistive technologies rely. A number of tools validate against Web Content Accessibility Guidelines 1.0 and 2.0 such as AChecker, Fujitsu's Web Accessibility Inspector, Eval Access, Webaim's WAVE, Cynthia Says and TAW (Universidad del Pais Vasco , WebAim , Fujitsu 2008, AChecker 2011, Fundación CTIC 2010). A growing number of browser-based tools are also available such as the Web Accessibility Toolbar (WAT) for Internet Explorer (The Paciello Group 2012) and the Accessibility Evaluation Toolbar for Firefox (Gunderson 2011). Because standards evolve and often need to accommodate emerging technologies and techniques, some tools seek to be able to adapt quickly to such changing standards. For example, MAGENTA is an Extensible tool built to accommodate multiple guidelines and supports modification by developers using an XML-based language (Leporini, Paternò & Scorcio 2006). However, understanding the impact of specific barriers on end users is not straightforward and the problems inherent in counting the number of errors as an indication of the accessibility of a webpage has been raised (Parmanto, Zeng 2005). The Web Accessibility Barrier score addresses this problem by applying a metric that utilises a weighting to guideline errors that can be checked by automated tools (Parmanto, Zeng 2005). Web Accessibility validators have also been evolving in terms of the usefulness of the output to developers. AChecker expanded on previous tools by providing information on "Likely Problems" such as very short ALT tags rather than only reporting when such tags were empty or missing, as well as identifying "Potential Problems" which are barriers flagged for manual checking as they cannot be checked using automation (Gay, Li 2010). The proposed QualWeb tool seeks to provide automated test interactions with Rich Internet Applications (RIAs) as well as enact repairs (Fernandes 2013).

Barrier-specific tools also exist such as those that check the readability of a website in terms of the difficulty of the reading level (Juicy Studio 2011) or how content would appear to a text browser user (Yellowpipe Internet Services 2007).

Other tools visually simulate how a webpage would appear to someone with a visual disability such as macular degeneration, glaucoma (Web Aim 2001) or colour blindness (Vischeck 2008), in order to better communicate user accessibility requirements to developers. These simulations sometimes also have a task component to put developers in touch with the impact that their design choices have on users with a single visual or motor impairment (Immersion Active). Some tools, such as aDesigner, combine accessibility compliance with a simulation/visualisation component to provide designers with information about how a person using a screen reader would experience a page (Takagi et al. 2003).

While validation tools do aid designers, they are often limited in terms of scope, and developers have experienced difficulty with the validation of rich content such as Flash, the time needed to test content as well as problems interpreting errors and ambiguous validator output (Trewin et al. 2010). Tools can also be misleading both in production of false positives flagging non-existent errors as well as false negatives missing out real accessibility errors (Brajnik 2004). An evaluation of the Eval Access tool observed that when the tool was upgraded using WCAG 2.0 guidelines (which allows for more automated testing than WCAG 1.0) conflicting results regarding the improvement of WCAG 2.0 validation over WCAG 1.0 was presented. The results of the study reported that while there were fewer false positives in number using the fully automated WCAG 2.0 version, there was a higher percentage of wrongly detected issues (Aizpurua et al. 2011). There is concern that reliance on automated validation tools to provide a full picture webpage accessibility also leads to barriers being missed, as not all tests for accessibility can be automated. Even where checks for compliance can be automated, the accuracy of such tests is questionable. A study of several popular

tools found that such automated validators miss between 50 and 77% of success criteria when reporting true violations (Vigo, Brown & Conway 2013).

Even when webpages are manually checked for accessibility, problems identifying barriers exist. Accessibility is rich and nuanced and it is very difficult to treat a site as either accessible or inaccessible especially when even comparisons between accessibility metrics can vary widely (Brajnik 2011). Even when the WCAG or similar guidelines are used, information on how best to apply the tools, techniques and standards offered by such guidelines are not comprehensive and often hard to find (Ojalere, Lazar 2011). Manual checking of pages against guidelines is unlikely to be significantly useful for beginners, with fewer than a third of guideline errors identified by students participating in one experiment reaching a group consensus of 80% leaving the majority of guidelines as not reliably testable by novices (Alonso et al. 2010). Brajnik et al. found that expertise in accessibility matters. A study involving a Barrier Walkthrough with non-expert participants found that these non-experts missed nearly half of the problems on a website compared to the 70% success rate for the skilled testers (2011a). Even the use of experts is no guarantee that guidelines will be interpreted in a predictable way, as experts in another experiment were unable to reach a consensus on conformance to WCAG 2.0 guidelines (Brajnik 2011).

In response to the issue of abstract guidelines and the difficulty faced by developers concerning implementation, some researchers have sought to refine and contextualise the process of presenting information about accessibility. Efforts have been made to create a framework to filter guidelines according to disability type, web-page component type, the role of the guideline-user, and the guideline structure (Baguma et al. 2009). Other developments for guideline presentation include The Barrier Walkthrough which allows guidelines to be applied to different user categories (Brajnik, Yesilada & Harper 2011b). Guidelines have even been eschewed in favour of an approach to accessibility which includes recognising the importance of context in accessible development, de-emphasis of automated

accessibility checking, increasing Web Accessibility Initiative (WAI) education and creating a user-centred stakeholder model (Kelly et al. 2009, Kelly et al. 2007).

In response to the difficulty faced by developers who are non-expert in web accessibility, a number of companies now offer web accessibility auditing services and training such as the Paciello Group and AbilityNet (AbilityNet 2013). WebAim even offers to provide certification for free, providing all compliance issues discovered are resolved (Web Accessibility in Mind 2013).

Beyond the issues inherent in validation and accessibility tools is the simple fact that many developers do not use these tools in testing at all. Rossen et al. found that both informal and professional developers were primarily concerned with browser compatibility rather than standards or accessibility (2005). While testing with a number of browsers is important in terms of both functionality and layout, it has been suggested that tolerant browsers that render incorrectly formed HTML in a visually pleasing format leave the designer unwilling to improve upon invalid markup and thus compound the problem by not encouraging compliance to standards (Chen, Hong & Shen 2005).

Interestingly, with recent legislative changes in the UK requiring accessible web presences, there is no published information on developer views in terms of accessibility as a selling point to clients wishing to conform to these new laws, or their own conformance to such practices on their own websites. There is a gap in knowledge as there is no recent published data of guideline awareness and use among web professionals in the developed world.

2.1.3 Changing developer habits, challenges and opportunities

How then to 'sell' accessibility if legislation, economic arguments and basic awareness have not cured the web of inaccessibility in even the largest, most well-financed of sites? Developers themselves report that it is difficult to convince both clients and their management of the importance of accessibility (Lazar, Dudley-Sponaule & Greenidge 2004). General awareness-raising and education are promising approaches. A small study of web professionals points to education, not

only as a means of training, but also as a method of exposing professionals to peers experiencing similar challenges. The results pointed to self-reported greater knowledge of web accessibility as well as an appreciation of the course offered (Wood, Hollier 2013). An educational tool that breaks down complex guidelines by prioritising guidelines for a selected disability for novice auditors also exist (Bailey, Pearson 2010), however it is aimed at an audience already committed to web accessibility.

Creative approaches to appeal to developers have met with some success. The UTOPIA Project (Usable Technology for Older People: Inclusive and Appropriate) commissioned three dramas using actors that showed an amalgamation of actual experiences of older people such as buying a webcam (2004). The videos were successful in changing the attitudes of both undergraduates, and to lesser extent Human Computer Interaction (HCI) professionals, about the accessibility of interfaces, as well as their attitudes towards older people's use of technology (Carmichael, Newell & Morgan 2007). Other videos from the related "Requirements gathering for an inclusive digital economy" project had similar aims and methodologies for raising developer awareness to the experiences of older people by highlighting these experiences in a series of videos (Inclusive Digital Economy Network 2009). A theatre version of similarly-themed dramas with actors in roles of older people available to take questions from the audience about their experiences was also piloted. Over 85% of respondents agreed with the importance of highlighting accessibility issues and the use of the theatre format as a means of raising awareness (Morgan et al. 2008).

Even with the success of education in terms of raising awareness, the problem of accessible website development still persists as demonstrated in section 2.1.2. How then to raise awareness of accessibility for ageing that will reach a wider audience than theatre and the accompanying videos as well as provide simple, cost-effective advice regarding some of the most pervasive access barriers?

2.2 Ageing

Individuals experience the effects of ageing at different rates, and as a result, the capabilities of older users will have an even greater variability in terms of the severity and timing of age-related decline (Mynatt, Essa & Rogers 2000). It is this variety, inter-relation, and overall complexity of age-related capability decline that creates a unique challenge and designers and developers themselves need to be made aware of design patterns that aid older users (Zajicek 2004). Additions of minor impairments to a particular major impairment or a number of minor impairments in an older person can render 'mainstream' assistive technology solutions unusable (Newell 2008). While a subset of the WCAG 2.0 Guidelines has also been developed to apply to older users (Web Accessibility Initiative 2010) as well as an in-depth literature review of research-derived guidelines (Web Accessibility Initiative: Ageing Education and Harmonisation 2008), it is likely that these will have even less impact than the general guidelines. A gap regarding knowledge of industry awareness of and views on ageing as an accessibility issue and whether they are aware of age-specific guidelines exists. A review of the literature regarding age-related capability change and accessibility for older people is outlined in the following sections.

2.2.1 Cognitive changes

While the effects of ageing vary from person to person, certain changes do take place over the course of a person's life that affect their ability to use technology. In the cognitive domain, fluid intelligence, which includes processing speed and working memory (what was once called short-term memory) peaks in a person's mid-20s, at which point it starts to slowly decline and by an individual's mid-sixties it may be possible to detect sharp declines in such abilities (Shoemaker 2003). In terms of technology use, a decline in fluid intelligence can result in people losing their location or experiencing navigational difficulties in websites or interfaces resulting in longer searches and greater incidences of returning to homepages than younger users (Chadwick-Dias, McNulty & Tullis 2002, Meyer et al. 1997). For some people with declining abilities, problems with interpreting information is apparent,

with visual clutter and extraneous information impeding their ability to navigate a webpage successfully (Zaphiris, Ghiawadwala & Mughal 2005, Hanson, Richards 2005). Clearly defined links using terminology like "click here to" help older people in terms of understanding what information they were accessing (Sayago, Camacho & Blat 2009). Similarly, difficulties in attention and in discerning relevant information from distracting stimuli also become more apparent with age (Hawthorn 2000, Kotary, Hoyer 1995, Connelly, Hasher 1993). Attention difficulties have been observed "in the wild" too. Participants in one large-scale ethnographic email study reported feeling overwhelmed by the number of features available and would have preferred a simpler system (Sayago, Blat 2010). Difficulties remembering steps relating to a task as well as problems understanding technical words also impeded access to the Web (Sayago, Blat 2009). A synthesis of data found that working memory (fluid intelligence) and perceptual speed are very important for computer-based information search and retrieval tasks (Czaja, Lee 2007). Other cognitive barriers such as slower task completion times (Wirtz, Jakobs & Ziefle 2009, Chadwick-Dias, McNulty & Tullis 2002) and window and tab management have also been noted as age-related challenges (Chadwick-Dias, McNulty & Tullis 2002).

As older users experience a decline in their ability to process information, good interface design is crucial for the easy adoption of new technology. In terms of design, most techniques that aid cognition benefit all users and include keeping text readable, navigable and predictable (Morrell 2005). Design guidance for older users who experience difficulties with technology includes interface simplification, reduction of clutter and jargon, and clear, simple navigation paths (Dickinson et al. 2005, Web Accessibility Initiative 2010).

Even where older people are not seriously cognitively impaired, there are enough cognitive differences caused by the natural course of ageing to fluid intelligence to argue that older people are not "typical users" (Gregor, Dickinson 2007). Similarly, medicines can have an effect on cognition (Gregor, Dickinson 2007). For example,

"Chemo brain" is a well-known side-effect to chemotherapy and results in memory lapses, reduction in processing speeds and trouble concentrating (American Cancer Society 2013). Bearing in mind that over a third of people in the UK are projected to suffer from cancer at some time in their lives, and that the majority of cancers occur in the over-sixties (Cancer Research UK 2012) combined with the reality that chemotherapy is the treatment for many types of cancers, the number of people potentially affected by side-effects brought about by even this single medical treatment is significant.

Cognitive changes can also have a knock-on effect on accessibility in a non-cognitive manner. An ethnographic study of older people found that while participants were aware of accessibility features that changed size or magnified text to help with vision decline, the additional cognitive load caused by these features moving content off-screen or to a different position prompted users to simply get closer to the screen or to put on reading glasses rather than employ the accessibility features (Sayago, Blat 2011). Older people often had conscious knowledge that the effect of being rushed caused them to make more mistakes making them less efficient in their tasks and this caused them to use deliberate slowness as an error-reduction strategy (Sayago, Blat 2011).

Age, however, is a double-edged sword and experience does count. When presented with ill-defined tasks, older users fare better than younger people in terms of successful searches by using knowledge-driven (crystallised intelligence, or "wisdom") approaches (Chin, Fu & Kannampallil 2009). However, by using a different cognitive strategy than younger users, older users have demonstrably different browsing patterns (Fairweather 2008). Differing browsing strategies based on age is disputed, however, with a recent study of how older and younger people carried out an online search, observing that while older people failed to complete the task more often due to a time limit, there was little evidence that older adults employed a different search strategy (Trewin et al. 2012). Regardless, older people do score higher than young people in terms of crystallised intelligence

which comprises general knowledge, vocabulary, formal reasoning and experience (Horn, Cattell 1967) and this type of intelligence does not decline with normal ageing.

2.2.2 Motor changes

Difficulty using input devices also increases as an individual ages. In terms of motor coordination, in order to avoid transmission errors of movement signal to their muscles, older adults generally need to perform mouse-related tasks more slowly than younger people (Chaparro et al. 1999). Problems with tasks such as dragging and dropping and double-clicking the mouse and other fast repetitive motions are also related to ageing (Kurniawan et al. 2006, Hanson, Crayne 2005). Selection of text is also a difficult mouse-related task for older people with short physical movement of the mouse resulting in quite large movements of the cursor onscreen (Sayago, Blat 2009). Significantly, while keyboard navigation allowed older people to overcome a number of barriers faced by mouse use, their preference was to continue to use the mouse "as-is" without changing mouse settings or relying on the keyboard, as they wish to be like everyone else and not give the impression that they are frail or needing special attention (Sayago, Blat 2009). Complex motor tasks such as "walking menus" are similarly problematic as such design elements require sub-movements that can cause difficulty for the older user due to their slower response times for such movements (Kurniawan et al. 2006). The difference of mouse-movement speed is pronounced between older and younger populations and has an effect on target acquisition. Older people have a peak velocity of mouse movement 30% to 70% slower than the younger cohort and cover 10% to 70% less distance with the mouse (Hanson 2011, Ketcham, Stelmach 2004). Furthermore, the pattern of mouse movement was different as while younger people accelerate and decelerate the mouse for roughly the same amount of time, older people spend much more of their effort slowing the mouse down (Ketcham, Stelmach 2004, Keates, Trewin 2005). Overall movement consistency is also more variable in the older population and older adults often need to balance the demands of speed with those of accuracy (Ketcham, Stelmach 2004). Pointing and clicking can be

equally frustrating for older users who may have difficulty moving the mouse smoothly (Nielsen 2002, Zaphiris, Ghiawadwala & Mughal 2005).

Even with the ongoing paradigm shift to multi-touch, direct interaction does not fully alleviate barriers caused by motor skill decline. One study of multi-touch surface computing found that older users were successful (although much slower than younger people) at selecting, drawing and resizing on the large screen. They did however, have difficulty rotating onscreen objects (Piper, Campbell & Hollan 2010). In particular, the use of a finger as an input device caused unintentional touching by fingers not actively used in selecting items. This resulted in unexpected image movement and was more problematic for people with tremor (Piper, Campbell & Hollan 2010). A comparison of interaction with the iPad and iPod Touch found that older people had difficulty tapping small targets and had difficulty with parallax and the crudity of the finger as an input device in terms of its relatively large size, which resulted in selecting other keyboard items on the touch screen. Older people also preferred drag and pinch over tapping (Kobayashi et al. 2011). Timing taps onscreen was also a problem for some older people using touch screen interaction and contradictory to the Piper study, participants found the need to sustain pressure for dragging operations demanding (Leonardi et al. 2010).

Larger scale skeleto-muscular changes can also affect Internet use by affecting the length of time people use a computer before stopping due to back and neck pain (Yao et al. 2009). One accessibility barrier can also lead to another, for example, the decline in visual acuity has potential ergonomic side-effects of shoulder and neck pain caused by the user adopting an uncomfortable position while using the computer to compensate for the vision changes (Hanson, Richards 2005).

Considering the preference to adopting uncomfortable positions as evidenced in Sayago's study over using accessibility options, capability change resulting from ageing is not going to be easily solved by assistive technologies.

2.2.3 Sensory changes

Sensory deterioration can be experienced from 40 years of age. Visual acuity and the ability to focus decline and may require the use of corrective lenses from this time (Hawthorn 2000). Other visual changes include a decline of contrast discrimination and colour perception which can hamper the ease of use of technology with complicated visual design and colour use (Hanson, Richards 2005). This contrast decline is part of natural ageing, but the extent of the change is significant. A 60 year old receives only 40% of the light that a 20 year old would in the same lighting (Lighthouse International 1999). This change continues into old age with an 80 year old experiencing up to an 83% reduction in their contrast sensitivity (EveryEye 2004). In terms of sight loss, one in five people aged 75 and over have some degree of sight loss rising to one in two for people over the age of 90 (Royal National Institute for the Blind 2010). The social cost of vision impairment and blindness is stark; the RNIB reported that older people with sight loss are three times more likely to suffer from depression than their unaffected peers (Royal National Institute for the Blind 2010). Age-related macular degeneration (AMD) is the leading cause of blindness, with an estimated 14% of 70-79 year olds having intermediate to advanced AMD in the United States (BrightFocus Foundation 2013). Other age-related visual impairments such as glaucoma, cataracts and diabetic retinopathy also increase with age (Royal National Institute for the Blind 2010).

In terms of how these changes affect the accessibility of websites, older people express a preference for larger text sizes compared to younger people, but at least one study found that while older people took longer to complete a task there was no significant effect of change of text size between older and younger populations on successful task completion. However, the study disregarded the importance of preference, and the fact that none of the participants was reported to have age-related visual diseases (Chadwick-Dias, McNulty & Tullis 2002). Other research has pointed towards 14 point font being preferred to 12 point by older people and that the change in text size supported faster reading (Bernard, Liao & Mills 2001). The

same study found that serif fonts (Times New Roman) were preferred less than sans-serif fonts, even though the serif font at 14 points supported the fastest reading (Bernard, Liao & Mills 2001). Morrell (2002) and Zajicek and Morrissey (2003), identified that changes to contrast vision also resulted in older people sometimes missing elements that are similarly coloured to the background of the page cited from (Chisnell, and Redish 2005). Czaja and Lee (2003) also observed that where contrast was low and disability glare (decline in contrast discrimination) was present, older people missed over six times the number of letters as younger people cited from (Chisnell, and Redish 2005). A recent study in China supports that problems accessing web content due to small fonts and poor contrast continue to be an accessibility barrier (Yao et al. 2009).

Hearing also declines as a result of ageing. Of the 10 million people in the UK with hearing loss, over six million are of retirement age and over 40% of over 50s have some degree of hearing loss rising to 70% of over 70s (Action on Hearing Loss). Tinnitus, or ringing ears, affects about 10% of the adult population (British Tinnitus Association 2012). Tinnitus is often an accompanying feature to noise-induced hearing loss at the higher end of the speech frequencies (British Tinnitus Association 2011). For non-captioned multimedia content, these barriers could prevent people from properly comprehending what they are watching or listening to as evidenced by recent lawsuits concerning captioned content presented in section 2.1.

2.3 Ageing and accessibility

While both BSI 8878 and the WCAG 2.0 include references to older people in their accessibility guidelines, this differs from the WCAG 1.0 where older people were not considered as a group with distinct accessibility requirements. Older people frequently differ from people who have a specific life-long disability in terms of their use of ATs. If the changes or diseases experienced are linked to age, many older people do not consider themselves to be "disabled", and are less likely to make use of assistive technologies built into operating systems and browsers even

when they are aware of them (Hanson 2009, Sayago, Blat 2011). Redundancy of existing skills is also a barrier to ICT use, as old skills become obsolete with the replacement of older technology (Damodaran, Olphert 2010). These factors, while not negating the importance of ATs, hint at a need to look at cost-effective, simple accessibility solutions through design rather than through the distribution of specific age-related assistive technologies. Compounding the problem is that the number of conditions people experience rises with age. A 2004 Department of Health survey has provided an insight into chronic conditions and ageing. For people over the age of 65:

- 55% reported chronic problems relating to legs, arms, hands, feet, back or neck
- 24% reported problems with hearing
- 14% reported difficulties in seeing that does not involve wearing glasses (Department of Health 2004).

The link between ageing and number of chronic conditions is also established with the average number of conditions experienced by people reporting chronic conditions rising from 1.3 for people aged 16-44 years to 1.8 in the over 75s (Department of Health 2004).

2.3.1 Accessibility guidelines and older people

Gregor and Newell divide the older population into 3 broad groups:

1. Fit older people who do not look or consider themselves disabled but have different needs than their younger selves
2. Frail older people with one or more disabilities as well as age-related decline
3. People growing older with a pre-existing disability not related to ageing (2001).

For normal ageing, while the individual barriers themselves may be small, it is the interaction of a number of minor impairments that lead to barriers that are problematic on several different levels (Milne et al. 2005). Indeed, it has been argued that multiple minor impairments can combine to create a functional deficit that is greater than the sum of its parts and that single impairment solutions may

not be appropriate in such cases (Gregor, Newell 2001). Data derived from a literature review of older people and HCI publications resulted in a new set of 38 research-derived guidelines with 11 categories which include graphics, links, navigation, search engine, colour and contrast, cognitive design and feedback (Zaphiris, Ghiawadwala & Mughal 2005, Kurniawan, Zaphiris 2005). Ethnographic research has allowed for the severity of specific accessibility barriers to be observed. The results of such observations highlights the importance of cognitive barriers over sight barriers as participants sought to lessen cognitive demands, and that icons were also seen to be less valuable than text to participants (Sayago, Blat 2011). The Web Accessibility Initiative (WAI-AGE) project identified a number of barriers that raised the cognitive demands on older users and include moving graphics and advertisements, cluttered and dense design as well as non-linear paths through links affecting comprehension (Arch 2009). The WAI has released documentation outlining how WCAG 2.0 applies to older users and provides information about appropriate text, contrast, navigation, multimedia presentation, layout, organisational structure and other barriers based on the WCAG 2.0 four principles of "Perceivable, Operable, Understandable and Robust"(POUR) (Web Accessibility Initiative 2010). While some of the guidelines are well understood and have a good research base, information regarding social issues for older people using the Internet is not fully understood (Arch 2009).

Similarly, guidelines may not acknowledge the barriers caused by growing up in a previous technological paradigm during an individuals' formative years, for example older adults born before 1950 have trouble with multi-layered interfaces favoured today (Lim 2010). Lack of confidence in using technology (Age Concern 2009, Gregor, Newell 2001) is also not considered by accessibility guidelines. Even within existing guidelines for accessibility, the needs of older people may not be completely emphasised with the existing general guidance. For example, Sayago et al's study of techniques in WCAG 2.0 found that older users preferred the "click here to" form of link to allow them to predict the outcome of clicking on a link (2009). As identifying the link's purpose currently has a priority of AAA (Web

Accessibility Initiative 2010) and is at the highest level of conformance (AAA) it is unlikely to be a high priority for developers even though the barrier itself is an important one for older people. An emphasis on simple language is similarly recommended for older users (Carpenter, Buday 2007), but again is listed as priority AAA by WCAG 2.0. There is also no explicit guidance or insight provided into how older people differ from younger people in how they interact with technology (Affonso de Lara et al. 2010) in terms of selective attention (Sayago, Guijarro & Blat 2010) and search strategies (Chin, Fu 2010).

Solutions to the current problems with WCAG 2.0 in terms of providing guidance on accessibility for older users have been raised. Brajnik et al. use an aggregation of accessibility barriers to create an "older users" category which allows content to be validated against multiple disabilities (2011b).

The question could be raised as to whether old people *need* to use the Internet. Technology is now so crucial to everyday life that not being able to use ICTs puts older adults at a very real disadvantage in terms of successfully performing everyday tasks and living independently (Cabinet Office 2005, Czaja et al. 2006). There is evidence to suggest that older people not engaged with technology are beginning to feel excluded and recognise that this exclusion is likely to grow over time if they continue to remain offline (Age Concern 2009). While Internet access is growing among older people, 42% of people over the age of 65 have never used the Internet (Office for National Statistics 2011a) and comprise two-thirds of the people who have never used the Internet (Office for National Statistics 2011b). Alarming, 48% percent of people who have never used the Internet are disabled (Office for National Statistics 2011b). As there appears to be a correlation between non-Internet use and disability, the reality of an increase in chronic conditions experienced as people age hints at a potential risk of people abandoning technology. Indeed ageing is cited as a risk factor in the medium to long-term for people becoming digitally disengaged (UK Cabinet Office 2004) and as such, it is

more important than ever to ensure that the accessibility needs of an ageing population are understood.

But what about raising knowledge of guidelines targeted at removing barriers for older people? A gap exists about how to address the ongoing issue of lack of knowledge of designers with regard to the complex needs of older users. Although the UTOPIA project has proved that narrative is an important way to reach developers and designers, there is no learning resource for developers and designers to be explicitly introduced to the complexities and interactions of accessibility barriers for older users or to allow developers to look at the effects of ageing in the context of their own work.

2.4 Teaching about accessibility for older people

What is the most effective means of teaching young people about ageing and accessibility? The learning needs of younger people are changing. Young adults are well informed and often better educated than their forebears and possess more individualistic and entitled personality traits compared with the pre-1970 population, leading to over-confidence in skills and a lower ability to empathise (Twenge 2009). Similarly, younger people are more likely to make use of rich media for their information needs, which while benefitting their visual intelligence, often has a cost of less time taken for reflection and critical thinking about what has been learned (Greenfield 2009). In Computer Science, students particularly rely on the computer as an interface for programming exercises rather than pseudo-code and design done offline, with these steps often implemented after the programming task if required by the lecturer (Ben-David Kolikant 2011). This creates yet another challenge for traditional educational methods, as written guidelines may not have relevance to many younger learners.

Technology is traditionally a male-dominated field and there is evidence to suggest that both men and women in technological roles have lower empathising scores than their non-technological counterparts (Hudson 2009). This lower empathising ability may be a barrier to understanding. Carmichael et al. found that

undergraduates were generally neutral about statements about older people's experience with technology (2007). In the light of such attitudes, it is difficult to put forward to young designers the importance of accessibility. In terms accessibility in Computer Science education, Dundee University has pioneered embedding accessibility education throughout the undergraduate level. Dundee not only uses exposure to issues pertaining to diversity and inclusion, but also real world design approaches with real projects presented by experts, the philosophy underpinning accessibility as well as projects that involve a number of diverse end-user representing a number of accessibility needs (Waller, Hanson & Sloan 2009). At Auburn University, the approach is to introduce students to best practice, ATs, accessibility tools as well as having students evaluate their own work using such tools (Youngblood 2013). First-hand lab-based accessibility experiences such as using a screen reader combined with actively critiquing available papers also increased knowledge of the complexity of accessibility and the ability to think critically about the topic (Carter, Fourney 2007). Using the screen reader also had the effect of introducing accessibility barriers that can only be perceived through the use of screen readers (Freire et al. 2007). Students also experience attitude changes where projects contain an explicit accessibility element (Poor et al. 2009). However, while these practices are successful where implemented, the reality for most computing students is that subjects involving accessible design for older or disabled users are mostly an add-on topic rather than an embedded part of the curriculum (Waller, Hanson & Sloan 2009).

With over 60% of people working in technology being under 45, with the under thirty-fives making up nearly 40% of the technology workforce (Begum 2004), many people who actually implement websites have not had the first-hand experience of ageing to inform their design choices and education at the undergraduate level is a promising route to addressing this lack of knowledge.

2.5 Empathy and media

Newell's approach of using narrative video is not unique. Film can be used to reinforce theory presented by other means as well as provide an experiential exercise that through the delivery of a metaphor for ideas, can create a lasting impression on the viewer (Champoux 1999). Medical professionals have used popular media for the purposes of eliciting empathy in students and has been found to be successful in terms of its use as a teaching strategy for eliciting empathy for the experiences of others (in the case of the study cited, emotional crises) when combined with guidance in the form of a structured review (Wilt et al. 1995).

2.6 Simulation and training

As research points to the current generation preferring rich media content to traditional learning resources, and that the use of ATs and simulation has the effect of raising awareness and helping students identify design barriers, simulation is a promising technique to explore in terms of raising awareness of age-related changes. Simulation has been used as a method for creating rich experiences for training purposes in a number of fields including the military, police, aviation and medicine. Simulation in aviation in particular, has a long-established history for training pilots to respond correctly to events in flight. In terms of ageing simulations, there is evidence in the medical field pointing to the success of ageing simulations in the "ageing game", a half-day workshop where students assume the identity of an older person who "develops" chronic conditions over the course of the simulation (Pacala, Boulton & Hepburn 2006). The game is over a decade old and has been well received by students and is seen to be successful as both an experiential learning and awareness raising tool and there is anecdotal qualitative evidence pointing to the experience remaining memorable to past students over time (Pacala, Boulton & Hepburn 2006). Similarly, understanding the feelings and needs of older people is also increased through the use of simulation during a fourth-year rotation in geriatrics, with a statistically significant change in attitudes pre- and post-simulation in regard to attitudes towards older people (Lorraine et al.

1998). Outside of medicine, empathic modelling is employed in the design field with techniques designed to emulate disabilities for user trials such as wearing gloves with buttons to emulate osteo-arthritis or putting Vaseline on glasses to simulate a number of vision impairments (European Design for All e-Accessibility Network, Ergonomics and Safety Research Institute) or even the utilisation of a full third-age suit developed to help car engineers understand limitations caused by ageing (theMatureMarket.com 2004) in use. What about using virtual simulation? The benefit of using virtual reality to increase knowledge of accessibility barriers has also been demonstrated with children being able to identify more physical accessibility barriers after using virtual reality software, which put them in a wheelchair and had them navigate a building, than the control group (Pivik et al. 2002). Indeed, as demonstrated earlier in this review, simulation has been a component of a number of tools designed to aid accessibility. Some simulation work has also been done to demonstrate the effect of individual impairments on the completion of web-based tasks (Papadopolous 2011). This work has expanded to create structured workshops to increase lecturer awareness of issues faced by disabled students and create accessible online learning resources (Papadopoulos, Pearson & Green 2008).

Simulation for awareness raising is not, however, without controversy. Ethically, it is important to ensure that participants are not coerced to take part, efforts are made to reduce the stress of participation and confidentiality of any participant response to a simulation should be ensured (Kiger 1992). There is also the criticism that the effect of disability simulations is poorly evaluated and a meta-analysis of studies does not show a quantitatively measurable effect, although this analysis is now over twenty years old and focuses on the goal of attitudinal change (Kiger 1992) rather than a means of providing insight into concrete solutions to accessibility barriers. Also acknowledged is the tension between attitude and behavioural change with behavioural change being difficult to measure in disability simulations (Kiger 1992) and therefore not well represented in the analysis. Similar

tensions between quantitative vs. qualitative data collection methodologies also exist with quantitative attitudinal data showing little pre-post-questionnaire score changes, but qualitative data supporting the meaningfulness of the practice (Kiger 1992). Another meta-study also found negligible effects for attitude change, however the study was limited by the lack of current research and a very narrow inclusion criterion involving only 10 studies, six of which are unpublished (Flower, Burns & Bottsford-Miller 2007). In spite of these critiques, disability simulations are used in education, based on time- and cost- effectiveness of the methodology and is supported by data in the realm of design. The Accessibility Experience Lab collected data from 1730 engineering students who took part in an accessibility workshop. Both quantitative and qualitative data supported that students learned about product design for disability as well as experiencing raised awareness of disability issues they had not previously encountered using simulation techniques (Jordan, Vanderheiden 2010). The concluding lecture also raised awareness of the prevalence of age-acquired disability in an activity where students selected an older person on the screen to represent themselves and had to sit when their person was selected to acquire an age-related condition – resulting in two-thirds of the students sitting by the end of the exercise (Jordan, Vanderheiden 2010). While simulation can be valuable in certain areas, in order for a simulation to be successful and effective, it is important that learning objectives are clearly stated and concrete examples show not only accessibility barriers, but also strategies for overcoming such barriers (Burgstahler, Doe 2004). Simulations should be constructed with the help of the people who the simulation is aiming to emulate, ensuring that the experience of the person undergoing the simulation is a valid one (Burgstahler, Doe 2004). Ageing is not a disability, but it does confer real changes in capability to an individual, however no study of the impact of simulation on attitudes and awareness about ageing and web accessibility in web students or professionals exists.

3. Behaviour and attitudes to web accessibility in industry

This chapter is based on the Conference paper: "Guidelines, Icons and Marketable Skills: An Accessibility Evaluation of 100 Web Development Company Homepages" in W4A '12: International Cross-Disciplinary Conference on Web Accessibility. <http://dl.acm.org/citation.cfm?doid=2207016.2207024>

Web development company websites provide the best opportunity for firms to showcase their talents and sell their skills. Very little is understood about developer opinion of accessibility in terms of its worth to clients. This chapter presents the results of a study conducted in late 2011 of web developer homepages and their stated attitudes towards accessibility.

3.1 Evaluation of 100 web development company homepages – introduction

How accessible are the websites of companies selling web development services?

From this question, three main avenues of investigation arose concerning accessibility and conformance icons:

1. Do web development companies view accessibility as a selling point?
2. Does the mention of accessibility on a developers' site have an effect on the accessibility of their own site?
3. Do the presence of conformance icons and accessibility statements have any bearing on the accessibility of the website?

One hundred homepages of UK Web Development Companies' homepages were examined. Companies were selected using Google as it is the most likely search engine used by potential clients. The search term used was "web development" and name of a geographical area or city. UK cities and geographical areas were chosen to cover as large an area as possible in terms of both size and population. Areas were divided into regions in order to emulate the probable search strategy of people wishing to procure local services as well as allowing for the coverage across

the country in general in emulation of expected search user behaviour. Four regions/cities were chosen and the top 25 Google search results were examined from each of the four regions. The number 25 also covers approximately two and a half pages of Google search results, which similarly emulates searcher behaviour in terms of how many pages of search results people view as valuable. The selection of areas as well as the number of returned results included in each of the four samples was made to provide a wide variety of companies ranging from large to freelance and to ensure that the data was reflective of the country as a whole. As the point of the study is to gain insight into developer behaviour rather than to point fingers at any specific company, results were made anonymous. All sites were checked for the following:

- the presence of conformance icons
- the presence of accessibility statements
- whether the company mentioned accessibility as a service or selling point
- the use of standards compliant X/HTML
- the use of standards compliant CSS
- WCAG 2.0 compliance using AChecker

Two hypotheses were drawn from the checks performed:

H1: The presence of the mention of accessibility as a selling point on the developer site will increase the accessibility (that can be checked with automated tools) of the homepage.

H2: The presence of an accessibility statement will increase the accessibility (that can be checked with automated tools) of the homepage.

3.2 Study design

Each homepage was validated to WCAG 2.0 AAA using AChecker (AChecker 2011). AChecker is a well-known validation tool and not only flags up errors but will flag potential errors relating to content that require manual checking. Only the homepage was tested as the homepage is the first port of call for most people

viewing a site and may, if it is poor, be the only interaction that an individual has with that company's website. A comparison of three validators (Cynthia says, Total Validator and AChecker) was made on the first 25 homepages and AChecker was selected due to the low number of errors compared to two other validators tested. The reasoning was to err on the side of caution and underreport automated errors. Following validation, each page was checked manually using WCAG 2.0 Guidelines in Firefox (version 6+) and rechecked at least once to verify results during analysis. Manual checks focused particularly on keyboard navigation and the presence of keyboard traps as well as ALT tag descriptiveness. These observations are included in the discussion section to enhance and verify the automated output and where significant, mention false results arising from the automated process. To maintain data coherence, this data is not included in tables discussing validator output. After manual checks for accessibility were performed, sites were again checked for standards compliant X/HTML. These second checks were performed approximately 1 month after the first automated X/HTML checks.

3.2.1 Study limitations

As only the homepage of each site was examined for accessibility, some aspects of accessibility will be under-represented or not represented at all. Not all accessibility barriers are detectable by automated checkers and both false positives and false negatives can occur – for example, while the presence of ALT tags can be checked, checks on the usefulness of the ALT text cannot be automated. Manual checks were performed to ameliorate the effect of false positives and false negatives and to verify validator content.

3.3 Results

The results were compiled and analysed using SPSS. A condensed version of the data (with individual success criteria error numbers removed) can be viewed in Appendix 1.

3.3.1 Accessibility as a selling point

Accessibility as a skill listed by development companies was present in just under half of the companies examined, with 46 out of 100 companies listing skills in accessible web development. The accessibility information provided ranged from bullet point lists of phrases or single sentences listing accessibility services (for the majority of companies) to entire pages discussing accessibility, legal requirements and/or design philosophies. Other companies integrated accessibility into their overall design methodology or philosophy statements and one company had a separate accessible website. Only five of the 46 companies mentioning accessibility as a skill specifically cited aims to meet any level of WCAG 2.0 conformance, one company aiming for compliance at all levels, three companies aiming to meet Level AA, and one citing Level A as a minimum requirement. Three companies mentioned accessibility in their portfolio examples, demonstrating that they had clients who required accessibility and that they had the expertise to fulfil such requirements. Accessibility practices and techniques were also discussed in four company blog posts.

A t-test was conducted to test the hypothesis (H1) that the presence of the mention of accessibility as a selling point on the developer site increased the accessibility of the site. The t-test was chosen as a means of comparing the number of automated accessibility errors based on whether the company mentioned accessibility as a selling point or marketable skill and whether there was a statistically significant difference between the means of these two groups. The mention of accessibility as a selling point had no effect on the mean number of automated Level A accessibility validation errors of the company homepage ($M = 11.8$, $SD = 23.7$) compared to companies that did not mention accessibility ($M = 10.1$, $SD = 12.9$) conditions; $t(98) = -0.463$, $p = 0.644$. As the p value represents the significance of the t-test, and the p value must be less than or equal to 0.05, there is no evidence to support the hypothesis H1. Therefore, no association between the mention of accessibility on the site and a decrease in the number of Level A accessibility errors was observed.

Sixteen companies had accessibility statements that were discoverable from the homepage with a total 23 (23%) companies having discoverable accessibility statements on the site. Seven companies had accessibility statements which were not accessible from the homepage but were accessible from elsewhere on the website. Two sites had accessibility as a selling point or skill located within the accessibility statement.

A t-test was also conducted to test the hypothesis (H2) that the presence of an accessibility statement would increase the accessibility of the homepage. The inclusion of an accessibility statement on a developer website had no effect on the number of automated Level A accessibility validation errors ($M = 6.1$, $SD = 6.2$) of the company homepage than companies without accessibility statements ($M = 12.3$, $SD 20.7$) conditions; $t(98) = 1.42$, $p = 0.159$. Again, because of the high p value, there is no evidence to support the hypothesis H2. Therefore, no association between the inclusion of an accessibility statement on the site and a decrease in the number of Level A accessibility errors could be found.

Of the 23 companies that had discoverable accessibility statements, 16 were from companies listing accessibility as a selling point.

3.3.2 Validation icons, accessibility statements and conformance

Validation icons were not present on the majority of sites. Table 3.1 shows a breakdown of validation pass/fail frequency as well as the frequency of several conformance icons. Only 23 out of 100 sites have discoverable XHTML or HTML W3C validation icons for a page. The number of sites with CSS validation icons drops to 17 out of 100 with only eight out of 100 sites having WCAG 1.0 conformance icons and one out of 100 sites with a WCAG 2.0 conformance icon.

Table 3.1: Validation icons/Accessibility information present

Icon/accessibility information present	Yes	No
X/HTML validation icon	23	77
CSS validation icon present	17	83
Accessibility mentioned as a skill	46	54
WCAG 1.0 conformance icon present	8	92
WCAG 2.0 conformance icon present	1	99

Each homepage was revalidated using the W3C validators for XHTML/HTML (World Wide Web Consortium 2012a) and CSS (World Wide Web Consortium 2009). For XHTML/HTML validation only nine of the 23 websites with HTML or XHTML validation icons passed a homepage revalidation. A total of 20 homepages successfully validated for XHTML/HTML across the 100 tested. For sites with CSS validation icons, six out of 17 passed revalidation from a total of 17 sites out of 100 validating without error. Accessibility conformance icons were rare with only nine companies displaying either WCAG 1.0 or WCAG 2.0 conformance icons. The eight homepages with WCAG 1.0 conformance icons were also validated against WCAG 1.0 using AChecker and only one site passed Priority 1 using AChecker. The single site with the WCAG 2.0 conformance failed at Level A. Only eight out of 100 sites passed Level A through AChecker.

Table 3.2: Homepages passing validation

Icon and validation information	Homepages validating	Homepages failing validation
Homepages validating for X/HTML	20	80
Homepages validation with X/HTML validation icon	9	14
Homepages validating for CSS	17	83
Homepages validation with CSS validation icon	6	11
Homepages conforming to WCAG 2.0 Level A	4	96

3.3.3 Homepage WCAG 2.0 conformance

The most common accessibility barriers found on the 100 developer homepages are listed below and the error details are shown in table 3.2.

3.3.3.1 Text alternative errors

WCAG 2.0 Guideline 1.1A states that developers should, "provide text alternatives for any non-text content so that it can be changed into other forms people need" (Web Accessibility Initiative 2008). This error was present in 46 out of 100 sites. Manual checks found five false positives, making an adjusted figure of 41. All errors pertained to 1.1.1A (Non-text Content) and the most common error of this type, present in 20 sites, is missing ALT text for images in slideshow banners. A further eight sites used buttons made from images that were missing the ALT attribute.

3.3.3.2 Adaptable

Guideline 1.3A: requires developers to, "create content that can be presented in different ways without losing information or structure" (Web Accessibility Initiative 2008). Sixty-four homepages passed Guideline 1.3 validation. Missing form label elements was the most common error. Twenty-three errors of this type occurred due to the text element missing the associated label. The error was also the cause of the most false positives (10 in total) due to some sites still being accessible without the label element by using a technique where a pre-written text value is already present in the text field. When these sites are considered as meeting the guideline pass criteria, the total number of pages passing rises to 74 out of 100 homepages.

Other errors involved missing label text in input elements such as radio buttons, checkboxes and password fields (22 out of 100) as well as missing "fieldset" and "legend" tags for groups of radio buttons.

3.3.3.3 Keyboard accessible

Guideline 2.1 aims to, "make all functionality available from a keyboard" (Web Accessibility Initiative 2008). Eleven sites did not pass the automated keyboard accessibility check, however when manually checked most of these homepages were broadly accessible with inaccessible content appearing to be redundant.

Manual checking of the 100 homepages resulted in 10 sites failing keyboard accessibility. A total of 15 sites did not work properly in Firefox – mostly as a result

of Flash content either creating a keyboard trap, or by skipping the Flash content. When tested in Internet Explorer (IE) the number failing Level A due to keyboard traps dropped to six. The majority of accessibility errors in sites failing manual checks were caused by forms which would either prevent the user from navigating out of the search box or for skipping radio buttons where one of the radio buttons was pre-selected. Drop-down menu navigation difficulties also contributed to keyboard failures at Level A. Five out of 100 sites did not have keyboard navigation that followed a logical order.

Thirty-five sites failed at Level AA keyboard navigation requiring that the user should be able to see the keyboard focus (Guideline 2.4.7 – focus visible). A further 10 sites had some content with visible bounding boxes but these bounding boxes did not extend to all of the content navigable from the keyboard, leading to navigation difficulties. Another 17 sites had bounding boxes where the contrast made the navigational cue almost invisible (tester corrected vision 20/30). Further problems were sites where some of the content was visibly navigable, but did not activate when the enter button was pressed.

3.3.3.4 Navigable

Guideline 2.4 seeks to, "provide ways to help users navigate, find content, and determine where they are" (Web Accessibility Initiative 2008), with 75 out of 100 sites passing automated validation. This accessibility barrier primarily occurred in banner slideshows with images containing links to portfolio or other pages on the website having no ALT text (24 out of 25). When ALT text was checked however, the picture became much worse. Manual checks revealed that an additional 34 pages had non-descriptive link text such as "read more" or "see more" etc. Quality of ALT text was highly variable with a number of sites having well designed and aesthetically attractive and informative links as well as sites with poorly written or missing ALT text.

3.3.3.5 Readable

Guideline 3.1 aims to, "make text content readable and understandable" (Web Accessibility Initiative 2008). This guideline had the greatest rate of failure at Level A with 71 sites failing to add mark-up allowing the default language of the page to be programmatically determined. This error is a simple fix involving the HTML "lang" attribute and points to a reliance on web development products that do not automatically include the "lang" attribute in the opening HTML tag.

3.3.3.6 Input assistance

Guideline 3.3 states that developers must, "help users avoid and correct mistakes" (Web Accessibility Initiative 2008). Forty-two sites failed the automated check with all failures due to lack of labels or instructions on input elements.

This barrier is probably an under-represented problem due to forms often being used on individual contact pages. Like the failure in guideline 1.3, the lack of a label element for form fields contributed to the automated failures. Of the sites not using labels, 20 out of 42 sites did use prompts within the form field itself to help users with data entry. Again, while this creates a smooth design and follows the letter of the guideline, information solely available in form fields increases cognitive load, as the help/prompt text disappears as soon as that particular text field receives focus. While this may not be a problem for many users without cognitive difficulties, for older people with short term memory decline or people with learning disabilities, the disappearing text could lead to greater frustration and a reduction in usability of the site.

3.3.3.7 Compatible

Guideline 4.1 is concerned with parsing of content and aims to, "maximise compatibility with current and future user agents, including assistive devices" (Web Accessibility Initiative 2008). Fifteen sites had parsing errors caused by the reuse of the HTML "id" element.

Table 3.3: AChecker output of errors at Level A

Guideline Tested	Pass	Fail	Mean number of homepage errors	Median number of homepage errors
1.1.1 A: Non-text content	54	46	6	4
1.3.1 A: Information and relationships	63	37	5	4
2.1.1 A: Keyboard	89	11	20	8
2.4.4 A: Link purpose (in context)	75	25	5	2
3.1.1 A: Language of page	29	71	N/A	N/A
4.1.1 A: Parsing	57	43	N/A	N/A

3.4 Discussion

3.4.1 Conformance icons and selling points

Only eight sites had accessibility conformance icons and seven of these icons were for WCAG 1. Only one site had the WCAG 2.0 conformance icon. As the WCAG 1.0 guidelines were superseded by WCAG 2.0 in 2008, it is intriguing that only one site is currently displaying the WCAG 2.0 icon. A number of questions arise: Why is the WCAG 2.0 conformance icon not being used? Are the WCAG 2.0 guidelines a part of the web developers' toolkit? Or is the reliance still on WCAG 1.0? Or is the website not maintained for accessibility? One of the goals of the conformance icons, namely to raise awareness of accessibility, was not being met as such icons were buried in the accessibility statement rather than displayed on a page-by-page basis, in support of an older set of standards (WCAG 1.0) or, as in the majority of cases, not used at all.

Of the 46 sites that mentioned accessibility, four of the sites described accessibility purely in terms of screen readers and/or visual impairment. While this is not a large number, it is of interest to note that this visual impairment-centric view of accessibility still exists. Additionally, H1 was not supported as there was no association between a company mentioning accessibility as a selling point and the accessibility of the homepage. The lack of association raises questions regarding the success of the WCAG in terms of guideline awareness, usage and clarity. Taking

the stated developer commitment to accessibility, it is likely that web accessibility is something which companies are aware of and to which they are committed to, however, this is not necessarily translating to accessible web sites.

Conformance icons were visible in only a minority of sites and did not guarantee that the page would validate. The outcome is similar to the study mentioned in Chapter 2, where only 20% of sites had accessibility statements and that some accessibility statements were not particularly accessible (Parker 2007). Fewer than half of the sites with conformance icons passed validation during the study. This lack of validation is likely due to updates or pages not going through a revalidation process as suggested by Lazar and Olalere (2011). Due to the small number of sites that actually use conformance icons, the absence of such icons similarly does not mean that the site does not validate, leading to the question of the validity of such icons. Questions are raised in terms of developer understanding and awareness of accessibility. Are developers aware of the WCAG? Do development companies use the WCAG or similar guidelines? Do companies validate their web content specifically for web accessibility rather than for HTML and CSS? It was observed that some companies were clearly revalidating their content for HTML as during the course of this study, several homepages fluctuated over time in terms of whether or not they passed HTML validation. Regardless, H2 was disproven and there is no evidence to support that the inclusion of an accessibility statement on a website affects the behaviour of web development companies in terms of ensuring that their own content is accessible.

3.4.2 General accessibility

The lack of ALT tags for links and images remains a key barrier. Generally, most of the pages did have ALT tags but, the frequent lack of ALT text in banner images hints at the possible degradation of accessibility over time as new images are exchanged for old. As the purpose of such slideshows is often to show dynamism in terms of activity and highlight new clients, accessibility settings may get lost due to the frequent updates. The failure to include ALT tags for images was also present in

portfolio content displayed in grid formation on the homepage, likely another feature that is frequently updated. Again, this supports findings regarding the decline of accessibility over time due to updates that was mentioned in Chapter 2 (Thompson 2009). These findings were similar to previous observations highlighted in Chapter 2 that point to missing ALT tags as a common accessibility barrier (de Santana, de Paula 2013). Again, the likelihood of this content being regularly updated, implies the potential for degradation of accessibility. Additionally in some cases, it appears that the title attribute was used instead of the ALT tag, hinting at either a lack of understanding of the differences between ALT and "title" or a preference for Search Engine Optimisation (SEO) over accessibility as the "title" tag is often used to boost page ratings in the search results.

Missing labels were also a problem for at least a quarter of homepages – and the commonplace nature of the errors was similar to other recent findings (de Santana, de Paula 2013). This has implications for older people and people with motor impairment as the without labels, elements such as radio button present a much smaller clickable target. While some developers replaced missing labels with text values as default values for text input boxes, this tactic provides accessibility only for some as it ignores people with motor impairments. Additionally, for people with cognitive barriers, while text in the box is initially helpful, when the text disappears, the user is at risk of losing the information needed to complete the form.

Radio buttons were also problematic in terms of keyboard navigation where there were difficulties selecting radio buttons in instances where there was a pre-selected radio button. Often it was impossible to deselect the pre-selected button using only the keyboard.

The most common barriers to keyboard navigation were caused by Flash and HTML forms. HTML forms fieldsets would greatly increase the accessibility of the form and for sites with Flash content, either using JavaScript solutions (Web Accessibility Initiative 2008) or using ActionScript 3 (AS3) and JavaScript/Jquery tabbing fixes in

Firefox (England) would help with Flash content accessibility. Unfortunately these fixes are often not permanent as browser upgrades can undermine such fixes. Thirty-five of the homepages failed to provide a visible focus, which shows a screen-reader centric attitude towards keyboard navigation that does not take into account visually impaired users who may not use screen readers as well as people who are using keyboard or switch navigation as a result of motor impairment. However, it must be stated that some sites were excellent in terms of creating keyboard-friendly content which was visible and pleasing to the eye as well as rendering drop-down menu information accessible and visible to users navigating the page. The placement of focus visible at Level AA, also places the navigation needs of screen reader users over the navigation requirements of people using alternative forms of interaction as a result of motor impairment and also may inadvertently reinforce the screen-reader centric view of accessibility held by some developers.

The most common, easily correctable, accessibility barrier at 71% was the failure to declare a language for the page. This creates a barrier for people using assistive technology such as text-to-speech or a screen reader. It is interesting to note that this information is often generated automatically by the development environment rather than the developer and as a result, may well be easily missed by developers.

3.4.3 Conclusion and future work

While accessibility has increased both in terms of profile and compliance, WCAG compliance icons do not have the visibility of XHTML or CSS validation icons. WCAG 2.0 conformance icons were virtually non-existent on the websites checked and the presence of these icons were not particularly meaningful as their inclusion does not seem to affect developer behaviour in terms of development of their own sites (H2). In contrast, the desire and willingness of developers to develop accessible products and to advertise these skills to potential clients is far more visible. It is very promising that developers view accessibility as worthwhile and are clearly making efforts to provide accessible content. Further research into whether

developers use the WCAG 2.0, their views on the relevance of conformance and validation icons as well as more information on who drives accessibility as a requirement, clients or developers, may shed additional light on how accessibility is integrated as a practice within industry. While there is no association between the mention of accessibility and WCAG conformance of the site in terms of automated validation (H1), the recognition of accessibility as a marketable skill marks an important step in raising awareness of accessibility. However, the presence of easily rectified accessibility errors indicates that the problem of accessibility compliance is still present in modern sites.

4. Developer behaviour and attitudes to web accessibility

This chapter, builds on the information presented in Chapter 3 and explores the results of the online survey conducted into web industry professionals' views on accessibility in general and accessibility for ageing in particular.

4.1 Research questions

As a lack of information about attitudes to accessibility and ageing exists, the survey set out to investigate the question, "*What is the current attitude to accessibility in general and for ageing specifically?*" From this question, three sub-strands of investigation arose concerning accessibility and ageing:

1. Do industry professionals view general accessibility guidelines as relevant?
2. Are industry professionals aware of accessibility guidelines for older people?
3. Do industry professionals view ageing in terms of accessibility?

A questionnaire was designed to investigate web professionals' use and opinion of the WCAG and accessibility validators as well attitudes toward ageing, web accessibility and awareness of ageing-specific web accessibility guidance. The questionnaire was aimed at all web professionals rather than just designers and developers.

Five hypotheses regarding accessibility and ageing were drawn from the questionnaire:

- H1. Experience will increase the likelihood that professionals view ageing as an accessibility issue.
- H2. Age will increase the likelihood that professionals view ageing as an accessibility issue.
- H3. Experience will increase the awareness of age-specific guidelines.

H4. Job role affects the perception of ageing as an accessibility issue (i.e. front line vs. project management).

H5. Gender affects the perception of ageing as an accessibility issue.

4.2 Study design

A total of 500 questionnaire invitations were sent. Survey invitations were sent to the 100 companies used for the survey in Chapter 3 as well as 400 other companies across the UK. Companies were selected using Google as it is likely to be the search engine that would be used by potential clients. The search term used was "web development" and name of a geographical area or city. Like the companies selected in Chapter 3, UK cities and geographical areas were chosen to cover as large an area as possible in terms of both size and population so that the invitations covered a balanced range of companies. Where possible, contact names were included in the survey email invitation in the hope that it would raise response rates. Survey invitations contained information concerning the subject of the survey, the amount of time needed to complete the survey (approximately five minutes) and a link to the survey. Please see Appendix 2 for question text.

An ethics checklist was completed and signed. With regard to data protection, while survey invitations were kept on record, all responses were anonymous with ethics information presented at the start of the survey, and the option to opt-out explicitly stated. Researcher contact details were also provided. It is not possible to identify the respondents from the collected responses.

4.2.1 Study limitations

As with all surveys, there is a risk of bias through non-response. As non-respondents are typically less engaged with the topic, there is a chance that more people with interest in accessibility responded, which could potentially make responses more sympathetic to guideline use.

4.3 Results of survey

Of the 500 invitations sent out, 36 survey invitation emails were bounced back as failed deliveries. The response rate was calculated using only successfully delivered surveys (total 464 successfully delivered survey invitations). The response rate for the survey was 23%, a comprehensive break-down of the responses follows. The results were collected using Bristol Online Surveys and exported to SPSS for analysis. Please see Appendix 3 for response data.

4.3.1 Respondent background

One hundred and seven companies answered the questionnaire, of the respondents 99 were male and nine were female. All respondents worked for Small and Medium Enterprises (SMEs), with the majority working for small companies (under 10 employees).

Table 4.1: company size and respondent breakdown

Company size	Number of respondents
under 10 employees	64
10 - 49 employees	40
50 - 249 employees	3

In terms of job roles, respondents could choose as many job titles as applied. The majority of respondents identified themselves as Senior/Lead Designers, Senior/Lead Developers and Project Managers.

Table 4.2: Job roles of respondents

Job role	Number of respondents
Junior Designer	6
Senior Designer	42
Junior Developer	5
Senior Developer	59
Content Writer	6
Producer	8
Project Management	31
Other	15

Fifteen people selected the "Other" job role, four respondents reported themselves to be in Search Engine Optimisation (SEO) roles, two were freelancers, two worked in User Experience (UX) and two were at Director level. Eight of the respondents who selected "Other" did so along with another, more specific, job category. Most of the respondents (N=79) had more than five years of industry experience. The largest number of respondents was between 25 and 39 years of age, with 79 people falling into that category. Twelve respondents were between the ages of 16 and 24 years of age, fourteen people were between 40 and 54 years of age. One person was present in each of the 55-64 years of age and 65 plus categories.

4.3.2 General accessibility frequency results

The first question ascertained whether HTML/CSS validators were used by respondents. Validators for CSS and HTML were seen by most respondents to be relevant to their job role with 99 people out of 107 agreeing to the question, "Are the use of validators such as W3C's Markup Validation Service or CSS Validation Service relevant to your role?" Most respondents also reported making use of such validators as well as implementing validator recommendations.

Table 4.3: Validator use data

Question	Very much	Somewhat	A little	Not very much	Not at all
Do you make use of such validators?	28.3%	33.3%	21.2%	17.2%	0%

Question	Always	Often	Sometimes	Rarely	Never
Do you implement validator recommendations?	21.2%	51.5%	15.2%	7.1%	3%

The majority of respondents reported that accessibility guidelines were relevant to their job role, with 52% citing such guidelines as very relevant and 35% agreeing that guidelines were somewhat relevant. No one said that accessibility guidelines had no relevance to their work role.

Not only did people working in the web industry view web accessibility guidelines as relevant, they also used such guidelines in the course of their work. Guidelines were used "often" by 37% and 30% used such guidelines some of the time. However, a significant minority of 20% used such guidelines "rarely" or "never".

Table 4.4: Accessibility guideline relevance and use

Question	Very much	Somewhat	A little	Not very much	Not at all
Do you feel that accessibility guidelines are relevant to your work role?	52.3%	34.6%	12.1%	0.9%	0%

Question	Always	Often	Sometimes	Rarely	Never
Do you make use of published general guidelines for accessibility?	12.1%	37.4%	29.9%	14%	6.5%

Automated tools for web accessibility were not as popular as validators for HTML or CSS. Only 6% percent always use such accessibility validators (e.g. AChecker, WAT) compared to 28% for HTML/CSS validators. Half of the respondents used accessibility validation tools "often" or "sometimes", but 45% used such tools "rarely" or "never".

While tools for accessibility validation did not have the same number of users, people in industry take accessibility into account during the development cycle. Over a quarter of respondents started thinking about accessibility at the earliest stages in the project i.e. during initial consultations and project formation. The majority, 46%, either started considering accessibility during requirements gathering or prototyping. Another 24% considered accessibility during development or testing. Only a very small minority of 3% never considered accessibility in their projects.

Table 4.5: Point in the development cycle when accessibility is first considered

When in the development cycle do you first start thinking about accessibility?	Early stages	Planning	Prototyping	Development	Testing	Maintenance	Never
Percent of respondents	26.2%	20.6%	26.2%	17.8%	6.5%	0%	2.8%

4.3.3 Accessibility and ageing frequency results

Industry professionals did not consider older people to be a significant demographic for their products with close to 70% seeing older people as a non-significant demographic. Only 30% saw older people as a significant demographic with 2% seeing older people as a key demographic for their products. Professionals were evenly divided about whether ageing was an accessibility issue with half of respondents either neutral or disagreeing with the question "do you consider ageing to be an accessibility issue" and the other half in agreement with the statement.

Table 4.6: Perception of ageing as an accessibility issue

Question	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Do you consider ageing to be an accessibility issue?	11.2%	38.3%	39.3%	10.3%	0.9%

Awareness of age-specific accessibility guidance and documentation was low with only 18% (19 out of 107 respondents) of people actually aware of W3C's "Developing Websites for Older People: How Web Content Accessibility Guidelines

(WCAG) 2.0 Applies" document (Web Accessibility Initiative 2010). Even when professionals were aware of these guidelines, 37% percent made use of such guidelines "rarely" and 5% "never". Respondents who were aware of the guidelines are also evenly split with regards to their perception of the usefulness of age-related guidelines with 47% in agreement that the guidelines were useful. The remaining 42% have a "neutral" opinion and 11% "disagree" or "strongly disagree" with the usefulness of the age-specific guidelines.

Table 4.7: Ageing-specific guidelines, awareness and perceived usefulness

Question	Yes	No
Are you aware of the "Developing Websites for Older People: How Web Content Accessibility Guidelines (WCAG) 2.0 Applies" document?	17.8%	82.2%

Question	Always	Often	Sometimes	Rarely	Never
Do you use "Developing Websites for Older People: How Web Content Accessibility Guidelines (WCAG) 2.0 Applies" recommendations? (N=19)	0%	36.8%	21.1%	36.8%	5.3%

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
Do you believe that these guidelines match the web accessibility needs of older people? (N=19)	0%	47.4%	42.1%	5.3%	5.3%

A final question was asked of developers in an effort to understand if the current paradigm shift to direct interface manipulation (i.e. touch screens) had changed views about accessibility and ageing. Of the respondents, 45% either agreed or strongly agreed with the assertion that touch screens increased accessibility for older people. Only 8% disagreed with the statement and the remainder (48%) were neutral to the accessibility of touch screens for older people.

4.3.4 Results of non-parametric tests

Several statistical tests were conducted and the results are presented in this section. These tests were intended to draw inferences from the data regarding attitudes and behaviour toward web accessibility for older people.

The first test set out to substantiate H1, whether experience can change whether people view ageing as an accessibility issue. A Kruskal Wallis test was selected as it can compare independent groups (with ordinal values) of three or more, in this case, years of work experience. The under two years and two–three years experience groups were combined into an under four years category because the sample for the under two years group was too small to be statistically significant. As the Likert data is ordinal, the Likert values were ranked from one to five and then assigned a value in sequence from most positive (strongly agree) to most negative responses (strongly disagree). The Kruskal Wallis test was then run comparing the responses of people based on their years of work experience to the question of whether the respondent viewed ageing as an accessibility issue. No statistically-significant difference was observed between the groups ($H_2 = 0.087$, $p = 0.957$) based on years of experience, with a mean rank of 52.53 for people with under four years experience, 52.93 for four to five years experience and 54.53 for people with over five years experience. The Kruskal Wallis test indicates the presence of differences in the mean, in this case no significant difference between the means was detected based on the high p value which would need to be below 0.05 to be significant. As no significant difference was found, H1 was not supported.

The second statistical test to confirm the validity of H2 was run on the question, "does age change whether people view ageing as an accessibility issue?" As the data is ordinal and compares more than two groups, a Kruskal Wallis test was selected to identify if there was a statistically significant difference between the responses base on respondent age. As the sample was too small to be statistically significant for the 55 to 64 years old and over 64 years old categories, these results

were combined with the over 40 category. Again, numeric values were assigned to the Likert data in sequence from the most positive to most negative responses. The Kruskal Wallis test was then run on the age groups and no statistically-significant difference on the view of ageing as an accessibility issue ($H_2 = 1.447$, $p = 0.485$) was found based on age, with a mean rank of 62.62 for people aged 16 to 24, 53.34 for people aged 25 to 39 and 50.22 people over the age of 40. No significant difference was found, so H_2 was not supported.

A third statistical test was run to test whether H_3 , "does experience affect whether people are aware of guidelines specific to older people?" was valid. As with H_1 and H_2 , a Kruskal Wallis test was run on years experience and no statistically-significant difference existed in terms of awareness of the W3C's "Developing Websites for Older People: How Web Content Accessibility Guidelines (WCAG) 2.0 Applies" document ($H_3 = 2.047$, $p = 0.359$) based on years of experience, with a mean rank of 47.50 for people with under four years experience, 57.75 for four to five years experience and 53.21 for people with over five years experience. Again the categories of under two years and two to three years experience were combined to create a statistically valid sample. H_3 has a p value higher than 0.05 and, therefore, is not supported

Finally, tests exploring whether job role affected the view that ageing was an accessibility issue (H_4) were performed. The first test was a Kruskal Wallis test based on job role. However, as respondents selected multiple roles in the questionnaire, the roles needed to be combined into exclusive groups. The groups chosen were "exclusively senior developer", "exclusively senior designer," "both senior developer and designer" and "neither developer nor designer". The groups were divided in this manner to balance the largest groups of respondents made up of senior developers and/or senior designers with the remaining responses that made up a third grouping of similar size. Because respondents could choose multiple categories, it was important to make sure that there was no overlap between the groups and the above combination ensured that the groups were

exclusive. The Kruskal Wallis test found that there was a statistical difference between the "neither" group when compared to the other three groups ($H_2 = 9.714$, $p = 0.021$). The mean rank of the "neither" group was 69.9 with a mean rank for senior designer 45.88, a mean rank of 50.94 for senior developer and a mean rank of 50.61 for respondents with both design and development roles. The higher mean value in the "neither" group points to greater disagreement with the assertion that ageing is an accessibility issue. As the p value is less than 0.05, H_4 , that job role affects whether a respondent views accessibility for ageing as an issue is supported.

A follow on Mann Whitney U test was run on two populations to explore the results of the Kruskal Wallis test. A Mann Whitney U test was chosen as it allows for the testing of ordinal/ranked values of two populations. The first group contained respondents with an exclusively project management role and the second group contained respondents who selected any other role. The reason project management was singled out was that of the 24 respondents in the "neither" group, 21 were exclusively project managers. Did the project management role affect response to the question "do you consider ageing to be an accessibility issue?" The results indicate a negative association to being a project manager ($U = 176.500$, $p = 0.003$) with agreement to ageing being an accessibility issue. The mean value for project managers was 63.85 and for non-project managers the mean was 40.82. Lower values indicated agreement with the assertion that ageing is an accessibility issue. The test was re-run to include all people with any stated project management experience and not just respondents who exclusively identified themselves as project managers with regard to whether they viewed ageing as an accessibility issue, ($U = 887.000$, $p = 0.033$) with a mean of 63.39 for project management and 50.17 for front line respondents. Higher values are associated with disagreement with the view that ageing is an accessibility issues. So the inclusion of project managers with other work roles made the association weaker, but still statistically significant. H_4 is supported with a negative association with project managers viewing ageing as an accessibility issue.

Does gender affect whether people view ageing as an accessibility issue (H5)? A Mann Whitney U test was run relating to whether gender affected the response to the question "do you consider ageing to be an accessibility issue?" The Mann Whitney U test was chosen as it allows for analysis of ranked data and unequal population size of the groups being tested. The results supported H5, that being female is associated ($U = 231.500$, $p = 0.038$) with agreement to ageing being an accessibility issue. The mean rank for men was 55.66 and for women 33.44. A higher mean value is associated with disagreeing with the view the ageing is an accessibility issue.

4.3.5 Additional qualitative data

A small number of professionals ($n = 16$) also wrote additional comments which added insight into views about accessibility:

Some developers expressed frustration at the low profile of accessibility as a whole and the fact that it is "always overlooked or ignored by companies... and increasingly within the web community as a whole" or that that companies work to satisfy "usability satisfaction" of the majority of users which effectively means that a "true 'accessibility' website is never even considered". Several comments focused on their belief that websites should be adaptive and inclusive and that older people are a part of this inclusivity, underlying the commitment to accessibility seen in the questionnaire responses.

A minority of comments were less positive about the need for accessibility practices citing that the web is inherently more accessible than a few years ago, and that some issues such as font size are no longer accessibility barriers as browsers are "able to either zoom or increase font size," and that, "most people with accessibility problems will know how to increase the font size". A similar argument was presented that as people in general become more IT-literate, the ageing population will be more technologically literate.

Others expressed frustration with the guidelines, the lack of proper guidance and accountability:

"No one is held accountable for not meeting these standards, and the standards themselves are so grey that unless you want to trawl through pages of robot-talk W3C and WAI-ARIA documentation you have to rely on intuition and forums. It's a fundamental change that needs to occur. Just like responsive design, you can't really put it in after – it needs to be planned from the start."

Others point for the guidelines to be simple "do's and don'ts" and for the need for accountability as there is "no policing of minimum accessibility standards on the web."

In terms of older people, respondents observed a need to consider cognitive disabilities and concentration difficulties as well as age-acquired visual changes. The conflict between usability of new technologies and visual disabilities as well as lack of awareness of accessibility features by older users was also observed.

This lack of awareness of accessibility features was furthered by two respondents who discussed industrial failings in terms of "a presumption of experience" and that accessibility standards do not account for the need to consider people who do not have a good working knowledge of the technology they use and that professionals have become blind to this fact:

"I believe the issue with conforming to accessibility standards on the whole is that it's difficult to consider people who don't have a working knowledge of the web and modern devices. We're surrounded by it every day and it puts us in a bubble: constantly updating browsers, touch screen devices and massive dual monitors lead to a distancing from what the 'normal' user experiences - especially the older user. It's downright painful sometimes having to watch non-web professionals use the Internet."

4.4 Discussion

As with all surveys, there is a risk of bias through non-response. The 23% response rate is low, however, it is within a standard deviation of organisational response rates (35% SD 18.2) reported in an analysis of published research survey response

rates (Baruch, Holtom 2008). The possibility that the email was regarded as spam is potentially another contributing factor to the response rate.

It is interesting that the majority of responses (N=64) came from enterprises with one to nine employees. Broad statistics place the number of UK companies in the information and communication sector at 165 500 with 7175 of the 7195 companies listed as being "information services activity enterprises" having under 250 employees, with the vast majority (6105 companies) having fewer than five employees (Office for National Statistics 2013a). As most companies are very small, it is likely that people have to take on multiple roles, and as a result, accessibility will not be the domain of the specialist. Un-utilised expertise is costly and such companies require employees who can be flexible in terms of the duties they carry out. While the advantage of multiple roles for employees is that more services can be offered, such companies risk offering less specific expertise than companies where people occupy a single role.

The positive responses regarding guideline use and that respondents felt that accessibility was relevant to their work role is unsurprising, but does show that the current guidelines are considered to be of use to industry professionals.

Validator use was common for web professionals and seen as relevant by the majority of respondents. All groups including content writers, producers and project managers used validators, although this may be due to over a third of respondents having more than one role (N=37).

It is very promising that accessibility is viewed as a part of work roles for many, pointing to industry awareness of the need for accessibility practices. The use of these guidelines is similarly promising. This is a change from historical data at the SME level where only 29% took accessibility "into account" while building a website (Disability Rights Commission 2004). The findings also are likely more significant for generalisation in the developed world as less awareness of accessibility has been reported in developing countries (Baguma and Wanyama et al., 2007, Goodwin and Susar et al., 2011). While the vast majority of questionnaire respondents

considered accessibility as relevant to their workload, it is interesting that use of validators for accessibility is not as popular as traditional validators. When compared to the use of accessibility guidelines, validators appear to not be perceived to have the same usefulness as the guidelines themselves. Over half of respondents "always" or "often" use guidelines; compared to less than a third who "always" or "often" use validators. As these validators are only of limited use, their lack of use is not overly worrying if accessible development practices are followed, but it is an interesting behaviour change. HTML and CSS validators are popular tools and accessibility tools usually have mark-up validators bundled into the main tool as they are a key component to accessibility for ATs, so for users of such tools, it would be a simple matter to do both mark-up and accessibility tests at the same time.

Table 4.8: Traditional vs. accessibility validator use

Validator type	Always	Often	Sometimes	Rarely	Never
HTML/CSS validator	28.3%	23.3%	21.2%	17.2%	0%
Accessibility validators	5.6%	22.4%	27.1%	29.9%	15%

Ageing appears to be a hidden demographic in terms of web accessibility. Neither the age nor the experience level of web professionals' increases agreement with the statement that age is an accessibility issue in statistical tests, disproving both H1 and H2. This is despite the regular use of guidelines by many respondents. As ageing is mentioned in WCAG 2.0 accessibility guideline, it is concerning that either this information is missed, or is simply not believed. The possibility exists that the opinion of ageing and accessibility is formed prior to entry to industry. Regardless, the fact that half of respondents disagree or are neutral to the idea that ageing is an accessibility issue points to the need for education about the need for accessibility for older people. Some of the less positive qualitative observations also show a failure by some web professionals to understand and accommodate capability change as a result of age or any future interaction paradigm changes. Current guidance provided by standards organisations works on the assumption that industry professionals are already in agreement that older people have accessibility

needs, however, data from the questionnaire points to the need for advocacy and awareness initiatives being a better starting point for ageing and accessibility education as many are unaware of the need for accessible practices for ageing despite using accessibility guidelines.

Awareness of ageing-specific guidelines is poor with only 18% even being aware of such guidelines. Again, neither age nor experience contributes to awareness of these guidelines, pointing again to the hidden nature of accessibility needs for older people. The level of experience does not change the awareness of such guidelines (H3). Even when professionals were aware of the guidelines, less than half perceived them as useful. The lack of faith in the usefulness of such guidelines is concerning as it is unlikely that people who do not perceive the guidelines to be useful are going to pass their knowledge of the existence of these guidelines along to other professionals.

The result of the Mann Whitney U test on the association between gender and the greater agreement of women with the view of ageing is an accessibility issue (H5) could possibly be due to the greater likelihood of women having caring roles in their lives, for children or ageing family members, affecting their view of ageing. However, due to the small size of the female sample ($n = 8$) compared to the male sample ($n = 99$), the result needs to be treated with caution, although the Mann Whitney test does reduce the impact of different sized groups.

Another contributing factor to the lack of awareness about accessibility for older people is the view that they are not a significant target for products and services provided. The majority of companies consider older people to not be a significant demographic for their products, however older people represent a large part of the UK population with 16% of the UK population being over 65 as of the last census (Office for National Statistics 2013b). Older people are also working longer: with number of people of state pension age in work at the last census at 1.4 million, a doubling from twenty years ago (Office for National Statistics 2012). Significantly, older people (over sixty years old) are significant consumers of goods and services

(JLD Media 2013). While it is possible that web professionals are looking at the clients purchasing services as end users, from a consumer stand-point, older people are a likely significant demographic of any website.

The question regarding the possibility that touch screens will reduce accessibility barriers for older people was asked as a means of gauging attitude toward the argument that ongoing interaction changes will render accessibility for ageing unnecessary. The responses given point to developers either agreeing that paradigm change will aid accessibility for ageing or being neutral to the effect of such developments. This is consistent with historical research where attitudes to ageing and accessibility is seen as a passing need that will diminish over time (Hanson 2009) and opinion which was also mirrored by qualitative data discussed in the previous section.

A critical observation was made regarding project management and accessibility. Unlike front-line professionals, project managers are statistically more likely to not see ageing as an accessibility issue, showing an association between job role and the view that ageing is an accessibility issue (H4). This is particularly concerning as project managers define and drive project deliverables. If they do not view ageing as an accessibility issue there is risk that even where developers and designers are committed to accessibility, they will meet with organisational disinterest at the level of their project managers. It is interesting to note that when project managers have other duties (20 of 31 project managers have multiple roles with development or design duties) the negative association decreased from a strong association to a weaker one. This points at the need to include project managers as a key target group for awareness raising as well as people before they enter industry.

4.5 Conclusion and future work

It is very promising that developers view accessibility as valuable and are clearly making efforts to provide accessible content. The inclusion of accessibility early in the development cycle is equally promising as it points to the view that accessibility is not merely a bolt-on requirement. Unfortunately, the accessibility needs of older

people do not have the same visibility as people who have a disability and are not particularly well understood in industry. Neither age (H1), nor experience (H2), affect whether industry professionals view ageing as an accessibility issue. Similarly, experience does not affect awareness of age-specific accessibility guidelines (H3). However, job role, in particular, project management is associated with a greater disagreement with ageing being an accessibility issue (H4), while being female is positively associated with viewing ageing as an accessibility issue (H5). As project managers are key to project delivery, and the industry is male dominated, there may be cultural forces at play that are affecting how ageing is perceived by people working in industry. Regardless, there is evidence to suggest that ageing is a hidden need group in terms of accessibility. As there is little awareness of the needs of older people in terms of accessibility, it is important to communicate these needs through education and intervention. As there is industry willingness to engage in accessibility, a focus on raising awareness of the need for accessible development for older people as well as the presence of relevant age-specific guidelines is required.

Questions about the suitability of WCAG 2.0 were also raised as while professionals are aware of the WCAG 2.0, this awareness did not necessarily affect the belief that ageing can raise accessibility barriers. Does the WCAG 2.0 documentation not serve the needs of older people? How visible are the accessibility needs of older people presented in the WCAG 2.0? The following chapter explores the current iteration of the WCAG 2.0 and explores how the needs of older people are addressed within the document.

5. WCAG 2.0 documentation for meeting the accessibility needs of older people

Following on from the results of Chapter 4, this chapter examines how the structure of the WCAG 2.0 itself may be obscuring the needs of older people due to WCAGs emphasis on guidelines aimed at ensuring the proper functioning of ATs. Some background to the web standards movement in general and the WCAG in particular is supplied. The WCAG 2.0 structure is then examined with regards to the demonstrated lack of visibility of guidelines pertaining to the accessibility requirements of older people and action points are presented.

The World Wide Web Consortium (W3C) is a community of member organisations, staff and members of the public that develop web standards. The W3C was founded by Tim Berners-Lee the inventor of the World Wide Web. The mission of the W3C is to help the web develop to full potential by, "developing protocols and guidelines that ensure the long-term growth of the web" (World Wide Web Consortium 2012b). This mission includes a number of Design Principles including the Principle of "Web for All" which acknowledges the social value of the web and has among its primary goals, the aim to make the web available to all people regardless of "hardware, software, network infrastructure, native language, culture, geographical location, or physical or mental ability" (World Wide Web Consortium 2012b). The Web Accessibility Initiative (WAI) forms the branch of the W3C concerned with ensuring that the principle of "Web for All" is met.

The WAI unites under its umbrella, people from industry, disability organisations, government and research. The aim of the WAI and its participants is to, "develop guidelines and resources to help make the web accessible to people with disabilities including auditory, cognitive, neurological, physical, speech, and visual disabilities" (World Wide Web Consortium 2013a). The guidelines issued by the WAI are widely considered as the international standard for web accessibility. Level A marks the minimum level of conformance, Level AA requires greater accessibility and Level AAA denotes maximum accessibility. This allows developers to prioritise accessible

practice. The WAI also designs support materials that aid in the understanding of web accessibility as well as other resources (Web Accessibility Initiative 2005b). The work of the WAI is collaborative and consensus-based and has five primary activities that are pursued to meet the goal of web accessibility including education and outreach (Web Accessibility Initiative 2005b).

The current version of the guidelines, introduced in 2008, is the Web Content Accessibility Guidelines version 2.0 (WCAG 2.0). WCAG 2.0 has three levels of conformance; A, AA and AAA. The WCAG 2.0 also includes older people in the body of the guidelines, which marked a change from WCAG 1.0 (finalised in 1999), which did not specifically mention older people within the guideline body. While the inclusion of older people is a valuable step forward, the guidelines themselves do not match the actual needs of older people. This is not to say that guidelines that aid accessibility for older people are not present in WCAG 2.0, but WCAG 2.0 places much of the guidelines relevant to older people in the AA or AAA level or conformance. It should be noted that the WAI does not recommend Level AAA be generally required on sites as it would not be possible in practice to conform to AAA for all web content (World Wide Web Consortium 2013b).

In order to understand what this means in practice, it is useful to look at the ranking system through the eyes of web content developers. A number of the more relevant guidelines for older people are at Level AA and AAA. Even for companies dedicated to accessibility, it is unlikely based on the findings in Chapter 3 and 4 that non-priority guidelines (i.e. guidelines at Level AA and AAA) will be met, when Level A errors are already commonplace, and awareness and understanding of guidelines and how they apply to older people is divided. The remainder of this chapter will look at the WAI's document "Developing Websites for Older People: How Web Content Accessibility Guidelines (WCAG) 2.0 Applies" with a critical eye to the stated levels of the recommendations that have the greatest relevance to older people as demonstrated by research.

The document breaks down the guidelines using the four principles of WCAG 2.0: perceivable, operable, understandable and robust (POUR) and addresses them in order. The principles are then further broken down by element type (e.g. text size, contrast, links, keyboard use). Guidelines and success criteria for meeting the guidelines for each of these elements are discussed in turn in terms of their relevance to older people and are presented in the order they appeared in the "Developing Websites for Older People: How Web Content Accessibility Guidelines (WCAG) 2.0 Applies" document. (Appendix 4 offers a complete breakdown).

5.1 Perceivable

The P in POUR means that information and interfaces must be "perceivable" to users (Web Accessibility Initiative 2008).

5.1.1 Text size

The WCAG 2.0 success criteria that pertains to text size is: 1.4.4 "text can be resized without assistive technology up to 200 percent without loss of content or functionality" (Web Accessibility Initiative 2008) and is in Level AA. Older people with natural decline in vision start to experience presbyopia from middle age. As discussed in Chapter 2, research supports both the preference for larger text size (i.e. 14 point vs 12 point) (Chadwick-Dias, McNulty & Tullis 2002) as well as evidence supporting that increases in text size supports faster reading (Bernard, Liao & Mills 2001). As these changes are universal for older people, it may be appropriate to consider the ability to resize text as higher priority for older people.

5.1.2 Text style and text layout

Success criteria 1.4.8 provides advice on text layout and style at AAA and recommends the following practices for meeting the criteria:

- the ability for users to select foreground and background colours
- keeping text/paragraph width to 80 characters or less
- unjustified text

- line spacing of a minimum of a space and a half for text in paragraphs and the same amount for spaces between paragraphs.
- resize text to 200% without requiring horizontal scrolling (Web Accessibility Initiative 2010).

As the browser is able to both resize text (although this will not ensure the absence of horizontal scrolling) as well as select foreground and background colours, the argument could be made that it is the responsibility of browser manufacturers to make such features discoverable and usable by people who need them. However, such features require knowledge of their existence as well as the confidence and computer literacy to change the settings. Equally, some website developers do offer the ability to change default foreground and background colours as well as text size, leaving the burden of responsibility up for debate. Regardless, the ability to alter paragraph justification, character width and spacing is in the control of the developer and it may be beneficial to place some of these recommendations at a higher level for older people as is supported by Kurniawan and Zaphiris's age-related guidelines with regard to text (Kurniawan, Zaphiris 2005). Arguably, some of the recommendations such as the 80 character width maximum are unlikely to be realistically expected of developers, but the ability to select foreground and background, line spacing and justification may be worthy of higher prioritisation. Additionally, while the 80 character maximum may be unrealistic, raising the profile of the benefit of reducing the width of content is worthy of greater prominence. Unlike AT-centric success criteria for guidelines, all of these criteria are appropriate for older people who as a population will, without exception, experience change to contrast vision and the ability to focus/presbyopia, yet the AAA placement of these guidelines does not adequately express their importance relative to older people.

5.1.3 Colour and contrast

Colour and contrast guidelines are covered by guidelines 1.4.1 recommending use of colour, 1.4.3 contrast ratios for text and images and 1.4.6 enhanced contrast ratios for text and images (Web Accessibility Initiative 2008). Guideline 1.4.1 is at Level A minimum and recommends that colour is not used as the sole means of

conveying meaning. Guideline 1.4.3 is Level AA and recommends a contrast ratio of 4:5:1. As contrast vision declines are universal and the contrast needs of older people (as discussed in Chapter 2) are much greater than for younger people, it is probably more appropriate to place colour contrast ratios as a higher priority for older people.

5.1.4 Multimedia

Multimedia content has a number of guidelines regarding accessibility. Level A requires alternatives to video and audio content that is pre-recorded, captions for both live (e.g. webcast) and pre-recorded video and audio descriptions or media alternative for pre-recorded video. Due to the high cost of audio descriptions, it can be argued that current guidelines match the needs of older people while balancing the technical requirements of accessibility guidelines at Level AA and AAA.

5.1.5 Text to speech (speech synthesis)

Like section 5.1.4, guidelines covering text to speech are at Level A. As many of the guidelines are concerned with ensuring the ATs can work with content, text-to-speech software compatibility is already determined to be a minimum requirement.

5.1.6 CAPTCHA

CAPTCHA, or "Completely Automated Public Turing test to tell Computers and Humans Apart" are frequently used to prevent spam in form submissions and have long been contentious with regard to accessibility. CAPTCHAs are often inaccessible to some users due to the inability to resize CAPTCHA text, the low contrast of most CAPTCHAs and sometimes as a result of the cognitive demands placed on users by a variation of CAPTCHAs that "test" users. Alternatives to CAPTCHAs are at Level A and therefore are appropriate for older people due to declines in contrast vision changes as well as changes to cognition. From a security standpoint, some view CAPTCHA as a necessary evil however, the use of this barrier to entry as a means of spam deterrent is contentious.

5.1.7 Links

Links are covered in three separate success criteria:

- 2.4.4: link meaning can be determined by the link or the link and surrounding content (A)
- 2.4.9: link meaning can be determined by the link alone (AAA)
- 2.4.7: keyboard focus – the link has a visual indicator that it has focus (AA) (Web Accessibility Initiative 2010).

Older people have an expressed preference for link purpose to be entirely available in the link with the "click here to" construct being popular (Sayago, Camacho & Blat 2009). The placement of this guidance at Level AAA may also not be appropriate for older people due to the cognitive barrier presented by less informative links. Because the most pertinent guidance for this user group is at Level AAA, there is a risk that a developer will not appreciate the relative importance of this guideline for the older population.

While it is impossible for some of the success criteria to be realistically implemented due to cost or technical complexity, there are some guidelines that could be presented as having a higher priority for older people without inflicting higher development costs or greater expertise requirements.

5.2 Operable

The O in POUR means the user interface (UI) and navigation must be "operable" for users (Web Accessibility Initiative 2008).

5.2.1 Links

Accessibility for links is covered by three separate success criteria and was discussed in detail in section 5.1.7. The same approach and issues with relative importance applies.

5.2.2 Navigation and location

Navigation is particularly important for older people due to declines in cognitive capacity particularly in fluid intelligence.

The three success criteria covering navigation and location are:

- 2.4.5: users should have more than one way to locate content on web pages (AA)
- 2.4.8: information about the users location within a set of pages is available (AAA)
- 2.4.2: the page has a title (A) (Web Accessibility Initiative 2010).

It has been long understood that older people get lost more frequently than younger people when navigating web sites and return more frequently to homepages (Chadwick-Dias, McNulty & Tullis 2002, Meyer et al. 1997).

Breadcrumbs, a technique to satisfy 2.4.8 are very useful to older people, however, this is ranked at Level AAA. It can be argued that this feature is more useful than the existence of a title element (Level A), which while very important to users of ATs such as screen readers are not as relevant to the typical older user. Similarly, the ability to locate pages using more than one path through the web content, again could be argued as being more important to older users than the title element. As with the other sections, the level system presents information to the developer that maintains the structure of the WCAG 2.0, but does not emphasize the relative importance of the guidelines to the specific user group.

5.2.3 Mouse use

The guidelines for accessible mouse use cover success criteria:

- 2.4.7: visible keyboard focus (AA)
- 3.3.2: labels and instructions for user input (A)
- 1.1.1: text alternatives (A)
- 1.1.4: resize text (AA) (Web Accessibility Initiative 2010).

For the most part, the recommendation levels match the research. Older people prefer to use the mouse regardless of the increase of ease associated with keyboard use. This preference is primarily for social reasons (Sayago, Blat 2009), therefore the case could be made that AA is appropriate for older people, as it is not the norm for this population to use the keyboard for navigation even when it

would be easier to do so. Similarly, the use of labels is appropriate for Level A not only to support cognition but also to support motor skill decline. Text alternatives (A) may not be as important for older users who prefer to avoid assistive technologies and do not identify themselves as disabled (Hanson 2009, Sayago, Blat 2011), which could support the claim that the ability to resize text (AA) is more important. Regardless, because the document still maps to the level system, it is more likely that a developer will ensure that the A level is met – this means that even where developers were hired to create an elder-friendly website, were they to follow the ageing-specific accessibility documentation, they are likely to expend more energy ensuring that ALT tags are accurate than making sure that text is resizable. While ALT tags are crucial for the use of ATs, this is not an accurate portrayal of the observed needs of older people.

5.2.4 Keyboard use and tabbing

Several success criteria are used to support accessible keyboard use and mostly concern avoiding keyboard traps, sensible ordering of keyboard accessible content and ensuring that content is reachable through the keyboard. Again due to the reluctance of many older people to use interaction techniques different from younger people, much of the keyboard advice will not have relevance for many older users.

5.2.5 Distractions

For people experiencing cognitive decline, distractions can make web browsing a frustrating and inaccessible experience. Three success criteria are discussed that reduce distractions for older people:

- 2.2.2: pause, stop, hide: allows users to control scrolling content (A)
- 2.2.4 interruptions: allows users to postpone or stop interruptions (AAA)
- 1.4.2: audio control: allows users to stop or pause audio (A) (Web Accessibility Initiative 2010).

The placement of interruptions (2.2.2) and pause, stop, hide (2.2.4) at Level A is appropriate for older people. However, it could be argued that interruptions could

be ranked higher, as real-time content that loads new information in such a way that the person could lose their location (such as seen on Facebook and other social media sites) may have greater impact on older people than their younger counterparts.

5.2.6 Sufficient time

Sufficient time means that people should have enough time to interact with the content. Again, as there is evidence that older people take longer to complete tasks, time limits should be avoided where possible. Success criterion 2.2.1 (Level A) allows users to adjust or turn off time limits and due to its Level A status is appropriate for older people. The ability to pause, stop or hide scrolling content (success criteria 2.2.2, Level A) is also appropriately ranked. The final recommendation is AAA and concerns the absence of timing for all but real-time media and non-interactive, synchronised media (e.g. video) (Web Accessibility Initiative 2010) and it could be argued that the Level A success criteria (2.2.1) regarding timing is sufficient to meet the needs of many older people.

5.3 Understandable

The U in POUR means, the UI and information must be understandable to users (Web Accessibility Initiative 2008).

5.3.1 Page organisation

The success criteria for page organisation concerns descriptive headings and labels (AA), use of section headings to organise content (AAA) and visual presentation techniques (AAA). There was no published data specific to the success criteria for page organisation found to support a change in level for the success criteria concerning page organisation in terms of making web content more comprehensible for novice older adults. However, there is information regarding the value of good visual presentation techniques. Organising pages in a consistent manner using visual techniques that aid comprehension as suggested in success criterion 1.4.8 was discussed in section 5.1.2 in terms of aiding people with vision decline. The same principles will also support people with cognitive difficulties, so a

case could be made for visual presentation techniques supporting cognition needing to have a higher profile than AAA. This is similarly supported by age-centred research into appropriate guidelines (Kurniawan, Zaphiris 2005).

The documentation presents text style and layout advice purely on visual accessibility grounds earlier in the document when discussing the "perceivable" principle and fails to fully emphasise the cognitive benefits of paragraph spacing, justification and width by stating that the success criteria benefits the "many older people" who "are inexperienced web users" (Web Accessibility Initiative 2010). As cognitive decline, however minor, is related to age, the lack of emphasis regarding cognitive accessibility reasons for following text style and layout guidelines is unhelpful, especially as cognitive decline has been argued to be the greatest accessibility barrier for older people (Hanson 2008). Again, the structure of the document works against the developer understanding the needs relevant to older people. By breaking down the guidelines in terms of the POUR principles, repetition is built into the document. This repetition could potentially cause developers to miss details such as the cognitive benefits of visual presentation for older people as they mistakenly skim parts of the document they feel they have seen before.

5.3.2 Understandable language

Understandable language (success criteria 3.1.3-3.1.5) is important for removing barriers caused by specialised language and jargon (AAA), reading level (AAA) and abbreviations (AAA). As all of the success criteria related to removing barriers caused by inaccessible language are at Level AAA, an argument could be made that this is not meeting the needs of older people as indicated by the research. Fluid intelligence declines with age and the greater cognitive load and distraction from the actual task caused by struggling to decipher unfamiliar language is a barrier that will be experienced to a greater or lesser degree by all older people when compared to their younger selves.

5.3.3 Consistent navigation and labelling

The consistent presentation of information is covered by the following success criteria:

- 3.2.3: consistent presentation of navigational features across website content (AA)
- 3.2.4: consistent identification of components with the same functionality (AA) (e.g. links) (Web Accessibility Initiative 2010).

Again, due to the cognitive demands placed on older people by distractions, consistency lowers cognitive barriers and it may be appropriate for the importance of cognitive barriers reduction techniques to have greater emphasis in guidelines specific to older people.

5.3.4 Pop-up and new windows

Pop-ups, new windows, tabs and the resultant focus changes can be distracting to people with declines in fluid intelligence. Success criteria 3.2.1 says that a change of context should not take place when a component receives focus (A) and success criterion 3.2.5 states that such changes of context should be initiated by the user and that they also retain the ability to turn off automatic changes (AAA) (Web Accessibility Initiative 2010). Some of the changes such as page redirects can be handled in such a way as to be invisible and therefore less distracting to users. Similarly techniques exist to allow the user to select whether the content loads in the same or another tab or window. As these techniques make changes of context more apparent to users, the argument that this is more relevant to older people and is perhaps worthy of greater emphasis.

5.3.5 Page refresh and updates

Page refreshes and updates aid both people with cognitive difficulties and those with visual impairment. Two of the success criteria concerning page refresh and updates were discussed in the previous section (3.2.1 and 3.2.5) and the same reasoning for page updates applies. The remaining success criteria 3.2.2 concerns the guidance to avoid changing context on user input (Web Accessibility Initiative

2010) (i.e. provide a submit button for input, rather than changing context when a field has been completed) and is represented as a minimum (A) requirement.

5.3.6 Instructions and input assistance

In order to reduce cognitive load, appropriate assistance should be provided to help people with interactions. Three success criteria provide information on how to reduce accessibility barriers caused by confusion over how to interact with content.

- 3.3.2: labels or instructions (A)
- 3.2.4: consistent identification (AA)
- 3.3.5: help that is context sensitive (AAA) (Web Accessibility Initiative 2010).

The first two points have been covered earlier in the chapter. There is no doubt that context-sensitive help would be very useful for older people (and everyone else), however there are significant barriers in enabling context-sensitive help across an entire site and it is likely unrealistic to consider such recommendations at a level higher than AAA in terms of extra content and work required.

5.3.7 Error prevention and recovery for forms

Ensuring that cognitive barriers to successfully filling in forms are reduced the following success criteria have been suggested:

- 3.3.4: error prevention for pages with financial or legal transactions allowing for checking and correction of submitted content (AA)
- 3.3.6: error prevention allow for the correction and checking of any submitted information (AAA)
- 3.3.1: error identification alerts and descriptions to the user for automatically detected input errors (A)
- 3.3.3: error suggestion of corrections (where known by the system) for input errors (AA) (Web Accessibility Initiative 2010).

While it is likely unrealistic to expect error correction suggestions for all submitted information the ability to correct errors for financial and legal transactions should have a higher emphasis for older people with reduced cognitive function/impairment to fluid intelligence. Equally error suggestions for known

input errors should have a greater emphasis – this is particularly notable for entry of data such as phone number which sometime require a set pattern (e.g. no spaces or hyphens).

5.4 Robust

The R in POUR stands for "robust" and supports accessibility on older equipment and software (such as browsers). The sole success criteria for this principle is the need for content to be standards compliant and that mark-up parse without error. Conforming to valid HTML/CSS and other specification is considered basic good development and is crucial for the ease of function of ATs and successful rendering of content by browsers (although as all developers know, all browsers do not parse all mark-up the same). As this is general good practice, it transcends stakeholder groups.

5.5 WCAG 2.0, older people and the level system

While the document "Developing Websites for Older People: How Web Content Accessibility Guidelines (WCAG) 2.0 Applies" does cover most of the information needed to remove accessibility barriers, the WCAG 2.0 level system is misleading in terms of stating the relevance of each of the success criteria to the majority of older people. Because much of WCAG 2.0's emphasis is on ensuring that ATs can successfully interact with web content, a tension exists in terms of ensuring visibility of the differing needs of an older population that neither wishes to use ATs nor views itself as disabled even where an impairment that could be ameliorated by an AT exists.

The level system is particularly misleading in terms of the most important success criteria for barrier removal for older people. The mapping has been applied directly from the WCAG 2.0 documentation and was likely implemented for consistency. That said, this consistency has a potentially negative effect by inferring that elements such as ALT tags and keyboard navigation at Level A are more important to remove as barriers for older people than contrast ratios (AA and AAA) and link purpose solely with the link (AAA) which is not supported by observational data.

The problem with mapping is particularly apparent for the prioritisation of success criteria for the "Understandable" principle, where many of the success criteria for ameliorating cognitive decline have a lower priority than is appropriate for older people.

Other elements such as drop-down menus and the need to ensure that they are able to withstand user slip off of hotspots are not discussed at all in the documentation. Similarly no information regarding older people primarily not identifying as disabled can cause confusion when following the level system. For example, while keyboard navigation and page titles are very important to people who use ATs for interaction (or the keyboard), older people (as mentioned in Chapter 2) generally prefer to use what everyone else uses and therefore information about drop down menus and the proper use of labels are more relevant to this population.

The concern is that because the disconnect between perceived usefulness by the developer based on the level system and actual usefulness based on data, the developer using this document risks creating a site that they perceive to be accessible to older people without actually understanding what is actually representative of the behaviour of older people. Some of the requirements will always be too difficult to be ranked as anything but AAA, but where that is not the case, it is important to map the information more directly to the needs of older people rather than seeking to maintain a parallel to the main body of the WCAG 2.0.

Table 5.1 addresses the short fallings of the current WCAG 2.0 documentation with regard to the placement of recommendations relevant to older users by presenting the WCAG guidelines that may currently be listed at the wrong level for this user group and highlighting where a change to the level may be beneficial.

Table 5.1: Importance of WCAG 2.0 guidelines, level vs relative importance to older people

Perceivable: success criteria	Meaning	Level	Relative importance to older people
1.4.4 - Resize text	Text can be resized without ATs to 200% without loss of content/function	AA	Greater
<u>1.4.8 - Visual Presentation</u>	In-depth guidance on number of characters, justification, line spacing, resize text and	AAA	Greater*
1.4.3 - Contrast (Minimum)	Images and text should have a contrast ratio of at least 4.5:1	AA	Greater
1.4.6 - Contrast (Enhanced)	Images and text should have a contrast ratio of at least 7:1	AAA	Greater
1.4.7 - Low or No Background Audio (Pre-recorded)	Reduce to background 20Db lower, eliminate background noise, or allow control to turn off	AAA	Greater

*unrealistic to implement as a whole for all sites either due to cost or technical requirements

Operable: success criteria	Meaning	Level	Relative importance to older people
2.4.9 - Link Purpose (Link Only)	Link purpose can be determined by the link text alone	AAA	Greater
2.4.5 - Multiple Ways	More than one way to access a webpage from anywhere in the site is present	AA	Greater
2.4.8 - Location	Information of the location of the user relative to the rest of the site is available	AAA	Greater
1.4.4 - Resize Text	Text resizable to 200%	AA	Greater
2.2.4 - Interruptions	Ability to suppress or postpone interruptions	AAA	Greater
2.2.3 - No Timing	Timing is not essential to the activity (not multimedia or real-time events)	AAA	Greater

Understandable: success criteria	Meaning	Level	Relative importance to older people
2.4.6 - Headings and Labels	Description of topic/purpose for headings and labels	AA	Greater
2.4.10 - Section Headings	Section headings used for organisation of content	AAA	Greater
1.4.8 - Visual Presentation	Text justification, width, contrast for foreground and background, text size, line spacing	AAA	Greater
3.1.3 - Unusual Words	Have a means of explaining or defining words or phrases used in an unusual way	AAA	Greater
3.1.4 - Abbreviations	Have a means of explaining the abbreviation	AAA	Greater
3.1.5 - Reading Level	Keep reading level to lower secondary level (or provide a version that accomplishes this)	AAA	Greater
3.2.3 - Consistent Navigation	Navigation presented in the same relative order across the entire site	AA	Greater
3.2.4 - Consistent Identification	Components are consistently identified	AA	Greater
3.2.5 - Change on Request	Changes of context are initiated by the user	AAA	Greater
3.3.5 - Help	Context sensitive help is available	A	Greater*
3.3.6 - Error Prevention (All)	User can check and edit submitted information	AAA	Greater*
3.3.3 - Error Suggestion	Provide suggestions for error correction for automatically detected errors where such suggestions are known	AA	Greater

*unrealistic to expect across all sites

How best then to communicate to developers about the accessibility needs of older adults when their needs are different from people using ATs? Several factors are at play that need to be addressed:

1. The existence of documentation is not enough. There is a need to first raise awareness that older people are beneficiaries of accessible practice and that they have accessibility needs that differ from their younger selves and younger people. Chapter 4 demonstrated that awareness of age-specific guidelines is low, and that

people are split about whether ageing is an accessibility issue. However, it is not enough to simply point to existing documentation which is flawed in terms of clearly representing older people's needs.

2. Guideline advice needs to present the relative importance of guidelines for older people. As the WCAG is AT-centric, many techniques that help older people who prefer to avoid such technology are given much lower priority within the documentation than is appropriate. Similarly, the added cognitive complexity caused by such ATs may render AT-centric techniques unworkable, so it is imperative that techniques addressing clear presentation are prominent in age-specific guidance.

3. In order to make the document more understandable, either the level system should be avoided when presenting advice on accessible development or such information should be presented with its own set of levels that, while risking confusion, would be more representative of the needs of this group.

The next chapter presents a possible response to these factors in terms of educating developers and other professionals about the accessibility needs of older people.

6. Development of a learning tool for awareness raising

This Chapter introduces the structure and architecture of the Virtual Third Age Simulator. Chapter 7 will report the results of the evaluation of the simulator by healthcare professionals.

As presented in Chapter 5, the current version of WCAG 2.0 does not adequately promote or prioritise the accessibility needs of older people. Similarly, Chapter 4 demonstrated that the perception of a slight majority of surveyed industry professionals was that ageing is not an accessibility issue. Lack of awareness of age-specific guidelines was particularly apparent with less than 20% of web professionals answering the questionnaire in Chapter 4 even being aware of age-specific guidelines available through the WAI. Project Managers scored especially low and were less likely to perceive ageing to be an accessibility issue. There is a real need to educate not only front-line staff but also people who are not technically-oriented, but have control over outputs, schedules and budgets of the simple choices required to reduce accessibility barriers encountered by ageing users. To address both the lack of awareness as well as the poor profile and structure of guidelines and learning materials concerning accessibility and ageing, a step back must be taken and the focus must shift to first raising awareness of the problem, then providing targeted solutions based on existing guidelines.

In addition to the lack of awareness, the changing learning needs of young professionals must inform the approach for the development of any advice. The use of simple text guidelines may not be the appropriate approach to educate people used to non-linear, rich media learning resources. Unfortunately, the WCAG 2.0 guidelines, while informative, are dry, machine-centric and confusing, supplying no rich content. Crucially, such guidelines also miss the first step of convincing industry professionals that the problem of accessibility for older people actually exists in the first place.

In order to raise awareness of the problem the need to supply an engaging learning resource that explicitly points out the impact of age-related changes, the decision was made by the author to use the approach of a "virtual third-age simulator" with a guided simulation/lesson component. The multimedia component, as demonstrated in the literature review especially in the research of Newall et al, provides the empathetic "hook" to allow users to connect with situations and barriers encountered by older people and provides context for the simulation. Acknowledgement of such barriers also extends the work of the WCAG by supplying social and psychological reasons for barriers – an important step in presenting the argument that accessibility for older adults is important. The simulation component seeks to add to this connection by allowing the user to take a further step in understanding the impact of ageing changes through activities where they experience simulations of age-related change. Simulation as an approach has previously been validated by the Accessibility Lab discussed in the literature review and often provides insight and greater connection not experienced by users of traditional resources. This ability to simulate capability changes not only allows developers to encounter the barriers that older people experience (raising awareness) but, crucially, suggests simple fixes for a number of barriers as well as links to further information. The software departs from current simulation offerings in the ability of the software to simulate multiple capability changes simultaneously as well as allowing the user to control the level of severity of the capability change from mild to severe. The novel browser capability of the software furthers the impact of the simulation by allowing users to view any content with the simulator, including their own.

The aim of the simulator was not to overwhelm with information but to prime people to the subject and provide understanding of the barriers from the point of view of the people experiencing such changes. The simulator aimed also to support the justification for the undertaking of the simple solutions provided to ameliorate such barriers. The level of the information is targeted to as wide a group as possible, so that project managers, who may not have advanced development

experience as well as managers and other people in non-technical roles can use and benefit from the lessons. Finally, the emergence of new technologies (in particular eye-trackers at a low price point of \$100) allows for the creation of a cost-effective, high fidelity simulation of ageing, that could act as the primer that is currently missing from age– and accessibility– related resources. The development of the software in general and the simulator in particular will be addressed in the rest of the chapter.

6.1 Simulator development

The "virtual third-age simulator" provides an example of what people may experience when they have age-related conditions. It is important to note that simulation can provide only an idea, or flavour of experiences and barriers, and cannot take into account that individual experience is just that – individual. Similarly, the amount of time spent by a learner in simulation may not allow them to experience the development of coping strategies experienced by people with disabilities and, as pointed out in the literature review, great care was taken to provide solutions to developers rather than to generate pity. This information formed the introduction to the lessons to orient the learner to the purpose of the simulation as well as the shortcomings of the simulator in terms of fidelity (pain cannot be experienced), the lack of individual variation in the perception of disability (e.g. tinnitus sufferers hear a variety of tones, whooshes and other noises with only a few being demonstrated in the simulator) as well as what people with a disability experience long-term. Where possible, people with such conditions have been approached and asked about their experiences using technology. The author herself has had a number of conditions that have illuminated the development of the simulator – including a month-long bout of moderate neurological hearing loss, six months of viral arthritis that mimicked rheumatoid arthritis as well as having tinnitus for over 20 years. These experiences have informed the development of the simulations in addition to the medical resources describing such conditions.

6.2 Simulator architecture

The simulator uses an Adobe AIR wrapper and ActionScript (AS3), C#, HTML, Javascript, Flash, xml and CSS components. Each technology was chosen for its relative merits for the task implemented. For example, C# allows for direct manipulation of cursor data and operating system functions, while AIR has excellent graphics capabilities. Similarly, the code written in HTML and Javascript are easily updatable, allowing for fast iterative design of the lesson materials. Development took six months.

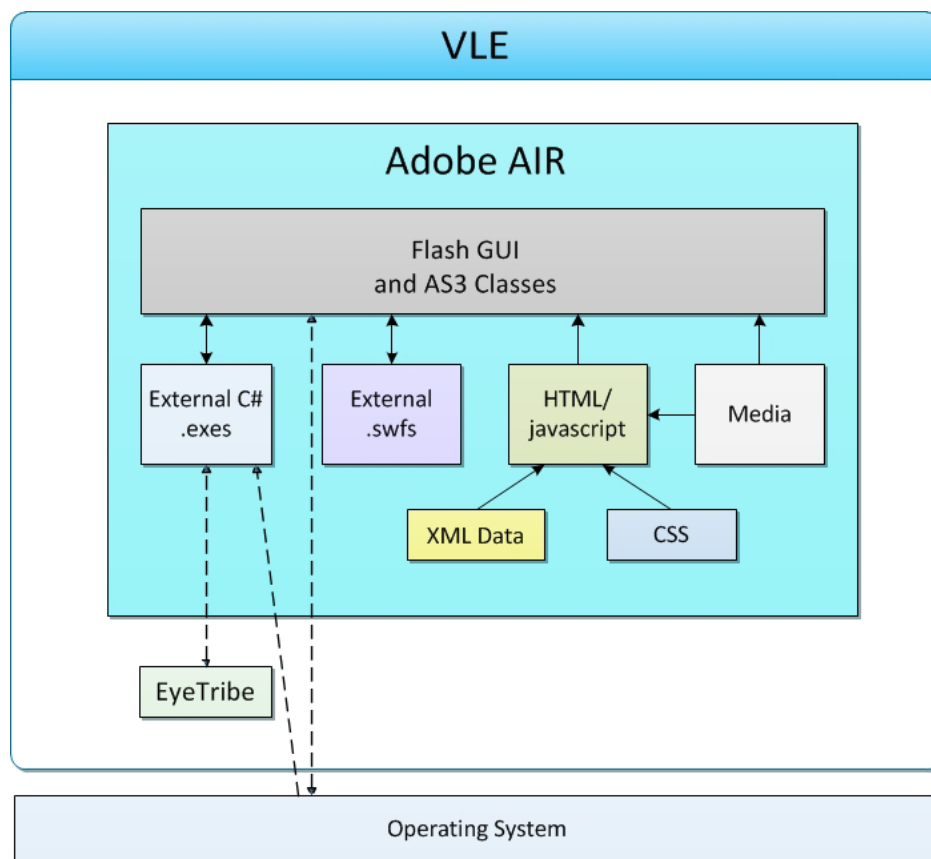


Figure 6.1: High level architecture

The main simulation functionality is coded in AS3 and uses the `htmlLoader` class for the display of all web content. This allowed for the creation of the internal web browser. The internal web browser has the capability to load both live web content from the Internet as well as local content from within the simulator itself. This technique allows for complete control over the browser. The `htmlLoader` also provides the basis for the display of all lesson pages. AS3 also has the ability to

communicate with external C# programs using the NativeProcess class. This functionality allows the AIR wrapper to load and communicate with the eye tracker program. The NativeProcess class also allows connectivity to the C# programs developed that implement the tremor and hearing loss components of the simulator. Additionally, Adobe AIR provided an excellent development environment as it allows connection to Native Menu functions allowing for window menus as well as context menus. These capabilities combined with the visual processing advantages and quick visual development environment of Flash made it well suited for the implementation of the simulator wrapper.

The shell was structured in such a way that content can be updated and expanded by developers with relative ease. The potential for expanding the simulations to include non-age related conditions in combination also exists. An object-oriented approach was used for the creation of the AS3 content, with over 30 classes making up this part of the software.

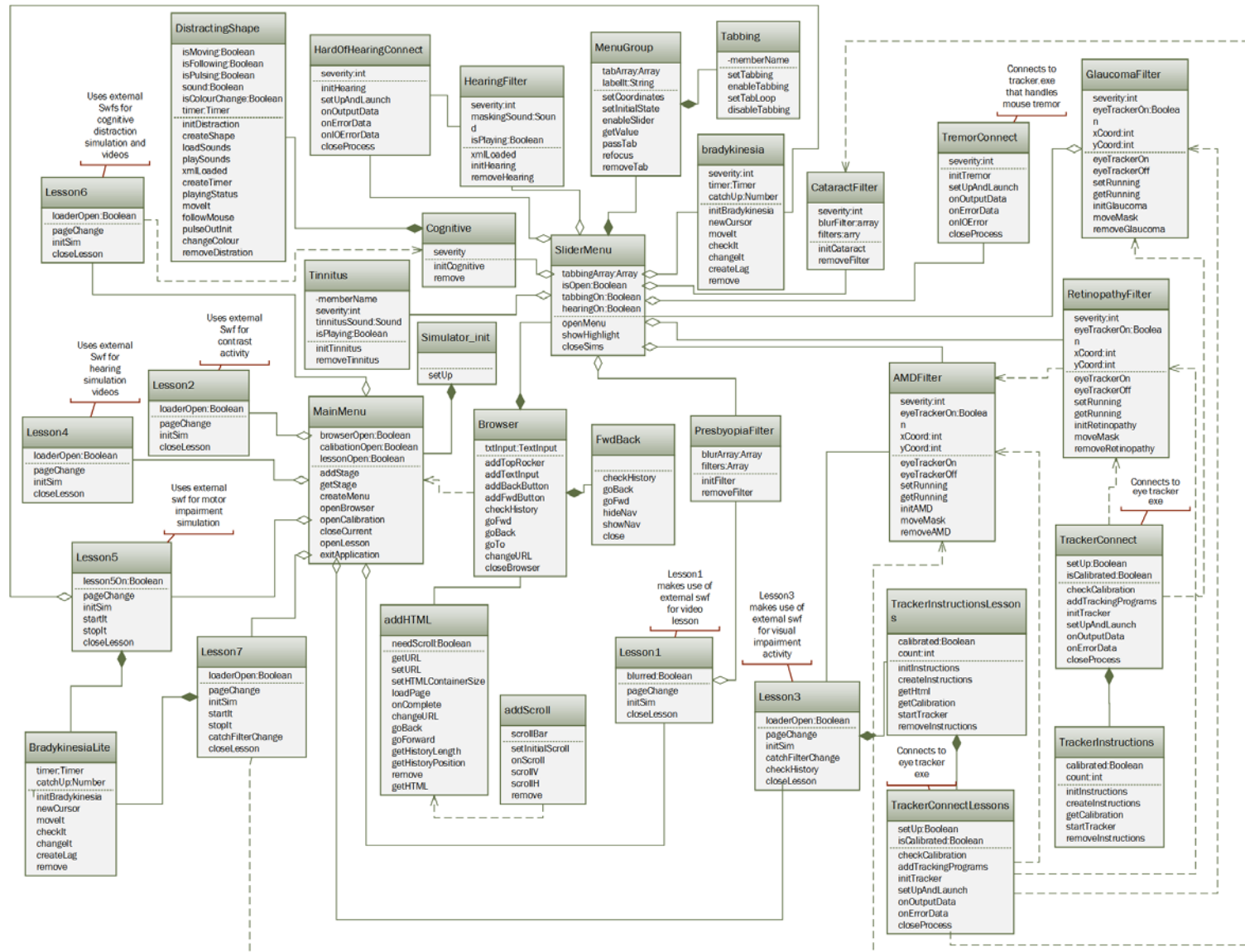


Figure 6.2: Class diagram for AIR content

Browser functionality has been kept purposely basic as older people may not know how to adjust browser settings and this design choice was intended to prevent unintentional coping by the learner through the adjustment of browser settings. To that end, only browser forward and back buttons and a text field displaying the URL with a button allowing users to go to addresses entered in the text field are included.

The eye tracking technology used is a developer's beta of the EyeTribe's eye tracker and allows, for the first time, due to a low price tag of \$100, the potential for high fidelity vision impairment simulation to be made widely available:



Figure 6.3: The Eye Tribe tracker

6.2.1 Accessibility

As the software simulates conditions affecting sight, hearing and motor control, the validation of the success of simulator required participants with good vision who were able to use a mouse. Where possible (i.e. when it does not interfere with learning objectives requiring poor accessibility) the content was made accessible as an example of good practice. Design is uncluttered and all content was manually checked for accessibility as well as with validators for HTML and CSS pages.

Keyboard navigation was implemented, media was subtitled and transcripts were provided. Clear navigation is present with breadcrumbs included in the content and the Flash content within the main simulator is keyboard navigable. Keyboard navigation of external Flash content was particularly difficult to implement as such content could not be embedded in HTML pages without causing a keyboard trap. Unfortunately due to AIR's htmlLoader making use of an older version of WebKit,

the usual Javascript solutions for Flash keyboard traps were not successful when published outside the development environment.

6.3 Simulator overview

The simulator can mimic the following conditions:

- motor slowness (bradykinesia)
- motor tremor
- age-related macular degeneration (AMD)
- glaucoma
- general age-related changes (presbyopia and contrast vision)
- diabetic retinopathy
- cataracts
- hearing loss
- tinnitus
- cognitive load changes (i.e. distractions).

Any combination of these conditions can be activated at one time, either singly or in groups. The user can also independently set the severity between 1 and 10 (mild to severe) for each of the conditions.

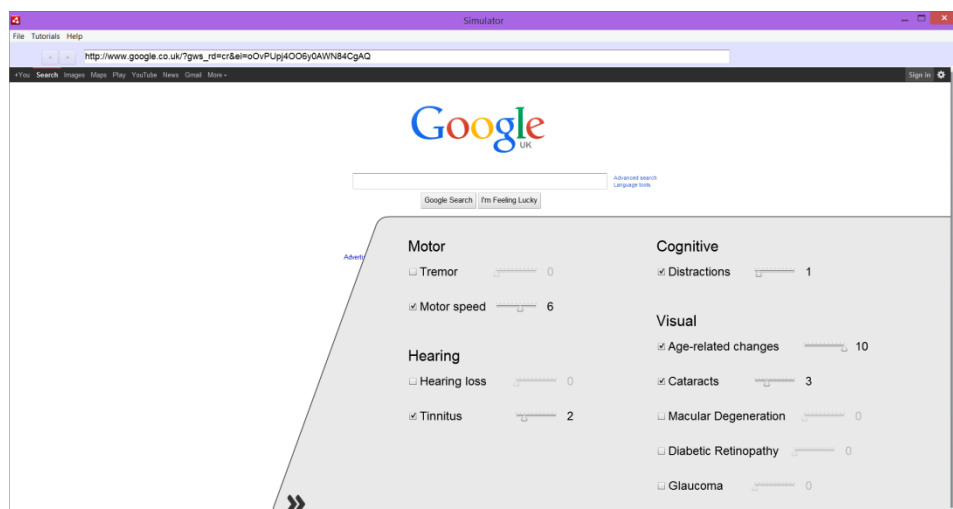


Figure 6.4: The user interface of the in-browser simulator

6.3.1 Development of simulated capability changes

The following section describes the development of each of the simulated impairments. It is important to note (and is mentioned within the text of the accompanying lessons) that these simulations can only provide an example of how people experience sensory changes and do not account for individual variation or coping strategies developed by people experiencing these changes or conditions. For this reason, the focus of the simulation is to raise awareness of barriers that arise from such conditions and how different accessibility techniques can reduce such barriers.

6.3.1.1 Bradykinesia

Bradykinesia is slowness of movement and affects all people as they age to some extent relative to their younger selves. Bradykinesia is simulated using ActionScript 3 (AS3) and is identified in the UI of the simulator as "motor speed". The operating system cursor is hidden and replaced by an identical cursor arrow. In order to mirror the system cursor behaviour, the cursor arrow changes to a hand when hovering over links and text boxes.

This replacement cursor is then "slowed" programmatically. When the user selects a severity level from 1 - 10, a switch statement assigns a "catchup" value to the cursor that slows the movement of the replacement cursor relative to the actual cursor position and progressively slows the cursor so that the end of the movement is slower than the beginning of the movement – this mimicks observed behaviour of older mouse users who tend to expend more effort slowing the mouse than younger users who spend equal amounts of time accelerating and decelerating the mouse (Ketcham, Stelmach 2004, Keates, Trewin 2005). The result is that cursor movement is slower regardless of the user's speed of movement and it is more difficult to gauge where the cursor arrow will stop. As the operating system cursor is still active a second method is used to disable all HTML content until the replacement cursor is in a range of 15 pixels of any interactive content.

6.3.1.2 Motor tremor

Motor tremor is simulated in C# and controls the location of the system cursor. The severity selected by the user (values from 1 - 10) in the interface determines the range of the "jump" in cursor location when a tremor occurs. The tremor occurs randomly with a range of 5-10 seconds between jumps. For example, for a severity of "1", the cursor could jump in any direction between a range 20-30 pixels on both the x- and the y-axis while a severity of "10" would jump the cursor between 110-120 pixels. The direction of the jump is determined pseudo-randomly by selecting a value of "1" to "4" for each jump. A value of "1" will jump the cursor by the determined range using a positive displacement of X and Y mouse coordinates i.e. $\text{mouse.x} = \text{mouse.x} + \text{range value}$, $\text{mouse.y} = \text{mouse.y} + \text{range value}$. A value of "4" will use a negative displacement of the X and Y mouse values, while values of "2" and "3" will displace either the mouse.x (horizontal) or mouse.y (vertical) location respectively. This allows for the ability to displace the cursor in any direction and in a range that is dependent on the severity selected by the user. While the implementation of the tremor is in C# and the motor slowness is in AS3, both of these simulated impairments can be used simultaneously.

6.3.1.3 Hearing loss

Hearing loss is simulated in two different ways. For the lesson component, the higher frequencies of the video soundtrack were suppressed using a bandpass filter to emulate moderate high-frequency hearing loss. For the general simulator, the system volume is turned down and a pink noise sound overlaid, as programmatically altering audio streams in real-time would have been prohibitive to the timely completion of the simulator. Pink noise was chosen for its masking properties of sounds along the spectrum of frequencies audible to people.

6.3.1.4 Tinnitus

Tinnitus is simulated using three separate sine waves. Each sine wave generated is within the range of frequencies used in speech (250 - 6000 Hz). A lower frequency sine is used for mild impairment (severity 1-3) and the volume of the sine wave is determined by the severity selected by the user. For mild impairment, the sine

wave is output at a frequency associated with vowels in speech. A higher frequency sine wave is output for moderate tinnitus (severity = 4-6) and has a higher volume than the mild tinnitus—this sine wave is at a frequency associated with consonants as the loss of consonants is harder to adapt to than the loss of vowels. The volume is determined by the severity selected by the user. The high severity tinnitus (severity = 7-10) uses a high frequency sine wave as well as masking pink noise to obscure speech and is output at a frequency associated with spoken consonants. Again the volume was determined by the severity level selected by the user. The tones themselves were selected as tones similar to those the author has experienced in her twenty years with tinnitus.

6.3.1.5 Distractions

As it was impossible to mimic cognitive impairment through the modification of external content viewed in the simulator browser, the decision was taken to add to the cognitive load of the user by overloading the senses with moving graphics that require interaction to remove as well as unpleasant sounds designed to irritate and distract the user. Moving graphics were chosen over alert boxes or similar widgets in order to add an element of unfamiliarity that a person who is a novice or is cognitively impaired might encounter. The level of severity chosen by the user determines the number of distractions present and is identified in the interface as "Distractions". For example, a severity of "1" results in the generation of a single object that has a static location and shape, while a severity of "7" results in the generation of three separate objects. Some objects play sounds on mouse over and some shapes also slowly change colour or size as they move around the screen. All objects can be disabled by right-mouse clicking and selecting the menu item that will temporarily allow access to the content under them:

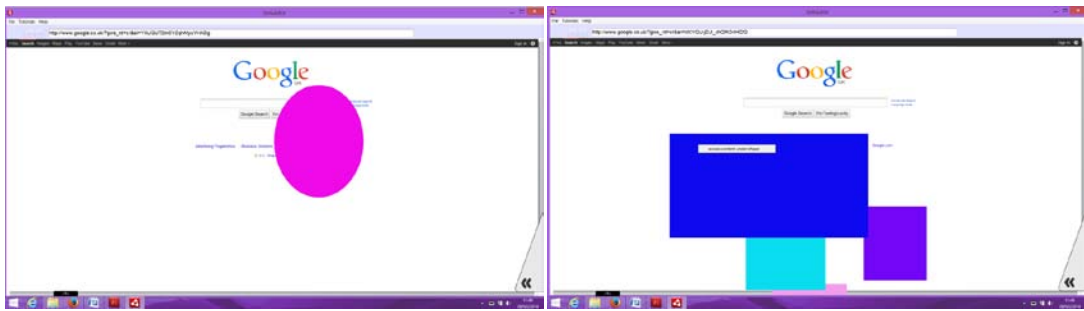


Figure 6.5: Side-by-side comparison of distractions severity = 1 and severity = 7

The cognitive load caused by needing to disable distractions, coupled with annoying sounds added to the cognitive load of the user enough to cause frustration and to slow task completion, mimicking the effect of decreased capacity to ignore distractions relative to an individual's younger self.

6.3.1.6 Presbyopia and contrast vision changes

Presbyopia is simulated by blurring content, and contrast changes are simulated by reducing the brightness, contrast and saturation of browser content. In order to maintain the legibility of content, the blur filter is spread over 2 pixels (along both x and y axis) which is enough to blur words and to make them significantly harder to read without making the text illegible, and the severity entered by the user determines the number of times that the image is blurred. The brightness, contrast and saturation settings are all controlled using the severity level selected by the user. For brightness and saturation settings each increment of severity, from "1" to "10" reduces these settings by 5% of the default setting. For contrast, 2% was the chosen reduction per severity increment.

```
color.brightness = color.brightness + (severity * -5);
```

```
color.saturation = color.saturation + (severity * -5);
```

```
color.contrast = color.contrast + (severity * -2);
```

The minimum reduction of brightness and saturation is 5% from default with the maximum being 50%. Although light requirements for older people can be up to two to three times the amount needed for younger people, such reductions did not transfer to programmatically derived changes to bitmaps and would have rendered

even accessible content unreadable. For contrast, the minimum reduction is 2% with a maximum reduction of 20%:

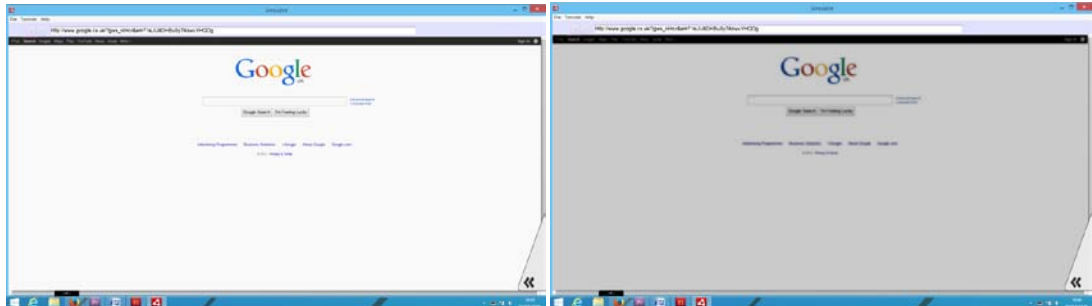


Figure 6.6: Side-by-side comparison of age-related sight changes severity = 1 and severity = 10

6.3.1.7 Cataracts

Cataracts are simulated by applying a blur filter to browser content. The blur filter is spread over the x and y axis by 1.5 pixels and the severity chosen by the user determines the number of times that the blur filter is applied. In order to simulate the brown film that many people with cataracts experience, 10 brown images with differing levels of alpha are overlaid over browser content to modify the severity.

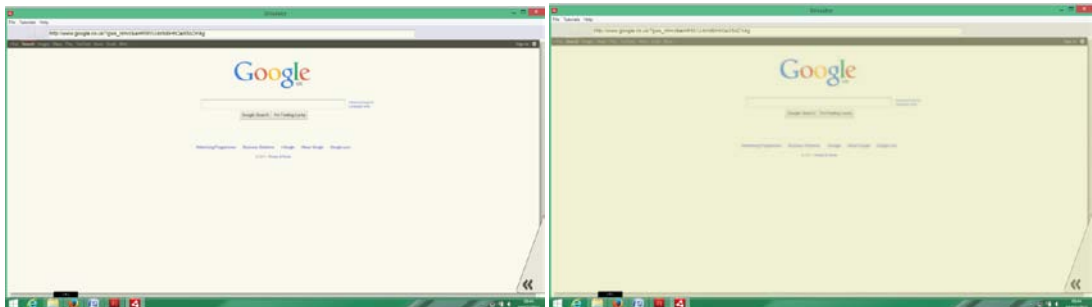


Figure 6.7: Side-by-side comparison of cataracts severity = 3 and severity = 10

While the severity of a cataract can, in reality, be worse than a severity of 10, the learning point regarding accessible practice for vision is the goal of the simulator, so it is important that developers see a real impact of accessible choices. To that aim, the filters create a barrier that can be surmounted with accessible design.

6.3.1.8 Age-related macular degeneration

AMD is simulated by using 10 images with different sized visual disturbances and increasingly greater alpha values to change the severity of the AMD simulation. The visual disturbance image moves with the users gaze to simulate the loss of the

central field of vision. The eye-tracking behaviour of the simulator is novel as it has not been previously implemented and marks a significant increase in the fidelity of such simulations as users cannot "look around" the visual disturbance. The difference in perception of fidelity (and difficulty) is marked when compared to earlier versions of the simulator software, which had the AMD image move with the mouse pointer and was easily ignored by the developer.

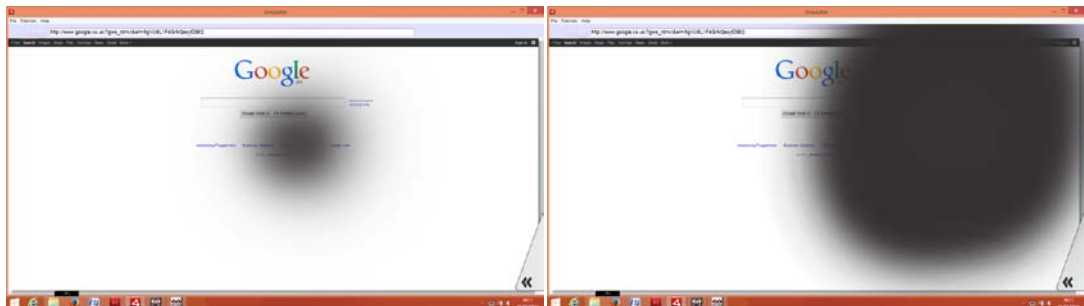


Figure 6.8: Side-by-side comparison of AMD severity = 3 and severity = 10

6.3.1.9 Diabetic retinopathy

Diabetic retinopathy is simulated using 10 images with different levels of alpha as well as different size and numbers of visual disturbances. The diabetic retinopathy simulation also uses the eye-tracking technology to allow the visual disturbances to move with the user's gaze point. Again, this gaze tracking adds greater fidelity to visual impairment simulation.

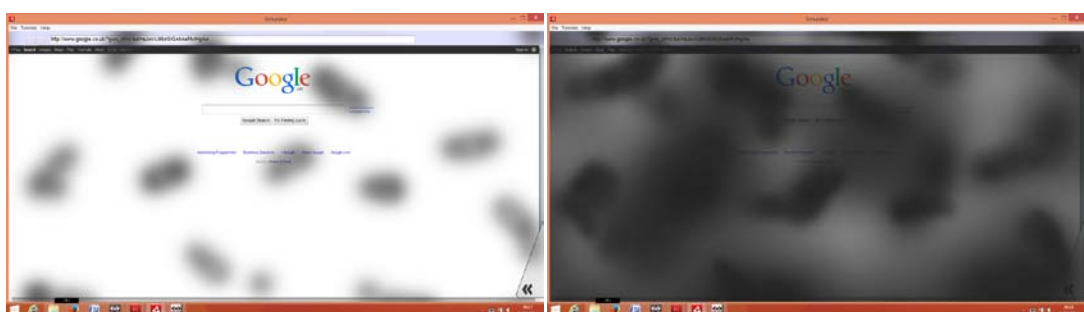


Figure 6.9: Side-by-side comparison of diabetic retinopathy severity = 1 and severity = 10

6.3.1.10 Glaucoma

The glaucoma simulation makes use of ten separate images with differing levels of peripheral obscuration depending on the level of severity selected by the user. Again, eye-tracking data is utilised to add to the fidelity of the simulation with the viewable area moving with the users gaze.

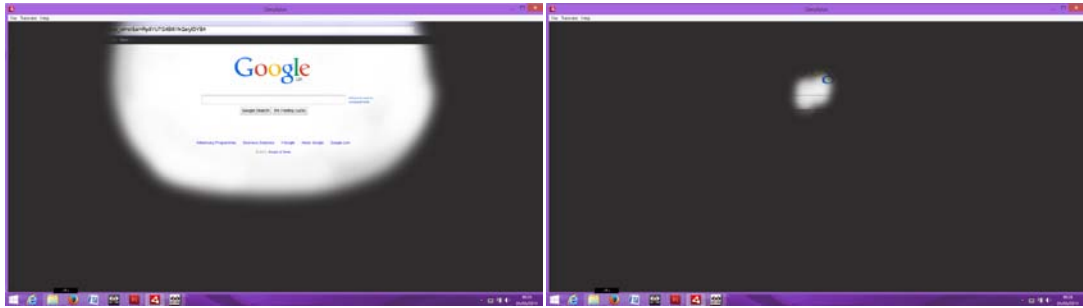


Figure 6.10: Side-by-side comparison of glaucoma severity = 1 and severity = 10

Although people with glaucoma often experience blurred vision, this was left out of the simulation as the interaction became so difficult for the user that the learning aim was lost.

6.3.1.11 Multiple impairments

Another novel development in the software is the ability to simulate more than one impairment at a time. The user can select any combination of impairments and can control the severity of each impairment independently. This functionality is extremely important for the simulation of the effects of ageing because, as demonstrated in the literature review, many older people with chronic conditions have more than one such condition, particularly in the over-75 population.

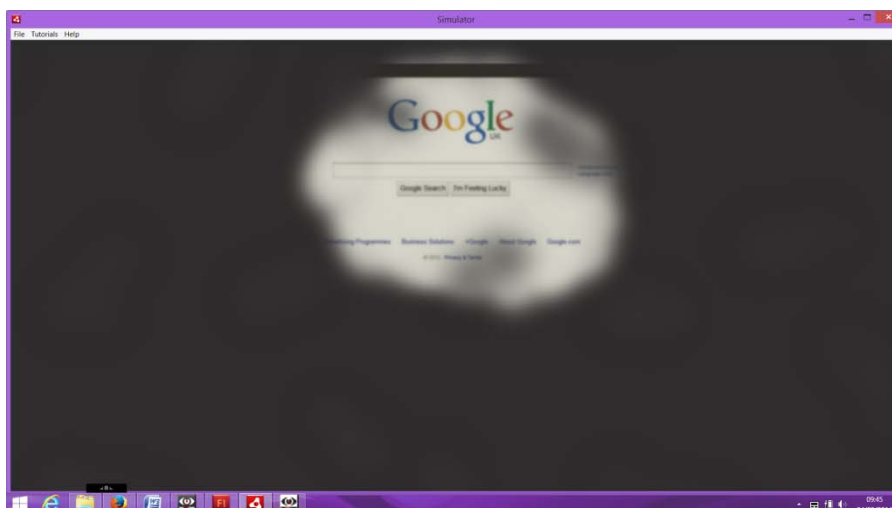


Figure 6.11: Age related changes severity = 8, cataract severity = 3, diabetic retinopathy severity = 2 and glaucoma severity = 5

6.4 Lesson development

Aristotle described three modes of persuasion (traditionally through spoken word) as, Logos, Ethos and Pathos. "Logos", which is essentially "proof" arising from the

argument itself, in other words, the appeal of the argument, is made to an individual's sense of logic. "Ethos" requires the audience to believe in the authority and credibility of the speaker or writer and "Pathos" uses an appeal to emotions to stir the audience (Aristotle translated by W. Roberts). The lessons use Pathos in the form of simulation as well as the use of media to stir the emotions of the learner in order to allow them to empathise with older people. Once the learner has been engaged emotionally, the logical (logos) argument showing simple fixes to accessibility is presented and while the software is essentially "faceless", ethos is also used in the form of referencing recommendations to existing peer-reviewed research. By utilising this approach, which is similar in spirit to BS 8878 rather than WCAG 2.0, the software serves to "champion" accessibility for older people, by raising awareness, including the voices of older stakeholders in the form of ethnographic data, as well as providing an initial touch-point that provides links to further information.

The lessons were designed to reach as wide an audience as possible within the web industry. It is crucial that professionals see a real impact of accessible choices during the simulation, in order to highlight the benefits of such choices. This approach is particularly important in the spread of awareness and behavioural change across organizations as the visible and experiential nature of the simulator casts a wide net across all levels of an organisation to wherever a potential sympathetic ear can be found. This approach also acknowledges the observations made in Chapter 4 regarding project manager accessibility awareness differences from front-line staff. This also allowed for the simulator to be tested at the student level as the assumption of previous knowledge is minimal.

An introduction to the lessons is included and emphasises that the goal of the simulations and lessons is to educate web professionals and students about the barriers experienced by people experiencing age-related capability change and how design choices can greatly improve accessibility for older people.

6.4.1 Lesson breakdown

All lessons follow the same structure and cover the following:

- an introduction to the age-related change or condition
- a simulation(s) of the changes or conditions described
- an explanation of why web professionals need to be aware of these conditions
- an explanation of how web professionals can help ameliorate the effects of such barriers through accessible practices (see Appendix 5 for the full lesson text).

The pronoun "you" is used throughout the lessons as a means of emphasising the global experience of ageing. The idea is to connect the person to the statistics – for example, "you have a one in two chance of cataract formation in the course of your lifetime".

6.4.1.1 Lesson 1: text size and ageing

Lesson 1 introduces presbyopia, a sight-related change that happens to all people as they age. An example of text viewed by someone with uncorrected presbyopia is then displayed. Emotional, social and practical reasons for people not getting sight-correcting glasses are then examined and a video showing discomfort at being seen to need glasses for presbyopia is presented. The majority of videos used were released under Creative Commons license; however, the presbyopia example involved a clip from *Star Trek II: The Wrath of Kahn*. While the video is under copyright, as the software is present only on one computer, not available online and is solely for the purpose of research, it falls under Fair Dealing under the Copyright, Designs and Patents Act, 1988 (legislation.gov.uk 1988). The final page provides information on accessible text as well as a side-by-side comparison of accessible and inaccessible text with simulated presbyopia:

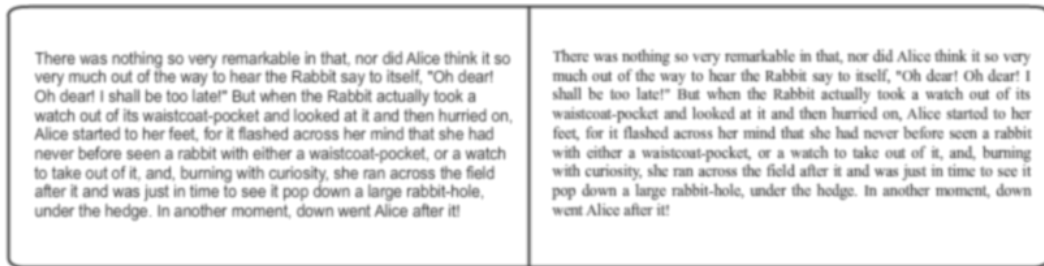


Figure 6.12: Side-by-side comparison of same size serif and sans-serif text with presbyopia overlay, Source: [Alice In Wonderland](#)

The lesson ends with information about accessible practices for the ageing eye including basic information about accessible font choice. Links to more detailed information are included in the lesson.

6.4.1.2 Lesson 2: colour and contrast and ageing

The second lesson builds on lesson one by examining universal contrast changes that happen to the eye as it ages. Again, the lesson starts with an introduction about how ageing affects contrast discrimination and colour perceptions. A word find activity is then introduced. This activity presents 10 groups of words, with one word identified in the top left corner as the word that needs to be found. In order to show the difference between good and poor contrast text colours, five examples of good contrast and five examples of poor contrast are used. With each turn the contrast is decreased.



Figure 6.13: Side-by-side comparison of poor contrast word group with and good contrast word group

The activity ends with a description of the contrast settings of the text relative to the background for more and less contrast. Finally, the lesson concludes with the advice that while such contrast changes are minor for people with good contrast discrimination, the legibility of the text quickly degrades for people who have experienced decline in their contrast vision.

The next section provides educational, psychological and environmental reasons for why people may have problems accessing content with poor contrast despite the existence of accessibility features and monitor contrast control. The lesson then adds to the information provided in lesson one by demonstrating the cumulative effect of presbyopia combined with declines in contrast discrimination.



Figure 6.14: Side-by-side comparison of simulated presbyopia with good contrast and poor contrast text, Source: Alice In Wonderland

The lesson ends with information on contrast and links to contrast calculators as well as links to more information about contrast vision changes.

6.4.1.3 Lesson 3: what about other conditions? Age-related disease and vision

Lesson 3 introduces age-related diseases that affect sight and described: cataracts, diabetic retinopathy, glaucoma and age-related macular degeneration (AMD). The second section contains a word find activity with examples of each of the four age-related visual impairments described in the lesson introduction. For ease of comparison, accessible and inaccessible word find paragraphs are included for each impairment. Because the eye-tracking prevented "cheating", an optional "skip example" function is included in this activity.



Figure 6.15: Cataract word find example with inaccessible font and contrast choices

The lesson continues with reasons, including psychological, social and technological reasons, why older people may not use assistive technologies or change their accessibility settings even if they have the conditions described. The lesson concludes with information on how to make text more accessible to older people who do not use ATs, as well as links to more detailed information.

6.4.1.4 Lesson 4: hearing changes

Hearing changes are introduced in lesson 4. Global changes to high frequency hearing as well as conditions causing other types of hearing loss are introduced in this lesson. Example videos simulating high frequency hearing loss, and tinnitus, which is common particularly among older people, are then shown. Where possible, Creative Commons videos were used so that there would be no copyright issues were the simulator widely distributed. Psychological, social and practical reasons are supplied for why understanding hearing loss is important for web professionals and students. And finally information on accessible rich content for people with hearing loss is introduced with links to further, more detailed content provided.

6.4.1.5 Lesson 5: motor changes

Global changes to motor function relative to an individual's younger self is introduced in this lesson. Also age-related conditions that impede motor control

are described. An exercise demonstrating slowness of movement with unpredictable tremor and the impact on tasks such as menu selection and form filling is then introduced to the learner. Social, psychological and practical reasons for why older people do not revert to keyboard navigation or change accessibility settings is supplied following the exercise. Finally, further information about how to provide more accessible content for non-keyboard navigating users is introduced as well as links to more content.

Please note that keyboard navigation compliance is discussed, but as such interaction is not typically used by older people who did not use such techniques before encountering age-related motor changes, it is not the focus of the lesson.

6.4.1.6 Lesson 6: cognitive changes

Global changes to cognition in terms of working memory, distraction and task switching are introduced in this lesson. Types of cognition that are unchanged (or actually improved) i.e. what is commonly described as "wisdom" are also introduced. As it is impossible to simulate cognitive decline directly, the menu-search activity uses distracting shapes and sounds to simulate the effect of increased cognitive load experienced by older people trying to navigate web pages. Distracting shapes were chosen for their unfamiliarity to developers, as pop-up messages, while more realistic, will likely not be perceived by developers to be as big a distraction due their familiarity with such interruptions. Half of the menu search item examples have distractions and half do not. Users can access content under shapes by right mouse clicking and selecting the menu item disabling distracting content. Some shapes play distracting sounds on mouse over. To further increase cognitive load, the search item to find is only displayed for a few seconds and if users wish to see the search item again, they need to press the "Hint" button.

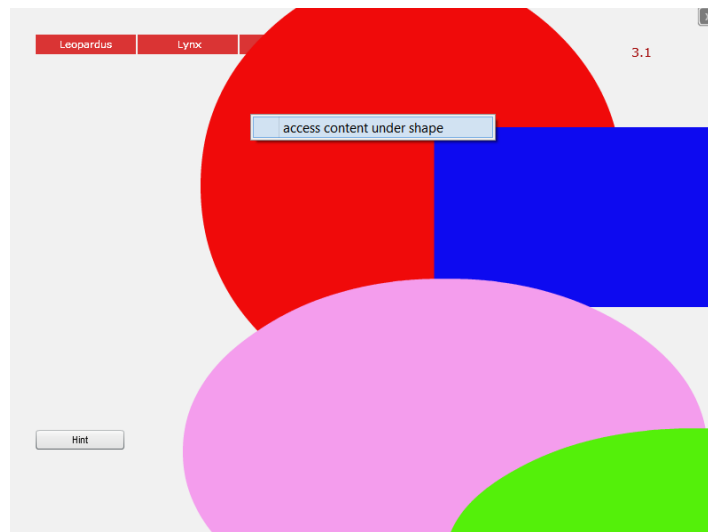


Figure 6.16: Menu item find activity with distractions present

Reasons why developers should be aware of the effects of cognitive change is presented with social, psychological, practical and medical reasons discussed. Two videos, the first showing an example of reducing cognitive load (*Space Cowboys*) and a second, Creative Commons video showing a guitarist in his 70s as an example of the use of familiarity (i.e. crystallised) intelligence is presented. The lesson ends with information on how to provide more accessible content for people with cognitive decline, as well as information about leveraging cognitive abilities that remain largely unchanged. Links to further, more detailed information is also provided.

Please note that accessibility practices for dementia were not taught due to the much higher needs of this group that will likely need a facilitator or proxy user in later stages. However, the condition is mentioned within the lesson body.

6.4.1.7 Lesson 7: putting it all together

The final lesson raises the question of what happens when older people have multiple chronic conditions and changes that impede their ability to use the web. The lesson provides information on the number of older people with multiple chronic conditions. Two separate activities are provided. One is a video with high frequency hearing loss and AMD combined and a second activity involves form filling with simulated cataracts, bradykinesia and tremor. A brief description of why

industry knowledge of multiple chronic conditions is important is presented. The lesson ends with a concluding statement about accessible practice.

The next chapter discusses the validation of the software in terms of the accuracy of the simulation with regard to fidelity of the barriers presented through the use of the simulations, success of communicating the learning points and the identification of any interaction barriers.

7. Simulator validation

Before commencing any experiments regarding the success of the simulator to affect attitudes towards web accessibility for ageing, the simulator was validated for quality, fidelity and interaction barriers. Although people with age-related conditions were approached about their experiences with technology, it was not possible to validate the simulator with older participants. This was for several reasons:

- issues of symptom triggers (the tinnitus simulation can induce spikes in symptoms -- and the simulator contains a warning to that effect)
- geographical spread of people consulted about their experiences
- difficulty recruiting participant advisors
- concern that people with conditions may find verifying the simulator itself difficult due to the individual nature of the experience of chronic conditions and disability.

In order to ameliorate the above but still allow for a quality validation, three doctors (two consultants and one GP Foundation Year 2) as well as one media/IT teacher completed the lessons. These testers were consulted on whether what they read and experienced matched their medical knowledge of the conditions discussed and in the case of the teacher, provided the information that met the intended learning objectives in a way that younger people would find engaging. A secondary benefit to having doctors for validation is that they not only have a good level of IT-literacy (current medical training involves VLE use) and a commitment, not only to life-long learning, but also experience of peer teaching if they work for the NHS. The same sessions also served to validate the UI of the content and to identify any major interaction barriers.

7.1 Evaluation procedure

Each of the testers was informed that the test would take forty minutes to an hour to complete, including discussion time. The system was launched for them and the developer was present. The testers were observed interacting with the device and

encouraged to mention any interaction or fidelity concerns as they arose in an informal think-aloud protocol. Notes were taken during each test and evaluators were asked the question whether the simulated impairment conformed to their medical knowledge after each simulation presented. Any problems noted by the developer in terms of bugs or interaction difficulties were also noted. The comments from the testers also helped to determine the minimum acceptable calibration output of four out of five stars on the calibration screen ("good" or "perfect"). Any other comments added by the testers were noted and informed the next iteration of the software. The simulator was updated after each test so the testing/validation conformed to a spiral type development model.

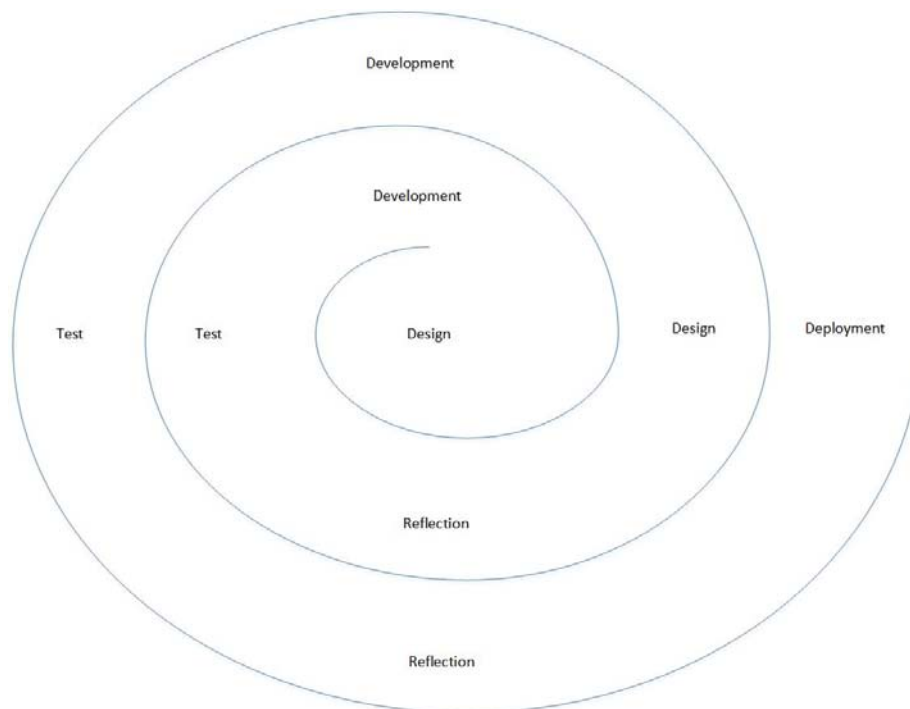


Figure 7.1: Spiral software development model

7.2 Evaluation findings

None of the doctors consulted raised any concerns about the fidelity of the simulator. The question of whether the simulation conformed to their medical knowledge was asked of all medical testers after each simulation. The doctors were unanimous in their agreement that the simulator was in keeping with their medical knowledge in all the simulations however, all of them moved forward and

backwards to see if the blur in the presbyopia simulation improved with distance. This behaviour resulted in information being added stating that the presbyopia simulation was static. It is important to note, that the fidelity for presbyopia has the potential to be increased in future iterations using the eye tracking functionality, but that as the Software Development Kit (SDK) for the Eye Tribe tracker is in its infancy, data regarding head position and approximate distance are not yet available to the developer.

Comments about the simulator were positive, and in particular the AMD simulator drew comment from one doctor in terms of the simulator demonstrating the effect of AMD very well, something she found lay people had a hard time understanding when the condition was explained to them. The only other comment other than general positive comments about the realism and fidelity of the simulator was that the content was presented in a warm and accessible manner.

In terms of interaction, the following improvements were made to the interface:

- addition of a progress bar
- inclusion of breadcrumbs improved to make current page more obvious
- improvement to eye tracker instructions.

The main barrier encountered by testers was in the amount of information presented. It was noted that all of the doctors skimmed the information presented which was initially, quite text heavy. As a result, the lesson content was reduced by about half. This reduction did not detract from the learning points but refined the presentation in such a way that it was less word-heavy and used a bullet point structure to communicate key facts. The text and media information presented was used to introduce the conditions simulated and then to explore why it was important to understand how people experience these conditions. Suggestions followed on how to make simple changes to increase accessibility. In this way an introduction and debrief to each of the simulations was included within the structure of the software. It is important to have an introduction to the simulation to inform the user what to expect allowing them the ability to make an informed

choice about whether they wish to proceed with the simulation. The debrief was similarly important in keeping participants mindful of the stated aim of the simulator. As the aim of the simulator is to provide information and examples of techniques that ameliorate the effects of age-related capability changes rather than fostering pity, the intention of the debrief was to keep participants in such a mindset.

An unintended secondary effect of the choice of testers was that the level of complexity of the content could be tested. Two of the testers had some web design and development experience, but all of the participants could understand the information presented. As the simulator is aimed at non-technical people as well as technical people, it was important to ensure that non-technical people would not be excluded from benefiting from the content providing advice and support.

8. Evaluation of the impact of the simulator

Upon completion of the validation for content and fidelity, the simulator was presented to students and professionals working in the web industry.

8.1 Research questions

The software was used to investigate if simulation could address the lack of visibility and awareness of ageing and accessibility. From this main research direction, two sub-strands of investigation arose concerning the simulator:

1. Do web professionals see web accessibility requirements as linked solely to the current generation?
2. How do web professionals rate their awareness of web accessibility for older adults?

From the research questions the following hypotheses were derived:

H1: Using the simulator can affect the attitude that accessibility for ageing is restricted to the current cohort of older people.

H2: Use of the simulator can raise the awareness that ageing can create accessibility barriers.

H3: Use of the simulator can raise awareness of age-specific good design practice.

H4: Use of the simulator can raise awareness of age-specific guidelines.

H5: Use of the simulator can increase confidence in implementing age-friendly websites.

8.2 Study design

The simulator was assessed using a pre- and post-simulator use questionnaire (see Appendix 6). Qualitative data was also gathered during and after use of the simulator. Qualitative data gathered *during* the simulator test was gathered only if voluntarily offered by the participant with no prompting from the researcher. Post-questionnaire questions consisted of one standard follow-up question: "What was your experience of the Learning Environment in terms of its success in teaching about web accessibility for ageing and age-related conditions?" Any other

questions asked were based on researcher observation of the participants during the test.

All participants were given an information sheet to read and were informed that they had the right to leave the study at any time during the test. An ethics checklist was filled in and all participants gave their consent before participation.

The test itself generally took between 40 to 60 minutes and involved:

- answering the pre-questionnaire
- completing the simulator lessons
- answering the post-questionnaire
- participating in a short debrief and answering qualitative questions.

The researcher was present during the test, but spoke during the test only when spoken to by participants and was primarily present to help people calibrate the eye tracking software and to observe participants in as unobtrusive a manner as possible.

The majority of student participants were recruited through sending emails to students taking modules in Computer Science at Loughborough University. Professionals and some additional students were recruited using snowball or respondent-driven sampling. The start of the "snowball" was the author's professional contacts gained during her time in web development. While snowball sampling is not random, the majority of respondents were not known to the author as they were recruited by other participants taking part in the study. While there is a risk of bias, the recruitment of participants outside of the author's network allowed for a varied sample in terms of age, experience, knowledge of web accessibility, gender and job role within the web industry.

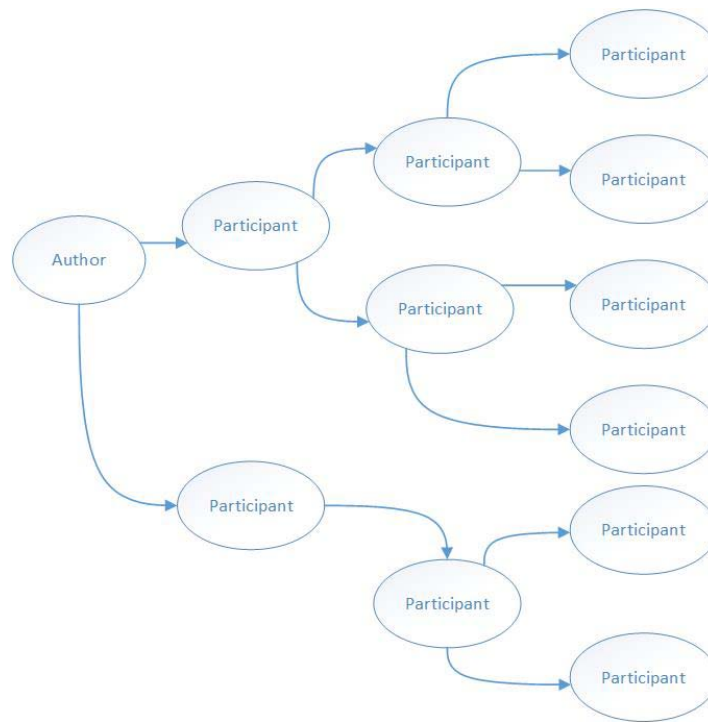


Figure 8.1: Example of snowball sampling

8.3 Results

8.3.1 Respondent breakdown

Fourteen people participated in the evaluation of the study. Six of the participants were students with an element of web development in their degree course and eight were working in the web development industry. Job types varied from development and design to content creation, social media content managers and management. Seven of the participants were women and seven were men. Of the professionals, participants were evenly split between people with front-end technical jobs and non-technical roles. The majority of participants were between 25 and 39 years of age.

Table 8.1: Age range of respondents

Age range	18-24	25-39	40-54	55-64	65+
Number of respondents	2	10	2	0	0

8.3.2 Responses to pre- and post-simulator use questionnaire statements

The first question sought to gauge the opinion of the statement, "Ageing as a barrier to technology use in the UK will disappear as current generations have spent their whole lives with technology." In the pre-simulator use questionnaire, 64% agreed with this statement. In the post-questionnaire five disagreed and five strongly disagreed with the same statement.

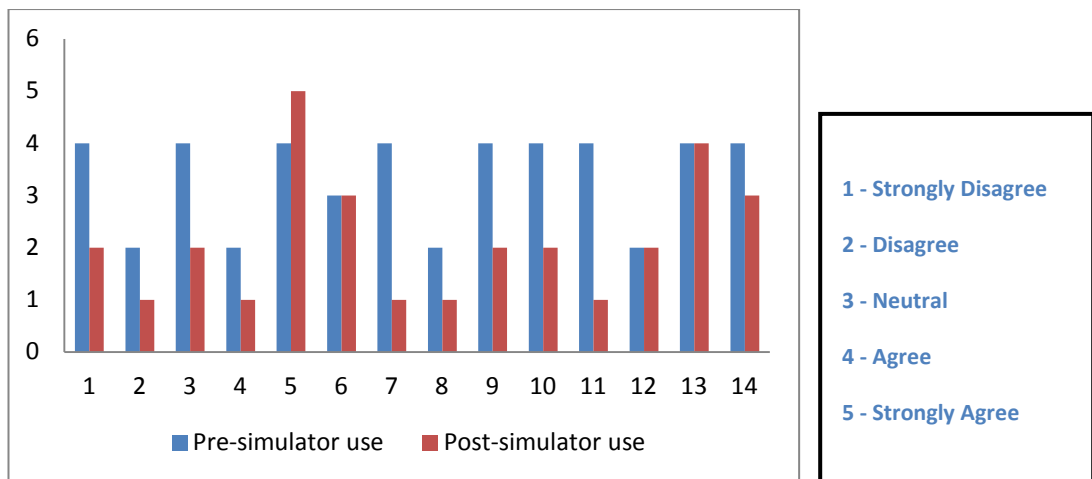


Figure 8.2: Pre- and post-simulator use: results by participant to ageing as a barrier to technology use statement

The second question continued in the same vein as the first, but asked more generally if, "Age-related changes can create barriers for older people accessing the web." Most of the respondents were in agreement with the statement. The post-questionnaire results showed stronger agreement in half of the respondents.

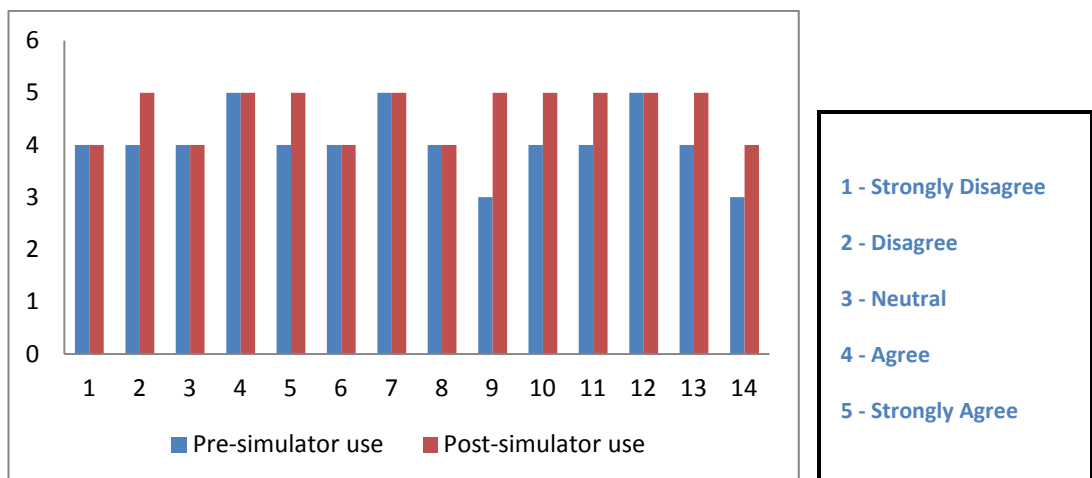


Figure 8.3: Pre- and post-simulator use: responses by participant to ageing creating barriers to web access statement

As direct interfaces such as tablets and Smartphones are an increasingly popular means of interaction, the third question sought to gauge opinion on the statement that "current changes to interfaces (i.e. touch screen, Kinect etc.) mean that technology is getting easier for older people to use". Nine participants were in agreement or strongly agreed with the statement. In the post-questionnaire, this shifted to a neutral position (N=6) or disagreement (N=5). Half of respondents remained unchanged in opinion pre- and post-simulator use. Where changes occurred, participants moved from agreement with the statement to neutrality to the statement.

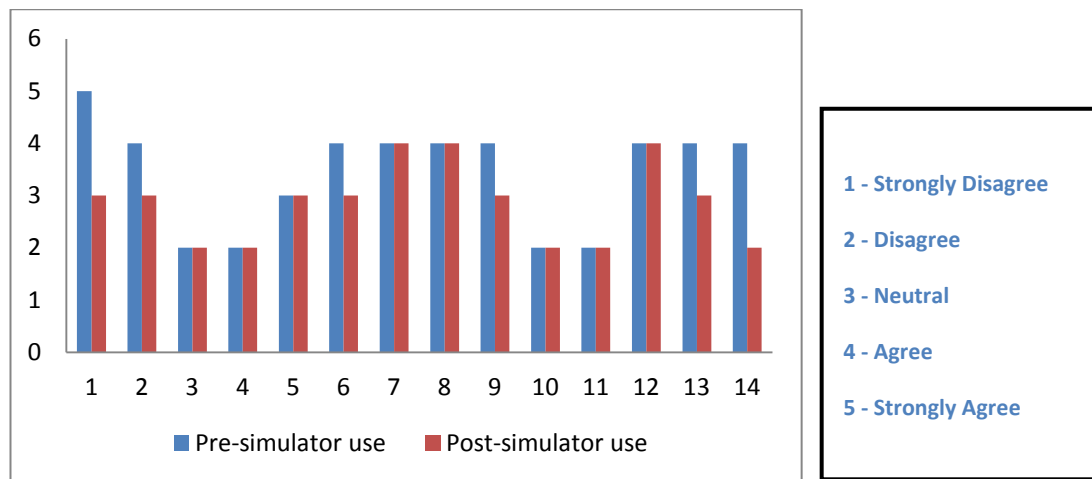


Figure 8.4: Pre- and post-simulator use: responses by participant to changes in interaction paradigm reducing accessibility barriers statement

Statement four measured how participants felt about their knowledge of general web accessibility. The majority of respondents (N=8) agreed or strongly agreed (N=4) with the statement "I understand web accessibility in general." Pre- and post-simulator use questionnaire answers were often the same. Where post-questionnaire responses differed, there was a change in greater or less agreement, N=2 for a drop and N = 3 for an increase in agreement (figure 8.5).

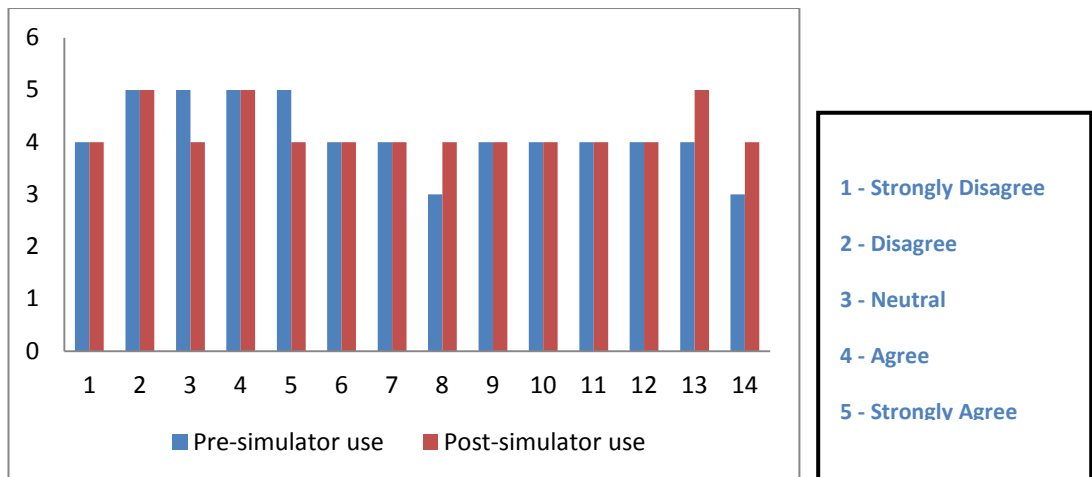


Figure 8.5: Pre- and post-simulator use: responses by participant regarding their understanding of general web accessibility

The majority (N=7) were in agreement or strong agreement with statement five, "I am aware of good practice for accessible design for older people" in the pre-questionnaire. One person did not answer this question in the post-questionnaire and was not counted, but where responses changed relative to the pre-simulator use questionnaire, greater agreement with the statement resulted (N=9) with only one participant showing less agreement.

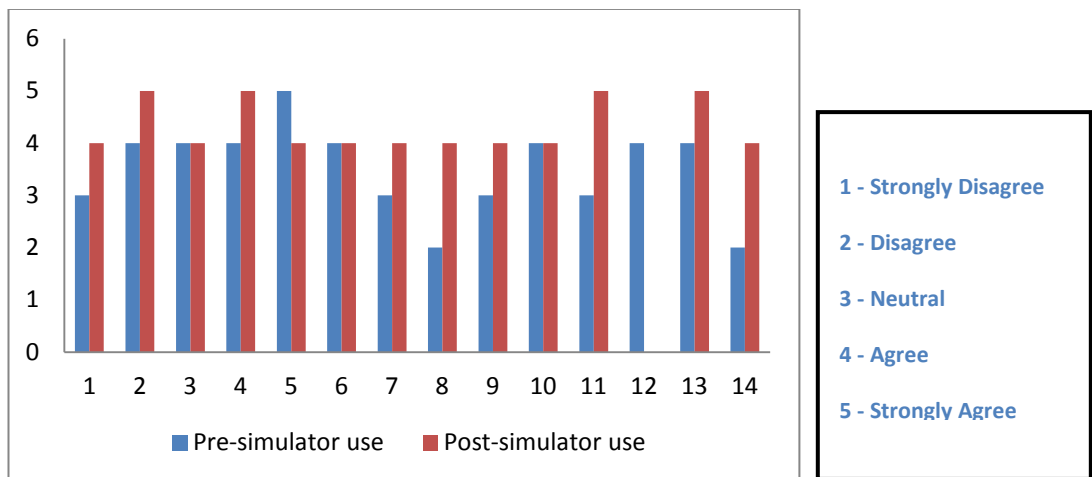


Figure 8.6: Pre- and post-simulator use: awareness of accessible design for older people by participant

Statement six looked at developer awareness of guidelines for older people. The majority of pre-questionnaire responses (N=10) were either neutral or disagreed with the statement, "I am aware of guidelines for accessible design for older people". Post-questionnaire results resulted in greater agreement with the statement (figure 8.7).

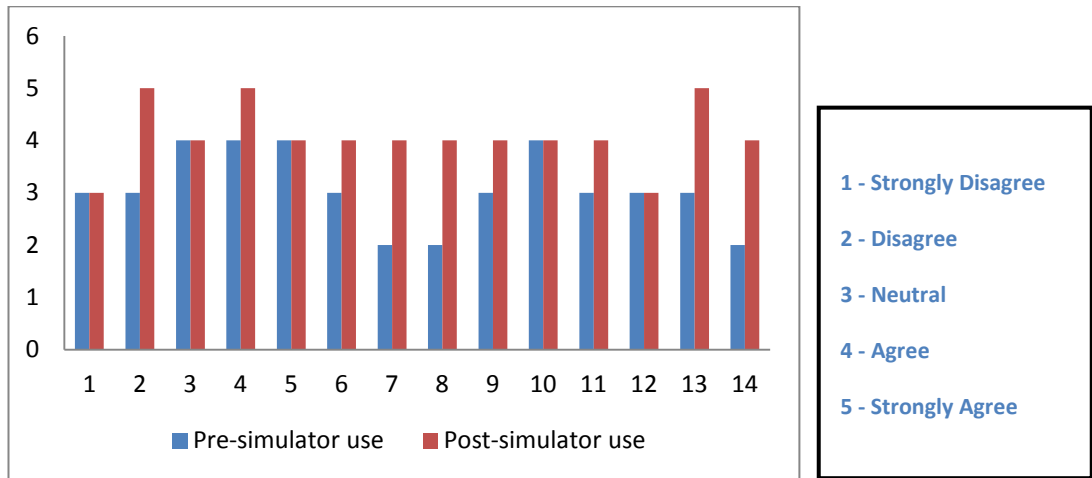


Figure 8.7: Pre- and post-simulator use: responses by participant regarding awareness of age-specific accessibility guidelines

Awareness of accessibility barriers faced by older people was examined with the majority in agreement that they were aware of age-related accessibility barriers. Post-questionnaire results were varied but unchanged in half of cases (N=7), (figure 8.8).

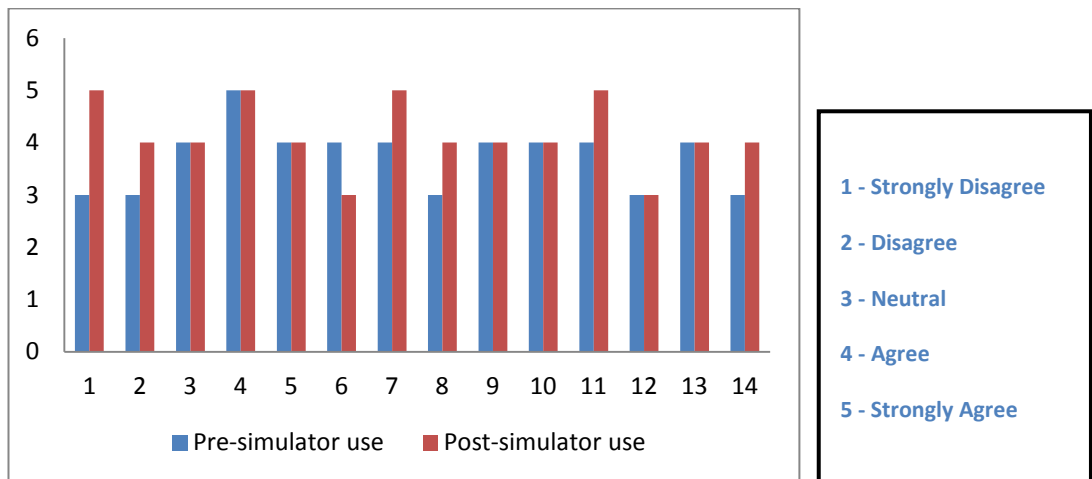


Figure 8.8: Pre- and post-simulator use: responses by participant to statement of awareness of accessibility barriers faced by older people

The intention to develop applications that take accessibility for older people into account was asked of participants. Two participants viewed this question as not relevant to their job role. Most participants intended to develop applications that took accessibility for older people into account. Where changes to responses

occurred in the post-questionnaire (N=6), greater agreement (N=5) was observed (see figure 8.9).

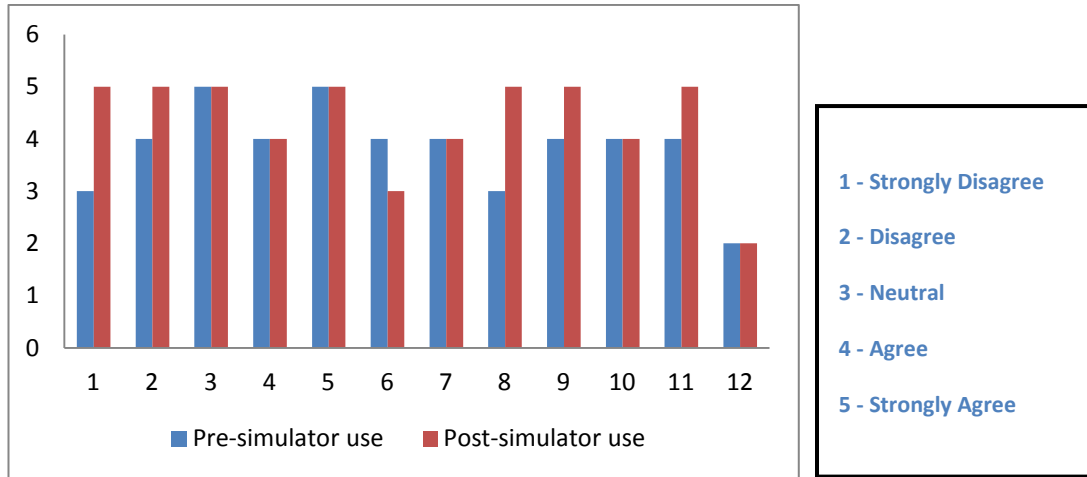


Figure 8.9: Pre- and post-simulator use: responses by participant regarding intention to develop accessible applications that took accessibility needs of older people into account

The final statement looked at confidence regarding the implementation of older people friendly websites. Greater agreement with the statement, "I feel confident about the implementation needs of elder-friendly websites" was observed (N=8) in the post-questionnaire.

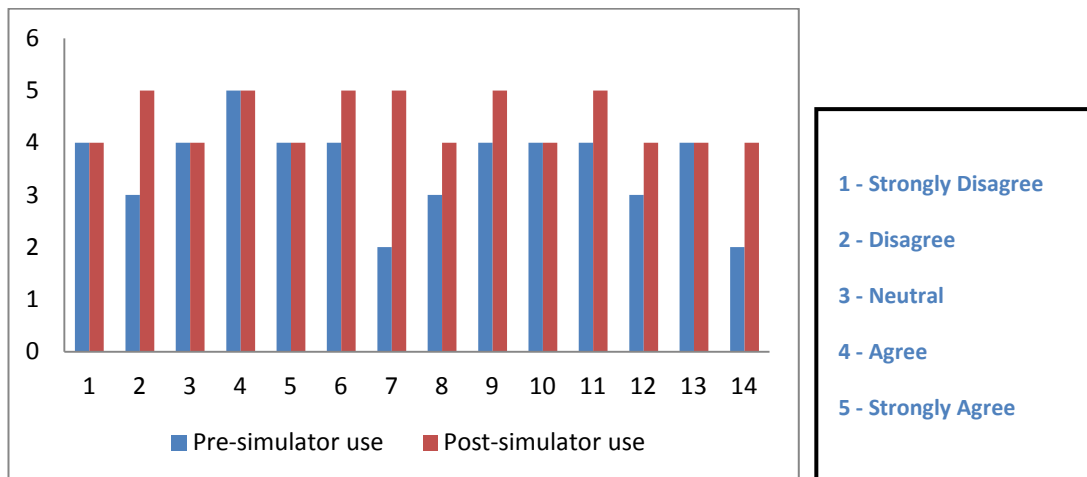


Figure 8.10: Pre- and post-simulator use: responses by participant to statement regarding confidence in implementing ageing-friendly websites

8.3.3 Results of non-parametric tests

Five statistical tests were conducted and the results are presented in this section. These tests were intended to draw inferences from the data regarding attitudes to ageing and accessible development.

H1, whether using the simulator would affect agreement to the statement that accessibility for ageing is restricted to the current cohort of older people was the first statistical test performed. A Wilcoxon sign test was chosen as the participants were tested on the same dependant variable (i.e. the response to question one at two separate points in time), once before using the simulator and once after. The test was also chosen as the data was ordinal and therefore not appropriate for parametric testing. A histogram of the differences between the distribution of pre- and post- test responses was taken and as the distribution was normal, the Wilcoxon sign test was verified as the correct choice for the analysis. The data was analysed using SPSS. Ten of the 14 participants had a negative rank meaning that the 10 participants had greater post-test disagreement with the statement "ageing as a barrier to technology use in UK society will disappear as current generations have spent their whole lives with technology." One participant showed greater agreement with the statement and three were unchanged. This was a statistically significant median increase (2 points on the Likert scale) in disagreement with the statement pre-(4) and post-(2) simulator use, $z = 2.709$, $p = 0.007$. As the result is significant H1 is supported

H2, that the use of the simulator could affect the awareness that ageing can create accessibility barriers was then tested. As the data was ordinal and the same group of participants was tested on the same dependent variable pre- and post- simulator use, a Wilcoxon sign test was initially chosen. As a histogram of the data was not normally distributed, the less statistically powerful sign test was chosen as an alternative as it does not assume a normal distribution. Seven of 14 participants had a positive rank meaning greater agreement with the statement, "age-related changes can create barriers for older people accessing the web." The remaining seven participants were unchanged in their responses. This was a statistically significant increase in median (1 point on the Likert scale) with the statement pre-(4) and post-simulator use (5), $p = 0.016$ and supports H2.

H3, that the use of the simulator could affect awareness of age-specific good design practice. A Wilcoxon sign test was chosen due to data being ordinal and involved the testing of the same dependant variable at pre- and post- simulator use. As a histogram of the data was not normally distributed, the less statistically powerful sign test was chosen as an alternative to the Wilcoxon sign test. Nine of the participants had a positive rank meaning greater agreement with the statement "I am aware of good practice for accessible design for older people" in the post-simulator use questionnaire. One person had a negative rank showing greater disagreement and three remained unchanged. One participant did not complete the post-questionnaire Likert response for this statement and was omitted from the analysis. While the median scores in the pre- and post-simulator use questionnaire were the same (4), the majority of participants (N=9) went up 1 or 2 points on the Likert scale response on the post-test, $p = 0.021$. The mixed results indicates support for H3, but that it should be treated with caution.

H4, Use of the simulator can raise awareness of age-specific guidelines. As the data was ordinal and tested dependant variables or related samples over time, a Wilcoxon sign test was chosen to analyse the responses. As the histogram of the differences of the pre- and post- results did not show a normal distribution, a sign test was substituted for the Wilcoxon sign test. Nine participants had a positive rank, showing greater agreement with the statement, "I am aware of guidelines for accessible design for older people" in the post-questionnaire. The remaining five participants had unchanged responses in the pre- and post-simulator use questionnaire. This was a statistically significant increase in median (1 point on the Likert scale) with the statement pre-(3) and post-(4), $p = 0.004$, and therefore H4 is supported.

H5, Use of the simulator can increase confidence in implementing age-friendly websites. As the data was ordinal and tested the same dependant variable over time a Wilcoxon Sign test was initially chosen to analyse the responses. A histogram of the differences of the pre- and post-test responses did not show a

normal distribution, a sign test was substituted for the Wilcoxon sign test. Seven of the participants had a positive rank, showing greater agreement with the statement "I feel confident about the implementation needs of elder-friendly websites." The remaining seven participants had unchanged responses in the pre- and post-simulator use questionnaire. While there is a statistically significant difference pre- and post- simulator use ($p = 0.016$) as only 50% of respondents had a change in outlook, the medians remain unchanged, the results will be examined in greater length in the discussion section.

8.3.4 Additional qualitative data

Additional qualitative data gathered both in written response to the question, "what was your experience of the learning environment in terms of its success in teaching about web accessibility for ageing and age-related conditions?" as well as responses during the debrief were collected. These responses were to semi-structured questions concerning the success of simulation in raising awareness. Any following questions posed by the investigator were asked in response to answers given to previous questions.

The initial response to the question was that the simulator was "useful", "enlightening" and "excellent and terrifying if you are over 40". Enjoyment was a word that was used by several participants in conversation.

In terms of the impact of the simulations, people responded that there were, "some good illustrative examples" and that it was a "positive experience – you do not fully realise how various impairments can affect others until you experience them yourself." Another called the simulation an "eye-opener" about what older people could potentially face. Two mentioned that it would make them think about their own designs more in terms of accessibility for older people. The visual simulations using eye-tracking were mentioned frequently.

Others specifically mentioned that they felt "empathy" for older people and had, "much better appreciation for the struggle of others. Lots I hadn't realised". One participant related the impact of the simulator in terms of now having greater

understanding of their parents and why they behaved as they did. The simulations were perceived to also have "a lot more impact than just reading something" and that it "helps you understand almost as a practical assessment" and "how hard simple things can be."

The lessons were also well-received with one person saying that the information was informative as while they knew about general accessibility, the guidelines do not specifically talk about the detail of ageing. Another echoed the sentiment saying it taught "the specifics."

Two participants specifically mentioned the demonstration of the serif vs sans serif fonts and were interested in the research behind font choice in terms of readability and information retention.

Three participants mentioned how they found the contrast example quite easy, but said that they were trying to scan for word shape rather than content. All said that the bad contrast examples at the end of the exercise were more difficult than the good contrast examples at the end of the simulation.

While the visual impairment simulations using eye-tracking were received as both difficult and effective, three participants also mentioned trying to "cheat" the visual impairment simulations by blinking, tilting their head or trying to take advantage of latency. This was mentioned as a coping measure, but it was also mentioned that the simulator was difficult to "cheat". One person said the AMD example was "horrible".

The debrief also allowed for reflection with participants saying, "the more I know, the less I know" and "there are limitations to what you can do, but you make it as accessible as possible" and while the "OS has some responsibility but can't be solely the OS. As a practitioner it is very hard to know everything and implement. You improve through experience."

Four participants were observed using unconscious coping for motor skills by tabbing where they could. One participant, with an expert level of accessibility

knowledge, explicitly mentioned, using keyboard navigation as a coping mechanism and of being aware that this was a coping strategy:

"As a disable (sic) person with a motor/sensory disability some of the motor-movement exercises were challenging, although it did mean I used some of the coping mechanisms such as tabbing to complete the form. As a disabled person, I perhaps had a greater awareness/appreciation of some of the issues of ageing and the assistive solutions."

Where people could not use tabbing, such as in the drag and drop simulation, visible frustration was observed.

8.4 Discussion

While the number of participants was low, 14 people donated their time to make the validation of the simulator possible. The value of their contribution is a far greater insight into how to address the lack of visibility of the accessibility needs of older people within the web industry. Due to the small size of the sample, however, the presence of outliers has greater impact on results than if a larger number of participants were recruited.

Although guidelines have explicitly included older people as beneficiaries of accessible development, this has been generally overlooked by developers, or have not had the expected visibility intended by the WAI. Pre-simulator use questionnaire results showed that the majority of participants were either neutral or disagreeing with the idea of accessibility with regard to ageing being a problem that affects all people as they age rather than just the current cohort who grew up in an analog society. Post-simulator use questionnaire data showed that the simulator changed the views of the participants and that these changes were statistically significant (H1). This change from neutrality or disagreement, to agreement to the idea that ageing is a global experience and not limited to the current generation of older people points to the usefulness of the simulator in terms of raising awareness.

Participants were widely in agreement that older people had accessibility requirements, demonstrated by the pre-questionnaire agreement with the statement that ageing can create accessibility barriers. While the simulator strengthened this agreement (H2) in a statistically significant manner, the belief that the barriers exist was present before using the simulator. This is in contrast to the general neutrality and disagreement with the statement mentioned in the previous paragraph in the pre-simulator use questionnaire. Does the belief that accessibility requirements for ageing is solely a problem for the current generation of older people affect interest in accessibility for ageing? An opportunity for further exploration of this question exists – the ability of the simulator to influence this view, may be useful in piquing the interest of web industry professionals to age-specific accessibility.

Direct interfaces have often been touted in the media as a panacea for ageing and the majority of participants (N=9) were in agreement with this statement in the pre-questionnaire. This changed in post-questionnaire to either neutrality or disagreement with the statement (N=11). While the main aim of the simulator was to raise awareness, information about accessibility barriers with regard to direct interfaces was presented and had an effect on participants' opinion.

Participants generally self-reported agreement that they were aware of general accessibility and this was expectedly unaffected by the simulator use. However, what was interesting was the qualitative data produced where people expressed that they had learned something from the simulator. The drop in participant assessment of their general web accessibility knowledge in the post-questionnaire leads to a question about the level of self-efficacy being greater than perhaps it should be. As the information regarding accessibility for older people is available within the WCAG 2.0 guidelines, the qualitative and quantitative data are partially at odds with one another in terms of pre- and post- simulator use results and participants' view of their own knowledge. While it is positive that people feel they are informed in terms of web guideline understanding, the drop in agreement in

the post-questionnaire points to this view possibly being a fragile one. It is also interesting to note that general web accessibility knowledge does not necessarily translate into knowledge about accessibility for ageing as seen by the greater neutrality to a similar statement concerning awareness of design practice for accessibility for ageing. While there was a statistically significant change in agreement that ageing could create accessibility barriers (H2), the numbers of unchanged results (N=7) were the same as changed results pre- and post- simulator use. While this could suggest that the results are inconclusive, it is more likely that this result is due to the high agreement in the pre- simulator use questionnaire (twelve of fourteen participants agreed or strongly agreed that ageing created accessibility barriers), leaving very little latitude to observe a change in attitude. The simulator, however, had a measurable positive effect in terms of communicating the accessibility needs of older people and post-questionnaire results with statistically significantly different responses from pre-questionnaire results in terms of participant perception of this knowledge (H3). From a standpoint of education and advocacy, the simulator is a promising tool.

Awareness of guidelines was similarly increased pre- and post- simulator use questionnaire (H4). As with the results of the questionnaire presented in Chapter 4, many of the participants (80%) were not aware of specific guidelines for older people. The simulator was able to change the awareness of such guidelines. This furthers the argument that such accessibility needs are not served by the general guidelines and that there are not enough pointers to supporting documentation for specific information. By sign-posting such documentation, the simulator not only raises awareness, but provides a means of accessing further information.

That the simulator can increase confidence in implementing elder-friendly websites (H5) was also supported. As the data was ordinal and tested the same dependant variable over time a Wilcoxon Sign test was initially chosen to analyse the responses. While the median remained unchanged and seven of the respondents did not have a change in response pre- and post- simulator use, the simulator was

successful in changing the confidence of all participants who either said "not really" or "not sure" (N=5) to "somewhat" or "very much". This indicates that for people with little pre-existing confidence about their ability to implement elder-friendly websites, the simulator can increase their confidence. While participants were often neutral or disagreeing with their knowledge of good design practice specific to ageing in the pre-questionnaire, only three participants were neutral or in disagreement with the statement that they intended to take accessibility for ageing into account in their work. Again, these two results are somewhat in conflict. Qualitative data seemed to support the first statement in terms of people expressing that they felt they had learned something new. This points to a possible dichotomy in terms of self-efficacy in implementation compared with theoretical knowledge. More research into the potential for industry reported self-knowledge and how this translates to actual practice is needed.

Qualitative data gathered supported the use of simulation as a good experiential learning tool, with the majority of participants valuing the simulations. The ability to "experience" ageing also seemed to connect with participants at the emotional level allowing for greater empathy and understanding as well as reflection in terms of why older people are a distinct group with accessibility needs that may not have an AT-centric solution. All participants were debriefed and any negative emotions raised by taking part (N=1) were listened to and addressed in the debrief. All participants were reminded that the purpose of the simulator was not to show the negative aspects of ageing, but to show solutions to potential accessibility barriers arising from ageing.

Observation of "coping" and "cheating" by participants demonstrated how people will often employ coping strategies. Where these were demonstrated, a discussion of coping strategies, over and above the information supplied in the simulator, was included in the debrief.

8.5 Conclusion

The simulator was successful in dispelling the myth in participants that accessibility for ageing is restricted to the current generation of older people. Increases in awareness and understanding of accessibility guidelines and design practices for older people were also observed. This simulation approach to addressing the hidden accessibility needs of older people is promising. The simulation aspect of the software seems to have had an impact in terms of providing guidance to ameliorating barriers but also connecting emotionally with participants. However, as one participant stated that there were "terrifying" aspects to the simulator, care must be taken to reassure participants and to focus not on the disability caused by ageing but rather on the solutions presented in the software. While this was only one case, more work should be done on the debrief within the simulator and is an opportunity for future exploration of sensitive, goal-focused simulation of ageing for web accessibility education.

9. Conclusion and future work

The purpose of this thesis was to explore developer attitudes and behaviour towards web accessibility and to examine the visibility of and offer solutions to the lack of visibility of ageing and web accessibility. Each of the four research questions will be addressed in turn.

9.1 Research questions and contributions to knowledge

1. Are there differences between web development companies' publicly-stated attitudes regarding accessibility and actual practice?

In terms of the first research question, the following contributions to knowledge were made:

1. Identifying that web professionals do perceive that knowledge of accessibility is a selling point.
2. Demonstrating through lack of uptake on the websites checked that the perceived usefulness of conformance icons is minimal among web professionals and use of WCAG 2.0 icons is almost non-existent.
3. Neither the mention of accessibility as a selling point (H1) nor the mention of accessibility as a selling point (H2) affects the accessibility of a developer's homepage.
4. The purpose of conformance icons is called into question, not only as they are a snapshot of conformance in that they bear no relation to the actual conformance of a site over time, but also because of their minimal use.

Web development companies are engaged with accessibility and accessibility services. However, while they are engaged, their behaviour at least on their own homepages points to a need for greater depth of knowledge of accessibility requirements. Simple accessibility barriers such as poor or non-existent ALT-tags and missing language tags were common, easily remedied errors present on developer homepages. The argument could be made that as the homepage is the ambassador for the company, the level of attention paid to the development of this homepage should be high. Engagement with accessibility conformance icons is low, and for WCAG 2.0 almost non-existent. This highlights a gulf between developer

attitudes and practices and their knowledge of accessible development.

Regardless, it is encouraging that accessibility is prominent and seen by companies as a valuable skill.

2. How is accessibility in general and for older adults in particular viewed by web developers?

The following contributions to knowledge were made with regard to the second research question:

1. Industry professionals view general accessibility guidelines and the use of validators as relevant to their work roles. Additionally, the view of the relevance of accessibility guidelines transcended job role.
2. The vast majority of industry professionals are unaware of accessibility guidelines for older people with fewer than 20% having awareness of WCAG guidance documentation for web accessibility and ageing. Of those who were aware of such documentation, over 40% reported using them "rarely" or "never" - highlighting not only the lack of visibility but also the lack of perceived usefulness of the documentation.
3. Only about half of web professionals view ageing in terms of accessibility. This is significantly lower than expected. Additionally, project managers are statistically less likely to agree than people in other job roles, identifying the need to target project managers in any training materials developed.

Of the five hypotheses presented with regard to the second of the research question the following was observed:

H1 not supported: Experience does not increase the likelihood that professionals view ageing as an accessibility issue. The lack of support for H1, indicates that training material needs to not just be aimed at students, but also at professionals working in industry regardless of their level of experience.

H2 not supported: Age will not increase the likelihood that professionals view ageing as an accessibility issue. Again, as with the lack of support for H1, this result indicates the need to have training materials that are widely inclusive, or created in such a way that it can provide layers based on experience and job role.

H3 not supported: Experience did not increase the awareness of age-specific guidelines. As with the lack of support for H1 and H2, the need for wide-ranging training materials is strengthened with this observation.

H4 supported: Job role affects the perception of ageing as an accessibility issue. Project managers were statistically less likely to perceive ageing as an accessibility issue. The identification of project managers is particularly novel and points to the need for specific educational materials for people working in this role.

H5 supported: Gender affects the perception of ageing as an accessibility issue. As the split of respondents was not equal, this result should be treated with caution, but the result highlights the need for further investigation into the effects of what is a male dominated industry (or more likely, the dominance of white males in tech (Google 2014)) on the perception of web accessibility and ageing.

People working in the web industry were not only aware of accessibility guidelines, but they regularly made use of them. However, while general accessibility self-reported knowledge is good, professionals were split about whether older people are beneficiaries of accessible design. Even where there was knowledge of the importance of accessible design for older people, some still held the opinion that the need for such practices is transient and will disappear with the passing of the current cohort of older people. This belief that accessibility for ageing is transient has the potential to affect the perception of the usefulness of age-specific guidelines and warrants further investigation.

3. How useful are WCAG 2.0 guidelines for developers with regard to ageing?

Contributions to knowledge with regard to the third of the research questions involved the Identification of potential problems with WCAG 2.0 age-specific documentation identifying and highlighting:

1. The need for awareness-raising about the existence of documentation for age-specific accessibility techniques.
2. The masking of research-derived accessibility techniques for the benefit of older people by the nature of the guideline level system.

WCAG 2.0 guidelines mention older people as beneficiaries of accessibility design. However, there is a visibility problem in terms of how accessibility guidelines aimed at age-related change and diseases are presented. Many of the guidelines that directly benefit older people such as contrast and page layout are categorised as Level AA or AAA. The placement of these techniques at Level AA and higher raises the risk of such guidance being overlooked by designers and developers working to

Level A conformity. Also, as discovered in Chapter 4, there is division with the development community about whether ageing presents accessibility barriers. As this is the case, the existence of documentation is not enough. First, the awareness about ageing and the accessibility challenges presented to people with age-related change must be raised. Once awareness is raised, targeted educational resources need to be developed.

In support of the observed difficulties with the existing documentation, a novel table (Table 5.1) was created with WCAG 2.0 guidelines with the recommendations of how levels should be mapped relative to the needs of older people.

4. How can knowledge of web accessibility barriers and techniques for older people be increased?

1. The outcome of investigation into the fourth research question contributed to increasing developer knowledge of web accessibility barriers through the creation of a virtual third age simulator. This simulator is the first to simulate multiple impairments simultaneously, allowing for people to understand the additive effects of multiple age-related changes - something that is crucial to the understanding of the effects of age-related change.
2. The medically validated, realistic fidelity of the simulator increased developer understanding of the changes caused by ageing and the accessibility barriers that these changes can create, as well as demonstrating techniques to ameliorate such changes.
3. The greater accuracy of the simulator in terms of simulating visual impairments by using an eye tracker compared to all preceding computer-based disability simulations which relied on mouse movement to simulate visual impairments caused by AMD, glaucoma and diabetes, allows for a much more realistic experience. The importance of the increase in fidelity is that it makes it much clearer to the people using the simulator which design choices have the greatest impact on accessibility.
4. The simulator also allows for greater developer reflection in terms of their own work as it is the first simulator that allows professionals to simulate impairments interactively against their own web content.
5. The experiential lessons designed to raise awareness and provide high-level technical guidance for people who may not have in-depth technical knowledge such as project managers (which were identified as a group which could benefit

from awareness raising), departs from the more specialised nature of guidelines and raises knowledge and awareness to a much broader audience.

6. The discussion within the simulator lessons of the psychological and social issues that affect how older people access the web, increases developer knowledge of ageing and accessibility in a more holistic manner than guidelines alone can achieve.

The software developed successfully used a combination of simulation, multimedia and lesson text to raise awareness of web accessibility barriers to people who used it. The simulator also helped to dispel the opinion that accessibility for ageing was limited to the current generation. It also served to raise awareness of the existence of age-specific accessibility guidelines, which have gone largely unnoticed by the web industry. Qualitative data pointed to the value of simulation as an experiential tool as it provided an understanding of the frustration and difficulty of overcoming barriers linked to ageing such as appropriate contrast ratios, use of appropriate fonts and point size as well as providing insight into the behaviour of older people and how this behaviour makes traditional accessibility solutions (i.e. ATs) not appropriate for many people in this user group.

9.2 Thesis limitations

The main limitations for the thesis are rooted in sample size of the simulator validation. The small sample for the participant study means that it may not be possible to generalise across industry due to its size and lack of proof of the randomness of the participants. The usefulness of the general simulator to developers was also not explored, in favour of validating the learning content.

The simulator would also benefit from the input of older users themselves. Such input by the stakeholders, who stand to benefit from greater awareness of their accessibility needs, would add to and enhance the strength of research-derived guidelines presented in the simulator.

The validation of the simulator used a 5 point Likert scale, and it is possible that a 7 point scale could have produced more nuanced results. A larger, more randomised sample of web industry professionals would also increase the robustness of the

data. Finally, using qualitative to quantitative data analysis techniques to examine the impact of qualitative data would be beneficial.

Another limitation is that although the simulator shows promise in terms of changing attitudes and raising awareness, it is not known what long-term affect exists in terms of changing behaviour. This is a common problem with simulator research as mentioned in Kiger as behavioural change is difficult to measure in simulations (1992).

The findings, which have brought greater understanding of both the attitudes and current behaviour as well as the development of the simulator software provide an number of exciting opportunities.

9.3 Avenues for future research

As the age of professionals did not affect perception of ageing as an accessibility issue, the initial focus on young developers was potentially exclusionary. However, the wide-ranging appeal of the simulator in testing show the potential for implementation beyond the student level.

9.3.1 Simulation opportunities

Greater emphasis on encouraging developer understanding of coping mechanisms that people develop as they age to reduce the effects of ageing, should be included in greater detail in further iterations of the simulator. This could increase the opportunities for reflection in terms of participants' own coping behaviour that they use in the course of using a computer that may unconsciously affect their understanding on how people in the wider world use technology.

Further opportunities exist in terms of raising the fidelity of the hearing impairment simulator using filters to allow for distortion of live content. Similarly using head distance data to increase the fidelity of the presbyopia simulation could be undertaken in further iterations. Engaging with people who experience these impairments would also enhance the fidelity and lesson content and allow for greater stakeholder involvement. While some fidelity increases would benefit the

simulator, it is important that any changes in fidelity enhance the learning aims rather than detract from them.

A related opportunity exists in terms of enhancing the learning content the simulator contains by partnering with older people to enhance the design of further iterations of the software. A series of focus groups and co-design sessions or similar methodology could strengthen the learning points of the simulator. Such co-design sessions could also add greater depth and nuance to the simulation activities.

A comparative study looking at the perceived and actual usefulness of the virtual third-age simulator vs. the existing documentation would provide more evidence to support the use the wide-spread use of this technique. This would be a good avenue for further research as the architecture of the simulator allows for moving beyond a third-age simulator and could be expanded as an awareness-raising tool of the barriers encountered by people who experience a wide range of conditions.

9.3.2 Investigation of behavioural change over time

An opportunity to observe behavioural change also exists in terms of creating an experiment with a follow-up element assessing behavioural change. Such a study could include either follow-up interviews or questionnaires some months after the completion of the simulation component of the study. This would help address the current weaknesses of disability simulation research.

9.3.3 Investigation of project managers views on accessibility

Of particular importance and priority would be an exploration of why project managers have less agreement with the idea that ageing raises accessibility barriers. With an ageing population, it is vital that the reasons for this difference in attitude from other web professionals is explored and addressed.

9.4 Final thoughts

Simulation is supported as a means to raise awareness for both web professionals and students and is a successful teaching tool about accessible design both in terms

of raising confidence and supplying the necessary information for developers to develop websites that are ageing-friendly.

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Appendix 1: SPSS data, homepage validation and accessibility checks conducted in Chapter 3

Specific success criteria validation errors have been removed with total guideline success criteria errors supplied for clarity

XHTML compliance icon	Total XHTML parsing errors	CSS compliance icon	CSS validation errors	WCAG 2.0 compliance icon	WCAG 2.0 Level A errors	WCAG 2.0 Level AA errors	Accessibility Statement accessible from homepage	Accessibility statement accessible from other locations on the site but not homepage	Accessibility mentioned as a selling point
no	49	no	17	no	8	2	no	no	no
no	2	no	26	no	0	1	yes	n/a	yes
no	16	no	0	no	21	0	no	no	yes
no	42	no	73	no	24	1	no	no	no
no	11	no	19	no	13	1	no	no	no
no	2	no	83	no	4	0	no	no	no
yes	4	yes	0	no	18	0	no	no	no
no	0	no	59	no	9	1	yes	n/a	yes
yes	0	no	63	no	72	10	no	no	no
no	16	no	25	no	3	1	yes	n/a	yes
no	0	no	144	no	3	0	yes	n/a	yes
no	1	no	56	no	19	2	no	no	no
no	1	no	0	no	4	0	yes	n/a	yes
no	51	no	42	no	23	1	no	no	yes

XHTML compliance icon	Total XHTML parsing errors	CSS compliance icon	CSS validation errors	WCAG 2.0 compliance icon	WCAG 2.0 Level A errors	WCAG 2.0 Level AA errors	Accessibility Statement accessible from homepage	Accessibility statement accessible from other locations on the site but not homepage	Accessibility mentioned as a selling point
no	32	no	0	no	5	0	no	no	no
no	43	no	19	no	151	0	no	no	yes
no	0	no	8	no	4	0	yes	n/a	no
yes	9	yes	0	no	4	1	no	no	no
no	20	no	32	no	7	1	yes	n/a	no
no	30	no	77	no	12	0	no	no	no
yes	0	no	30	no	23	1	yes	n/a	yes
no	6	no	0	no	2	3	no	no	no
no	6	no	2	no	2	0	no	no	no
no	14	no	13	no	0	0	no	no	no
yes	0	yes	30	no	18	1	no	no	yes
yes	0	yes	0	no	3	1	yes	n/a	no
no	14	no	1	no	3	1	no	no	yes
no	4	no	3	no	10	1	no	no	no
yes	17	yes	1	no	10	8	no	no	yes
no	3	no	29	no	19	0	yes	n/a	yes
no	2	no	13	no	3	1	no	no	no
no	0	no	285	no	11	0	no	no	yes
no	22	no	49	no	3	1	no	no	no

XHTML compliance icon	Total XHTML parsing errors	CSS compliance icon	CSS validation errors	WCAG 2.0 compliance icon	WCAG 2.0 Level A errors	WCAG 2.0 Level AA errors	Accessibility Statement accessible from homepage	Accessibility statement accessible from other locations on the site but not homepage	Accessibility mentioned as a selling point
no	41	no	18	no	59	1	no	no	no
no	2	no	0	no	3	0	no	no	no
no	3	no	5	no	1	0	no	no	yes
no	1	no	7	no	2	2	no	no	no
no	24	no	237	no	6	1	no	no	yes
no	14	no	2	no	10	4	no	no	no
no	58	no	0	no	22	2	no	no	no
no	3	no	1	no	9	5	no	no	no
no	72	no	1	no	7	1	no	no	no
yes	76	yes	11	no	2	0	no	no	no
no	5	no	1	no	2	0	no	no	yes
no	36	no	3	no	18	5	no	no	no
yes	9	yes	63	no	23	1	no	no	no
no	0	no	48	no	5	1	no	no	yes
yes	3	yes	1	no	2	3	no	yes	yes
no	0	no	133	no	2	0	no	no	no
no	4	no	0	no	3	1	no	no	no
no	24	no	14	no	17	3	no	no	yes
yes	2	yes	6	no	1	0	no	no	yes

XHTML compliance icon	Total XHTML parsing errors	CSS compliance icon	CSS validation errors	WCAG 2.0 compliance icon	WCAG 2.0 Level A errors	WCAG 2.0 Level AA errors	Accessibility Statement accessible from homepage	Accessibility statement accessible from other locations on the site but not homepage	Accessibility mentioned as a selling point
no	0	no	87	no	3	1	no	yes	yes
no	2	no	24	no	8	1	no	no	no
yes	0	yes	2	yes	9	0	yes	n/a	yes
no	5	no	0	no	8	0	no	no	yes
no	356	no	10	no	63	1	no	no	yes
no	25	no	35	no	11	0	yes	n/a	no
no	4	no	28	no	2	0	no	no	no
yes	4	yes	3	no	5	2	no	no	yes
yes	0	no	41	no	0	0	no	no	no
no	51	no	1	no	18	10	no	no	no
yes	13	yes	41	no	9	2	no	no	no
yes	0	yes	0	no	0	0	yes	n/a	yes
no	14	no	51	no	7	2	no	no	yes
no	17	no	0	no	3	0	no	no	no
yes	12	yes	8	no	13	27	yes	n/a	yes
no	3	no	6	no	7	0	no	no	no
no	25	no	21	no	14	1	no	no	no
no	34	no	358	no	2	5	yes	n/a	yes
no	24	no	73	no	14	0	no	yes	yes

XHTML compliance icon	Total XHTML parsing errors	CSS compliance icon	CSS validation errors	WCAG 2.0 compliance icon	WCAG 2.0 Level A errors	WCAG 2.0 Level AA errors	Accessibility Statement accessible from homepage	Accessibility statement accessible from other locations on the site but not homepage	Accessibility mentioned as a selling point
yes	0	yes	0	no	9	1	no	no	yes
no	49	no	1	no	3	2	no	no	no
yes	9	yes	0	no	3	0	no	no	no
yes	4	no	7	no	8	1	no	no	no
yes	0	yes	4	no	0	0	no	yes	yes
no	31	no	4	no	13	49	no	no	no
no	9	no	2	no	22	2	no	no	no
no	6	no	0	no	4	1	no	no	no
no	31	no	122	no	4	2	no	no	yes
yes	21	no	23	no	2	0	no	no	no
no	3	no	46	no	0	2	no	no	yes
no	10	no	44	no	2	1	yes	n/a	yes
no	196	no	12	no	11	0	no	no	yes
no	0	no	1	no	5	0	no	no	no
no	2	no	37	no	6	0	no	no	yes
no	0	no	1	no	32	0	no	no	yes
no	1	no	20	no	7	1	no	no	no
no	0	no	45	no	0	0	no	no	no
no	0	no	2	no	1	0	no	no	no

XHTML compliance icon	Total XHTML parsing errors	CSS compliance icon	CSS validation errors	WCAG 2.0 compliance icon	WCAG 2.0 Level A errors	WCAG 2.0 Level AA errors	Accessibility Statement accessible from homepage	Accessibility statement accessible from other locations on the site but not homepage	Accessibility mentioned as a selling point
no	2	no	63	no	7	3	no	no	yes
no	16	no	1	no	22	1	no	no	no
no	1	no	10	no	5	0	no	no	yes
no	52	no	113	no	0	3	no	no	yes
no	8	no	8	no	8	0	no	no	no
yes	0	no	0	no	3	0	no	no	yes
no	1	no	16	no	6	0	no	n/a	yes
no	4	no	32	no	2	0	no	no	no
no	3	no	66	no	1	0	no	yes	yes
no	5	no	2	no	2	0	no	yes	yes

Appendix 2: Chapter 4 Web Professionals Questionnaire

Section 1: Work Roles And General Accessibility Practices

1. What describes your role in Web Product Development?

Designer junior	Designer senior/lead	Developer junior	Developer senior/lead	Content Writer	Producer	Project Management	Other (Please Specify)
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2. Are the use of validators such as W3C's Markup Validation Service or CSS Validation Service relevant to your role?

Yes	No
-----	----

2.a. Do you make use of such validators?

Always	Often	Sometimes	Rarely	Never
--------	-------	-----------	--------	-------

2.b. Do you implement validator recommendations?

Always	Often	Sometimes	Rarely	Never	Not Applicable
--------	-------	-----------	--------	-------	-------------------

3. Do you feel that accessibility guidelines are relevant to your work role?

Very much	Somewhat	A little	Not very much	Not at all
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4. Do you make use of published general guidelines for accessibility?

Always	Often	Sometimes	Rarely	Never
--------	-------	-----------	--------	-------

5. Do you use validators that check for WCAG (Web Content Accessibility Guidelines) conformance?

Always	Often	Sometimes	Rarely	Never
--------	-------	-----------	--------	-------

6. When in the development cycle do you first start thinking about accessibility?

Early Stages (ex. project formation, initial consultations)	Planning (includes concept development, requirements gathering and analysis)	Prototypin g/ Design	Developme nt	Testing/ Acceptance	Maintenan ce	Never
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Section 2: Accessibility for Older People

7. What demographic do older people (60 years and older) represent for your products?

Key demographic	Significant demographic	Non-significant demographic
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8. Do you consider ageing to be an accessibility issue?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
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9. Do you think that touch screen interfaces increase accessibility for older people?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
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10. Are you aware of the "Developing Websites for Older People: How Web Content Accessibility Guidelines (WCAG) 2.0 Applies" document?

Yes	No
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10.a. Do you use "Developing Websites for Older People: How Web Content Accessibility Guidelines (WCAG) 2.0 Applies" recommendations?

Always	Often	Sometimes	Rarely	Never
--------	-------	-----------	--------	-------

10.b. Do you believe that these guidelines match the web accessibility needs of older people?

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
----------------	-------	---------	----------	-------------------

Section 3: Business Size and Developer Age

11. What is the size of your organisation?

1-9	10-49	50-249	250+
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12. How many years work experience do you have within your current and related jobs?

1 year or less	2-3 years	4-5 years	More than 5 years
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13. What is your age?

16-24

25-34

35-49

50-64

65+

14. What is your gender?

Male

Female

15. Is there anything you wish to add about general accessibility or accessibility for older people that you think may be of use?

Appendix 3: Chapter 4 Web professional questionnaire response data

1. What describes your role in Web Product Development?

Designer (junior): 6

Designer (senior/lead): 42

Developer (junior): 5

Developer (senior/lead): 59

Content Writer: 6

Producer: 8

Project Management: 31

Other (*please specify*): 15

Job titles cited in other:

MD

Data Analyst

design, project management, seo,

Director

Freelance Designer and Developer

Front End

Production Manager

Sales

Self-employed web developer

Senior UX Designer

2 SEO, 1 SEO Manager

Strategic

User Experience

2. Are the use of validators such as W3C's Markup Validation Service or CSS Validation Service relevant to your role?

yes: 99

no: 8

2.a. Do you make use of such validators?

Always: 28.3% (28)

Often: 33.3% (33)

Sometimes: 21.2% (21)

Rarely: 17.2% (17)

Never: 0%

2.b. Do you implement validator recommendations?

Always: 21.2% (21)
Often: 51.5% (51)
Sometimes: 16.2% (16)
Rarely: 7.1% (7)
Never: 3.0% (3)
Not applicable: 1.0% (1)

3. Do you feel that accessibility guidelines are relevant to your work role?

Very much: 52.3% (56)
Somewhat: 34.6% (37)
A little: 12.1% (13)
Not very much: 0.9% (1)
Not at all: 0%

4. Do you make use of published general guidelines for accessibility?

Always: 12.1% (13)
Often: 37.4% (40)
Sometimes: 29.9% (32)
Rarely: 14.0% (15)
Never: 6.5% (7)

5. Do you use validators that check for WCAG (Web Content Accessibility Guidelines) conformance?

Always: 5.6% (6)
Often: 22.4% (24)
Sometimes: 27.1% (29)
Rarely: 29.9% (32)
Never: 15.0% (16)

6. When in the development cycle do you first start thinking about accessibility?

Early stages (ex. project formation, initial consultations): 26.2% (28)
Planning (includes concept development, requirements gathering and analysis): 20.6% (22)
Prototyping/ Design: 26.2% (28)
Development: 17.8% (19)
Testing/ Acceptance: 6.5% (7)
Maintenance: 0%
Never: 2.8% (3)

7. What demographic do older people (60 years and older) represent for your products?

Key demographic: 1.9% (2)

Significant demographic: 29.9% (32)

Non-significant demographic: 68.2% (73)

8. Do you consider ageing to be an accessibility issue?

Strongly Agree: 11.2% (12)

Agree: 38.3% (41)

Neutral: 39.3% (42)

Disagree: 10.3% (11)

Strongly Disagree: 0.9% (1)

9. Do you think that touch screen interfaces increase accessibility for older people?

Strongly Agree: 8.4% (9)

Agree: 36.4% (39)

Neutral: 47.7% (51)

Disagree: 5.6% (6)

Strongly Disagree: 1.9% (2)

10. Are you aware of the "Developing Websites for Older People: How Web Content Accessibility Guidelines (WCAG) 2.0 Applies" document?

Yes: 17.8% (19)

No: 82.2% (88)

10.a. Do you use "Developing Websites for Older People: How Web Content Accessibility Guidelines (WCAG) 2.0 Applies" recommendations?

Always: 0%

Often: 36.8% (7)

Sometimes: 21.1% (4)

Rarely: 36.8% (7)

Never: 5.3% (1)

10.b. Do you believe that these guidelines match the web accessibility needs of older people?

Strongly Agree: 0%

Agree: 47.4% (9)

Neutral: 42.1% (8)

Disagree: 5.3% (1)

Strongly Disagree: 5.3% (1)

11. What is the size of your organisation?

1-9 employees: 64
10-49 employees: 40
50-249 employees: 3
250 or more: 0

12. How many years work experience do you have within your current and related jobs?

1 year or less: 2
2 - 3 years: 15
4 - 5 years: 14
Over 5 years: 76

13. What is your age?

16-24: 12
25-39: 79
40-54: 14
55-64: 1
65+: 1

14. What is your gender?

Male: 99
Female: 8

15. Is there anything you wish to add about general accessibility or accessibility for older people that you think may be of use?

- I. As a developer, I personally feel accessibility is tremendously important, but is always overlooked or ignored by companies such as mine, and increasingly within the web community as a whole.
- II. Consider Cognitive Disabilities also.
- III. I believe the issue with conforming to accessibility standards on the whole is that it's difficult to consider people who don't have a working knowledge of the web and modern devices. We're surrounded by it every day and it puts us in a bubble: constantly updating browsers, touch screen devices and massive dual monitors lead to a distancing from what the 'normal' user experiences - especially the older user. It's downright painful sometimes having to watch non-web professionals use the Internet. There is also no policing of minimum accessibility standards on the web. No one is held accountable for not meeting these standards, and the standards themselves are so grey that unless you want to trawl through pages of robot-talk W3C and WAI-ARIA documentation you have to rely on intuition and forums. It's

a fundamental change that needs to occur. Just like responsive design, you can't really put it in after - it needs to be planned from the start.

- IV. I have found that websites which are designed for greater accessibility levels often have greater usability generally, and not just for visually (or otherwise) impaired users.
- V. I think modern web sites are often inherently accessible, in comparison to techniques from a few years ago.
- VI. I'd just add the note that with the aging population also comes a more IT-educated population - i.e. the older generations are becoming more IT literate.
- VII. Interfaces should be adaptive to suit the needs of all users and across all devices.
- VIII. Nope!
- IX. Older segments of population have been starting to access websites later on. But this is a segment growing rapidly in UK. Depending on your target market if older people are included as a developer I need to consider common circumstances that challenge their ability like reduce vision and concentration span
- X. Over my 12 years in web design I have worked for many large companies who see general user usage satisfaction far more important than accessibility for the minority, thus a true 'accessibility' website is never even considered.
- XI. Text size too small and a presumption of experience is one of the big failings of most websites I come across. Yes you can increase text size, alter settings etc but if you are new to computing (as many older people with a first ipad are) they work with the default and don't know how to change settings. The ipad has such a huge part of the market share (especially with new computer users/silver surfers). it needs new design considerations for screen size and usability.
- XII. The guidelines are too hard to follow - should be simple do's and don'ts.
- XIII. There seems to be a conflict between the simpler intuitive operation of a touch screen interface (eg smartphone) and the visual disabilities more common in older people.

- XIV. To me the issues of accessibility for older people are no different from the issues which should be addressed when considering accessibility for other members of society.
- XV. Web sites should be designed to cater for everyone
- XVI. With modern browsers all being able to either zoom or increase font size, is the size of the font on a website an issue? As most people with accessibility problems will know how to increase the font size.

Appendix 4: Breakdown of Relative importance of guidelines presented in the "Developing Websites for Older People: How Web Content Accessibility Guidelines (WCAG) 2.0 Applies" document

Perceivable: success criteria	Meaning	Level	Relative importance to older people
1.4.4 - Resize text	Text can be resized without ATs to 200% without loss of content/function	AA	Greater
1.4.8 - Visual Presentation	In-depth guidance on number or characters, justification, line spacing, resize text and	AAA	Greater*
1.4.1 - Use of Colour	Colour should not be the sole means of conveying information	A	Same
1.4.3 - Contrast (Minimum)	Images and text should have a contrast ratio of at least 4.5:1	AA	Greater
1.4.6 - Contrast (Enhanced)	Images and text should have a contrast ratio of at least 7:1	AAA	Greater
1.2.1 - Audio-only and Video-only (Pre - recorded)	Provide an equivalent alternative such as a transcript for pre-recorded content	A	Same
1.2.2 - Captions (Pre-recorded)	Provide captions for pre-recorded audio or visual content	A	Same
1.2.3 - Audio Description or Media alternative (for pre-recorded video)	Provide audio description, transcript or an actual description of what is occurring in the content presented	A	Same
1.2.4 - Captions (Live streams)	Caption real time presentations	AA	Same
1.2.5 - Audio Description (Pre-recorded video)	Provide audio description in dialogue/sound pauses of actions taking place on screen	AA	Same
1.2.7 - Extended Audio Description (Pre-recorded video)	Allows for pausing of video content to allow for longer audio description	AAA	Same
1.2.8 - Media Alternative (Pre-recorded)	Alternative for people who cannot hear audio descriptions nor read captions	AAA	Same
1.2.9 - Audio-only (Live)	Live captions	AAA	Same
1.4.7 - Low or No Background Audio (Pre-recorded)	Reduce to background 20Db lower, eliminate background noise, or allow control to turn off	AAA	Greater
1.1.1 - Non-text Content	Provide text alternative for non-text content	A	Less (for ALT tags)
1.3.1 - Info and Relationships	Formatting is preserved when the presentation format is changed	A	Same

*unrealistic to implement in whole or in part for all sites either due to cost or technical requirements

Operable: success criteria	Meaning	Level	Relative importance to older people
2.4.4 - Link Purpose (In Context)	The link purpose can be determined by the link or the link and surrounding content	A	Same
2.4.9 - Link Purpose (Link Only)	Link purpose can be determined by the link text alone	AAA	Greater
2.4.7 - Focus Visible	A visible focus showing the active component on the web page exists	AA	Same
2.4.5 - Multiple Ways	More than one way to access a webpage from anywhere in the site is present	AA	Greater
2.4.8 - Location	Information of the location of the user relative to the rest of the site is available	AAA	Greater
2.4.2 - Page Titled	Web pages have a title	A	Less*
3.3.2 - Labels or Instructions	Provide labels for user input	A	Same
1.1.1 - Text Alternatives	Include a descriptive name for input components	A	Less**
1.4.4 - Resize Text	Text resizable to 200%	AA	Greater
2.1.1 - Keyboard	Content operable through keyboard	A	Less
2.1.2 - No Keyboard trap	Keyboard focus can be moved using the keyboard alone	A	Less
2.1.3 - Keyboard (No Exception)	All functionality can be accessed through the keyboard	AAA	Same
2.4.1 - Bypass Blocks	Ability to bypass blocks of content	A	Less
2.4.3 - Focus Order	Focus order should be meaningful	A	Less
2.2.2 - Pause, Stop, Hide	Ability to pause, stop or hide blinking and scrolling content	A	Same
2.2.4 - Interruptions	Ability to suppress or postpone interruptions	AAA	Greater
1.4.2 - Audio Control	Ability to pause or stop audio	A	Same
2.2.1 - Timing Adjustment	Ability to turn off or adjust time limits	A	Same
2.2.3 - No Timing	Timing is not essential to the activity (not multimedia or real-time events)	AAA	Greater

*Page titles more important for SEO than for navigation by older people where breadcrumbs and similar navigation devices are relative to page title, more important.

**name attribute for forms is AT-centric

Understandable: success criteria	Meaning	Level	Relative importance to older people
2.4.6 - Headings and Labels	Description of topic/purpose for headings and labels	AA	Greater
2.4.10 - Section Headings	Section headings used for organisation of content	AAA	Greater
1.4.8 - Visual Presentation	Text justification, width, contrast for foreground and background, text size, line spacing	AAA	Greater
3.1.3 - Unusual Words	Have a means of explaining or defining words or phrases used in an unusual way	AAA	Greater
3.1.4 - Abbreviations	Have a means of explaining the abbreviation	AAA	Greater
3.1.5 - Reading Level	Keep reading level to lower secondary level (or provide a version that accomplishes this)	AAA	Greater
3.2.3 - Consistent Navigation	Navigation presented in the same relative order across the entire site	AA	Greater
3.2.4 - Consistent Identification	Components are consistently identified	AA	Greater
3.2.5 - Change on Request	Changes of context are initiated by the user	AAA	Greater
3.2.1 - On Focus	When focus is on a component, it does not change context	A	Same
3.2.2 - On Input	Changing a setting does not change context unless user is informed	A	Same
3.3.2 - Labels or Instructions	Labels or instruction are present for user input components	A	Same
3.3.5 - Help	Context sensitive help is available	A	Greater*
3.3.4 - Error Prevention (Legal, Financial, Data)	Financial transactions have a mechanism to reverse submissions	AA	Same
3.3.6 - Error Prevention (All)	User can check and edit submitted information	AAA	Greater*
3.3.1 - Error Identification	Detected errors are identified and described to the user	A	Same
3.3.3 - Error Suggestion	Provide suggestions for error correction for automatically detected errors where such suggestions are known	AA	Greater

*unrealistic to expect across all sites

Robust: success criteria	Meaning	Level	Relative importance to older people
4.1.1 - Parsing	Markup meets specification	A	Same

Appendix 5: Virtual Third Age Simulator embedded lesson text

Introduction Page

Ageing and web accessibility

The following learning environment takes you through changes that many people experience as they age. Some of these changes everyone will experience to some degree, and others are examples of diseases linked to ageing.

All of the conditions and changes explored in the lessons will be simulated and are just one example of how people may experience such sensory changes. For example, some people with glaucoma:

- may experience halos around lights, making night time driving impossible
- may experience changes to their peripheral vision
- depending on the type of glaucoma, experience headaches and blurred vision.

Please remember that people who acquire these conditions often adjust over time and will develop their own personal coping strategies.

This learning environment is concerned with raising the awareness of industry professionals and students about the difficulties that these conditions create and then offering simple, cost-effective tips on how to reduce accessibility barriers with design choices that we, as web professionals, have the power to change.

Lesson 1

Page 1: Text and ageing

Starting from the age of 40, the eye starts to lose the ability to focus on close up objects – this is called presbyopia and it happens to everyone. This means at some point in your 40s:

- you will start to hold objects further away to see them in focus

- finding the right distance to read text, especially on smaller objects like smartphones, can be tricky
- counter-intuitively, if you already have corrected vision for near-sightedness, you may have to remove your glasses to read.

Eventually, the length needed to hold the book/tablet/smartphone to focus on the text will exceed the length of your arms (this takes years) and by the time you reach 65:

- most of the elasticity that allows your eye to focus on close-up objects is gone
- reading glasses can correct for this change in vision
- it may still be necessary for text to be zoomed for you to read it even with prescription lenses. (Source: PubMed Health).

*Please note: the following example is static and the blur will not decrease with distance from the monitor.

Page 2: Presbyopia example (text blurred in simulator)

Alice was beginning to get very tired of sitting by her sister on the bank, and of having nothing to do. Once or twice she had peeped into the book her sister was reading, but it had no pictures or conversations in it, "and what is the use of a book," thought Alice, "without pictures or conversations?"

So she was considering in her own mind (as well as she could, for the day made her feel very sleepy and stupid), whether the pleasure of making a daisy-chain would be worth the trouble of getting up and picking the daisies, when suddenly a White Rabbit with pink eyes ran close by her.

Source: Carol, Lewis. Alice's Adventures in Wonderland.

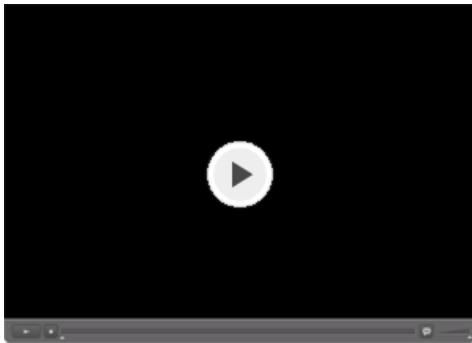
Page 3: Why does this matter?

Why is this the problem for designers and developers if people can just buy glasses? There are a number of reasons.

Presbyopia develops slowly and can take up to a decade for you to go from having no presbyopia to you needing glasses to help you read. Reasons for not getting glasses when you first notice presbyopia may include:

- If you already wear glasses you may not want to buy bifocals or varifocals until absolutely necessary
- cost of bifocals or varifocals
- worry that the glasses will make you look weak and old
- worry that the glasses will make you feel weak and old.

Click the image below to play video about reading glasses:



Read the transcript here ([link to transcript](#))

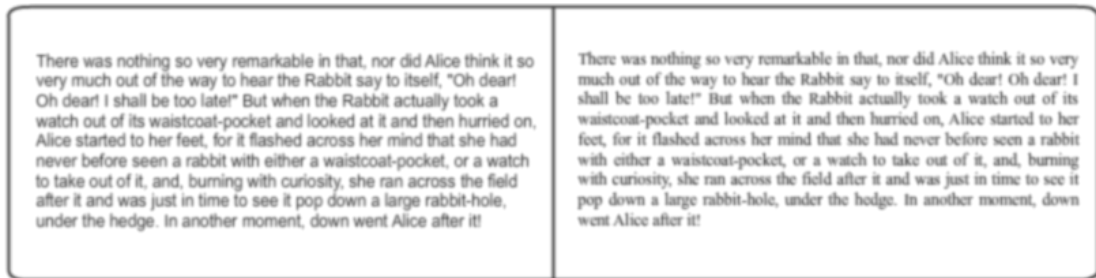
So, in the video above we see a very strong character given pause due to his own sense of weakness caused by the simple fact that he needs to wear reading glasses. While this is a fun example, the idea that needing reading glasses can cause people to feel uncomfortable is an all too real experience.

Page 4: How can I help?

You can help reduce the effects of presbyopia by:

- Making sure that text can be zoomed.
- Being aware that many older people don't know how to zoom using their browser
- keeping the font size to the default of the browser or no lower than 85% of the default setting (Source:WebAim).

Arial 12 point text and Times New Roman 12 point text with presbyopia (source: Alice in Wonderland)



In the above example, although both fonts are the same size, the even shape of the sans-serif font is more readable.

Other ways to improve readability of your content is to:

- avoid writing words in all capitals.
- avoid overuse of italics and underlines.
- use san serif fonts ex. Verdana, Arial
- leave text with a ragged right margin due to limitations of computer-based text justification.

Please note, in answer to the argument that ageing and technology barriers are limited to the current generation, there is evidence that accessibility barriers will continue to exist beyond the current older generation as:

- cognitive changes affects new skill acquisition required by the current rate of technological change.
- older people don't generally want to use assistive technologies or special computers (Source: <http://dl.acm.org/citation.cfm?id=1535682>).

Now, accessibility for older people is not just about good fonts. If something is zoomed, it's better to avoid scrolling horizontally, so allow for text to reform neatly. Why? Because vision is not the only capability change you experience as you age as you'll see in Lesson 5.

For more information about presbyopia:

- WebAim readability ([link](#))
- Literature review from W3C ([link](#)).

Lesson 2

Page 1: Colour and contrast

It's not just presbyopia that affects your vision as you age. Your pupils will also get smaller allowing less light in (source: vision changes). Smaller pupils affect your ability to discriminate contrast and colours, and by your 60s, you will need three to four times the light that you needed in your 20s to carry out tasks like reading (source: Vision Aware).

Page 2: Contrast example

Click on the image below to see how age affects your contrast discrimination.



The difference between the good and poor contrast choices may not be a problem for the under 40's, but for the ageing eye, poor contrast choices can become a very real barrier.

Page 3: Why does this matter?

Why is this a problem for designers and developers if people can adjust their monitor brightness, turn on the lights or move inside?

There are a number of reasons which may include:

- People may not know how to adjust their monitor brightness or other personalisation features
- worry that changing the settings might make things worse

- turning on a light may help, but not enough.

It is important to remember that it's not just contrast and colour discrimination that changes as we age. Presbyopia will also be present in older people.

Good contrast vs. poor contrast with presbyopia



While these changes make your experience of technology slightly more difficult when taken one at a time, when you start to add them together, things get more difficult. Any design choices you can make to alleviate the effect of these changes can greatly improve the quality of the experience for everyone over the age of 40.

Page 4: How can I help?

The following will help people with contrast discrimination problems:

- making sure that your background contrasts well with the text.
- avoiding colour combinations that make discrimination difficult such as blue/greens or dark blue/brown
- using a contrast calculator ([link](#)) or contrast calculator two ([link](#)).

Be aware that personalisation settings are not be used by all people and that there may be a reluctance to change settings. Using good contrast in your site design could make the difference between someone using your site or leaving it.

For more information about contrast discrimination:

- WebAim readability ([link](#))
- Literature review from W3C ([link](#))
- AbilityNet ([link](#))

Lesson 3

Page 1: What about other conditions?

The risk of eye-related conditions increases as you age. One in five people over the age of 75 have some form of sight loss (Source: RNIB). The main eye-related changes related to ageing are:

Cataracts: By the time you are 65 you have a 50% chance of having some form of cataract formation (Source: AllAboutVision). Cataracts develop slowly and make vision cloudy or dirty and people may also find that the glare from bright lights cause them difficulty. This is a surgically treatable condition. (Source: RNIB).

Diabetic retinopathy: Diabetic retinopathy is a common complication of Diabetes and symptoms include floaters (shapes floating in your eye that you can see), blurred vision, reduced night-time vision and even sudden blindness (Source: NHS). It is the leading cause of blindness in people of working age (Source Diabetes.org.uk).

Glaucoma: Glaucoma is another condition that tends to affect older people. About 1 in 100 people over 40 will have Glaucoma but this increases to 5 in 100 by the age of 65 (Source: RNIB). The most common form of Glaucoma is caused by an increase in pressure in the eye from a build-up of aqueous fluid (fluid in the eye). Glaucoma affects peripheral vision first. This condition is treatable, but any damage caused before treatment is permanent.

Age-related Macular Degeneration: AMD is caused when the part of the retina, called the macula stops working. The cones in the macula are responsible for seeing colour and detail as well as your central field of vision (Source: RNIB). AMD usually affects people in their 60s. It is estimated that over 600 000 people in the UK have AMD and that this number is expected to rise steeply with our ageing population (Source: Nursing Times). Eventually your field of vision can deteriorate to a point where much of your central vision is gone. While people with AMD often develop

compensating mechanisms to deal with the loss of central vision, any vision loss is permanent.

Page 2: Other age-related conditions example

Click on the image below to see the effects of cataracts, diabetic retinopathy, age-related macular degeneration and glaucoma. Find the selected word in each paragraph and click on it. There are two paragraphs for each condition, one with and one without accessible font and contrast:

Please note, the examples using eye tracking which mimic the conditions mentioned in this lesson. This can cause mild, temporary eyestrain similar to watching a 3D movie.



Paragraph source: The Wind in the Willows

The combination of slightly differing font size, serif vs. sans serif text and different contrast ratios combine to make a vast difference in the quality of text.

Page 3: Why does this matter?

Why is this a problem for designers and developers if people can use a screen reader or a magnifier to see content?

There are a number of reasons which may include:

- Assistive Technologies (ATs) may have steep learning curves
- older people may not even be aware of ATs that could help them

- people may not want to use ATs as they do not see themselves as disabled
- even with such conditions older people often want to use what everyone else uses
- budget constraints, or simply a desire to use what they have always used may reduce uptake of ATs among older people.

As many older people are not using ATs, there are techniques to make the webpage more accessible.

Page 4: How can I help?

Simply ensuring good text contrast and size will help people with any of the conditions mentioned as well as:

- using ragged right text margins rather than justifying text
- using relative size fonts to allow easy resizing
- providing white space around text as for greater readability
- if using CAPTCHAs, provide more than one way to access the text to enter
- making sure that pop-ups and alerts have sounds associated with them and that these pop-ups don't automatically create a change of context eg. move the focus from a text box to the pop-up alert box.
- avoiding horizontal scrolling
- having text-based or audio-based alternatives to images.

If you are able to, audio description for video content is desirable to explain the action taking place. And finally, where possible, create your pages to allow for easy personalisation, but remember that many older people may not possess the skills necessary to make such personalisations.

For more information about age-related sight conditions and accessibility:

- [Web accessibility for older users: WCAG \(link\)](#)

Lesson 4

Page 1: Hearing and ageing

As we age we slowly lose our high frequency hearing. This is called Presbycusis and it affects half of people over the age of 60 to varying degrees (Source: deafnessresearch.org). This sort of hearing loss affects high frequency sounds making them distorted or inaudible. Unfortunately, just turning the sound up may not make up for this hearing decline, as your tolerance for loud noises may remain the same meaning that you may struggle to find the right volume where you can hear and still be comfortable (Source: deafnessresearch.org).

Other hearing conditions related to age

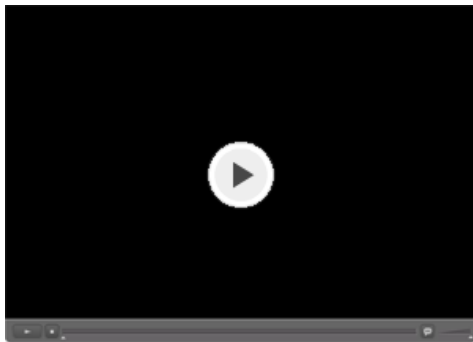
Tinnitus: is the perception of sound (often a ringing or hissing) that a person can hear, but is absent in the outside environment (Source: tinnitus.org). It can be any pitch and sometimes consists of more than one sound. About 10% of people have the condition all the time and it is more common in older people.

Ménière's disease: affects about 1 in 1000 people and causes attacks of dizziness, tinnitus and hearing loss. While these attacks tend to decrease over time, the hearing loss is sometimes permanent (Source: NHS). Unlike age-related hearing loss, people who experience hearing loss as a result of Ménière's lose hearing at lower frequencies.

Page 2: Hearing loss examples

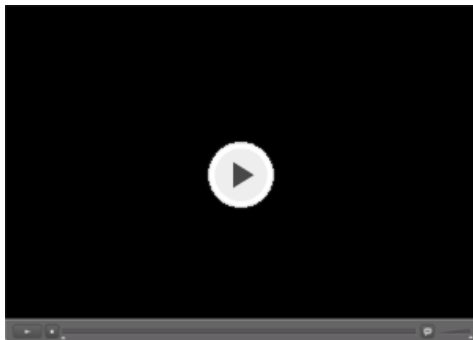
Example 1:

Click image below to play an example of dialogue with hearing loss



Example 2:

Click image below to play an example of dialogue with tinnitus



* please be aware that if you already have tinnitus, this can cause a spike in symptoms.

Page 3: Why does this matter?

Why is this the problem of designers and developers if people can just turn up the volume? There are a number of reasons:

- High frequency hearing loss happens gradually and people may not notice these changes initially
- when watching content in a group, it may be difficult to find a volume that appeals to all

- just turning up the volume will not work as there may be background noise blocking the speech
- just turning up the volume will not work as only some frequency's may be affected by hearing loss making some sounds unbearably loud while others are very difficult to hear
- people may miss some types (typically higher frequency) of alerts
- people may not wear hearing aids due to cost
- people may worry that the hearing aids will make them feel weak and old
- people with age-related hearing loss tend to rely on lip-reading, but lip-reading is a difficult skill to acquire and often not useful for rich media content where people are not facing the camera.

The reality is that hearing loss can isolate people, increase misunderstandings and affect how successful they are at a task.

Page 4: How can I help?

Some methods for helping people with hearing loss use your websites are:

- Providing alternatives to audio content such as transcripts. Transcripts are also helpful for people with vision impairment or blindness.
- captioning videos (this means you also include sounds that are important to the plot of the video).
- when creating audio content, making sure that background noises are low or eliminated and avoid more than one person talking at a time
- avoiding higher frequencies and opt for mid-frequency tones for alert beeps.

There are some very good resources to help you with captions. For HTML 5 there is the track element: This uses a linked text file to play captions over a video element. For Flash there is the FLVPlaybackCaptioning component which uses a linked xml file to play captions over a video element.

- Web accessibility for older users: WCAG ([link](#))
- WebAim ([link](#)).

Lesson 5

Page 1: Motor changes and ageing

Even with normal ageing, you will inevitably slow down. This means that even people with no motor changes other than those caused by normal ageing will use computer input devices more slowly than they did in their youth. This affects how you interact with the user interface and you may find the following are more difficult:

- dragging and dropping
- double clicking
- navigating walking/drop down menus
- using scroll bars (Kurniawan, 2006).

Osteoarthritis: is caused by wear and tear on the joints and results in stiffness and pain in the joints affected. 8.5 million people in the UK have this condition and while arthritis can affect anyone, it mostly affects people over the age of 50 (Source: NHS).

Rheumatoid arthritis: is more severe and affects about 400 000 people in the UK and also causes severe joint pain often in the hands. The main symptoms of arthritis are pain and stiffness in the joints, fatigue and restricted movement (Source: NHS). Rheumatoid arthritis is serious and life-changing.

Parkinson's Disease: mostly affects people from about the age of 60 although it can also affect younger people. It can cause tremors as well as slow muscle movement and affects about 127000 people in the UK alone, is progressive and very serious. (Source: NHS)

For all of these conditions, people have "good days" and "bad days" and while they may have little difficulty on some days, other days may greatly affect task ability.

Page 2: Motor changes example

Click on the image below to enter the motor impairment simulation:



Page 3: Why does this matter?

Why is this the problem of designers and developers if people can just use the keyboard to navigate? There are a number of reasons:

- Motor changes are not necessarily an impairment, but a natural consequence of ageing
- people want to use the same tools (i.e. mouse, touchscreen) as everyone else
- some people are unaware, unable or simply unwilling to change computer settings such as mouse double-click and tracking speeds
- worry that the specialist equipment will make you feel weak and old
- frustration caused by keyboard navigation being poorly implemented on a significant number of sites.

Page 4: How can I help?

The following help reduce accessibility barriers for people with motor impairment:

- Reducing the amount of scrolling required
- making clickable objects as large and well-spaced as your design permits.
- where possible allowing time for people with motor disabilities to complete tasks by extending or removing time limits

- making forms that do not require users to re-enter all data if there is a submission error.

Although older people have expressed a preference for using the same devices as everyone else ie. mouse, touchscreen, you should also provide clear and logical keyboard navigation for people who need to navigate your pages using only their keyboard.

For more information about motor changes and ageing:

- [WebAim \(link\)](#)
- [Literature review from W3C \(link\)](#)
- [Webcredible \(link\)](#)

Lesson 6

Page 1: Cognitive change and ageing

As you age, there will also be changes to how well you recall newly learned information (Source: W3C). Declines in fluid intelligence start in your 20s and become more apparent in your 60s. Fluid intelligence includes:

- how quickly you process information
- working memory (once called short term memory) holds the information you are currently using.

This doesn't mean that you are less intelligent. What it means is that:

- tasks may take longer to complete
- switching between tasks is more difficult
- searches take more time
- websites more difficult to navigate

it is harder to ignore distractions on a website and may take longer to distinguish what is useful information.

While things may take longer, your vocabulary and ability with language stays the same and what is commonly known as wisdom, remains. It's not all decline either,

as older people tend to be better than younger people in tasks that require experience such as in ill defined information searches than younger people (Source: Chin, J. et al.).

Page 2: Cognitive change example

It is impossible to fully demonstrate the effects of cognitive impairment, so in the example below, the intent is to increase the cognitive demands to mimic the extra time and sense of frustration that some older people feel when they are overloaded by a busy interface. Click on the image below to start the simulation:



As you will notice, the extra time and annoyance caused by distraction can be significant in terms of task completion and enjoyment. What may be easily ignored when you are young, may become an annoyance or even create confusion as you age due to reduced working memory and processing speed.

Page 3: Why does this matter?

Why is this the problem of designers and developers if people just need to take a bit more time? There are a number of reasons:

Cognitive changes happen slowly over time and people can have good days and bad days, and during bad days can experience the following:

- Getting easily distracted/overwhelmed by too much information and ads

- getting lost in the navigation structure of the site
- being afraid to do something wrong on the site
- feeling unable to ask children or other helpers for help as they go too fast for them to follow.

Remember that these changes can happen for a number of reasons including, undergoing chemotherapy or other medical treatments, having chronic conditions as well as regular brain changes related to ageing.

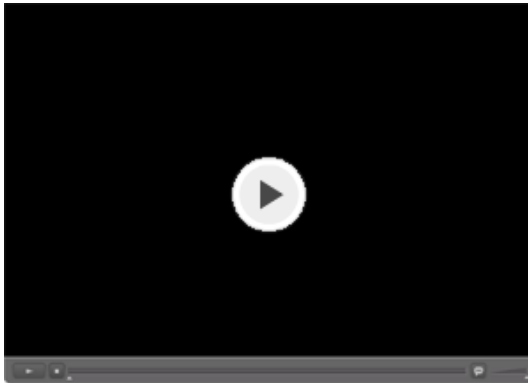
Page 4: How can I help?

You can make your websites more accessible to people with conditions affecting cognition by:

- Making sure that your webpages are consistent in design and navigation
- adding breadcrumbs on the page
- including the link purpose within the link text itself
- keeping language simple
- avoiding very deep menu structures
- include instructions for forms and other activities requiring user input.
- avoiding placing time limits on these tasks
- avoiding pop-ups, moving graphics and other distractions.

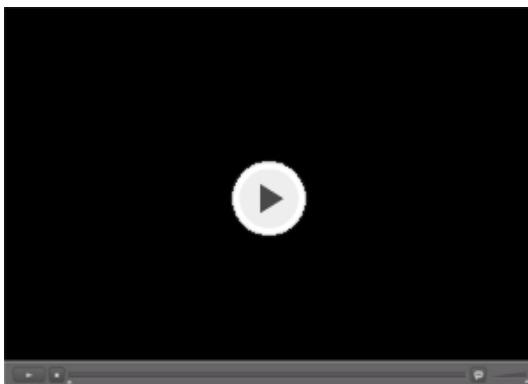
Make sure that instructions remain visible. For example, while having the information in a text field telling a person what they should enter looks pleasing from a design point of view, when people click on the textbox, that information will disappear. For people with cognitive difficulties this can be problematic.

Click the image below to play video about minimising distractions



In the above example, the astronauts solve a cognitively demanding job by breaking up the task into units and minimising distractions. By each person focusing on one job only they successfully reduce cognitive demands placed on them. Where possible tasks should be broken down.

Click the image below to play a video about familiar tasks:



Because 74 year old Buddy Guy has been playing the guitar for years, this familiarity allows him to move and play like a much younger person. Making use of existing knowledge will also make tasks easier as this information does not tend to decline over time.

For more information about cognitive impairment and how to implement accessible solutions:

- [WebAim \(link\)](#)

- Juicy Studio (link)
- Alzheimer's society (link)
- Literature review from W3C (link)

Lesson 7

Page 1: Multiple impairments and ageing

Age related changes creep up slowly and you will often unconsciously develop coping strategies for them such as:

- turning lights on
- moving objects further away to read
- writing lists on how to use new appliances etc.

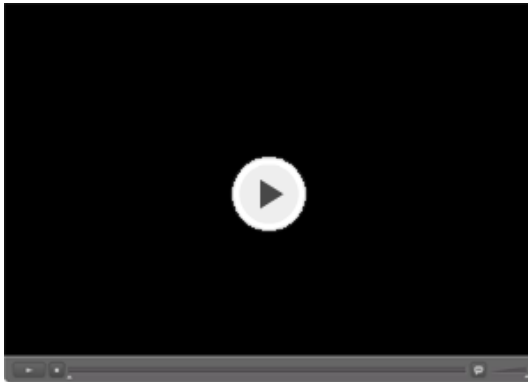
Often these changes are more of an annoyance than a barrier BUT these changes can add up. If you have multiple conditions and that's where things can get really difficult. What happens if you have:

- AMD and Arthritis?
- Mild cognitive impairment and Parkinsons?
- Hearing loss and cataracts?
- All the normal changes to hearing, vision and motor control associated with ageing?

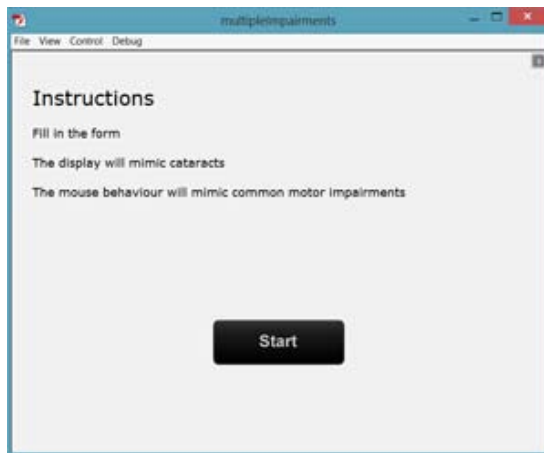
According to the Department of Health, of the people over 65 who have a chronic condition, nearly 70% have more than one condition with a quarter of such people having three or more conditions. (Source: Department of Health)

Page 2: Multiple impairment examples

Click the image below to play a video clip with AMD and hearing loss simulation.



Please note, the examples using eye tracking which mimic the conditions mentioned in this lesson. This can cause mild, temporary eyestrain similar to watching a 3D movie.



Click on the image below to start the cataracts, slowness of movement and tremor simulation.

Page 3: Why does this matter?

Because older people may have multiple impairments, often there is no simple one-size solution. Taken separately, most age-related capability change is relatively easy to work around, but when these changes are combined, the additive effect of multiple minor difficulties can create barriers to using sites that are unexpected.

Page 4: How can I help?

Make sure that the simple solutions using:

- accessible text settings
- accessible colour and contrast settings
- captions for rich media
- transcripts for rich media
- large buttons with good padding
- clear navigation.

For older adults, the majority of solutions are not about assistive technologies, but about consistently implemented accessible design.

Thank you for taking part in these lessons, to close the learning environment, click on the 'x' in the top right corner.

Appendix 6: Pre- and post-simulator use: web professional validation questionnaire

Participant Number: _____

Pre-participation Questionnaire

Age range (please circle):

18-24

25-39

40-54

55-64

65+

Gender: Male / Female

Job Role and/or area of study:

Please circle the statement that best applies:

1. Ageing as a barrier to technology use in UK society will disappear as current generations have spent their whole lives with technology.

Strongly agree

Agree

Neutral

Disagree

Strongly disagree

2. Age-related changes can create barriers for older people accessing the web.

Strongly agree

Agree

Neutral

Disagree

Strongly disagree

3. Current changes to interfaces (e.g. touchscreen, Kinect etc.) mean that technology is getting easier for older people to use.

Strongly agree

Agree

Neutral

Disagree

Strongly disagree

4. I understand web accessibility in general.

Strongly agree

Agree

Neutral

Disagree

Strongly disagree

5. I am aware of good practice for accessible design for older people.

Strongly agree Agree Neutral Disagree Strongly disagree

6. I am aware of guidelines for accessible design for older people.

Strongly agree Agree Neutral Disagree Strongly disagree

7. Current technology means that accessibility for older people is handled by the operating system and the browser.

Strongly agree Agree Neutral Disagree Strongly disagree

8. I know about accessibility barriers faced by older people.

Strongly agree Agree Neutral Disagree Strongly disagree

9. I do/intend to develop applications that take into account accessibility for older people

Always Sometimes Not Sure Rarely Never

10. I feel confident about the implementation needs of elder-friendly websites.

Very much Somewhat Not Sure Not really Not at all

Participant Number: _____

Post-participation Questionnaire

Please circle the statement that best applies:

1. Ageing as a barrier to technology use in UK society will disappear as current generations have spent their whole lives with technology.

Strongly agree Agree Neutral Disagree Strongly disagree

2. Age-related changes can create barriers for older people accessing the web.

Strongly agree Agree Neutral Disagree Strongly disagree

3. Current changes to interfaces (e.g. touchscreen, Kinect etc.) mean that technology is getting easier for older people to use.

Strongly agree Agree Neutral Disagree Strongly disagree

4. I understand web accessibility in general.

Strongly agree Agree Neutral Disagree Strongly disagree

5. I am aware of good practice for accessible design for older people.

Strongly agree Agree Neutral Disagree Strongly disagree

6. I am aware of guidelines for accessible design for older people.

Strongly agree Agree Neutral Disagree Strongly disagree

7. Current technology means that accessibility for older people is handled by the operating system and the browser.

Strongly agree Agree Neutral Disagree Strongly disagree

8. I know about accessibility barriers faced by older people.

Strongly agree Agree Neutral Disagree Strongly disagree

9. I do/intend to develop applications that take into account accessibility for older people.

Always Sometimes Not Sure Rarely Never

10. I feel confident about the implementation needs of elder-friendly websites.

Very much Somewhat Not Sure Not really Not at all

Addition verbal question: What was your experience of the Learning Environment in terms of its success in teaching about web accessibility for ageing and age-related conditions?