Technology and Disability 19 (2007) 205–212
IOS Press

Web accessibility design recommendations for people with cognitive disabilities

Mark G. Friedman* and Diane Nelson Bryen
Institute on Disabilities, Temple University, Philadelphia, PA, USA

Abstract. Web accessibility for people with Cognitive Disabilities has generated increasing interest in the professional web development, scholarly and advocacy communities in recent years, although there is little acknowledged agreement on how to proceed. This article conducts a review of the current understanding of experts in the field as exemplified by Web design guidelines. It provides current Web design recommendations that have achieved a high degree of agreement as well as four recommendations for implementation. Twenty existing Web design guidelines from Web accessibility experts, government and advocacy organizations were identified in an extensive literature review. Those disabilities specifically addressed by these guidelines included: cognitive disabilities (9), cognitive impairments (2), learning disabilities (4), dyslexia (3), aphasia (1), and mental retardation or intellectual disabilities (1). The authors of the Guidelines came from Australia (1), the United Kingdom (7), and the United States (12). The 20 guidelines contained 187 separate design recommendations which were combined due to duplications and organized for analysis. The top recommendations included: 1) Use pictures, graphics, icons and symbols along with text (75% agreement), 2) Use clear and simple text (70% agreement), 3) Use consistent navigation and design on every page (60% agreement), and 4) Use headings, titles, and prompts (50% agreement).

Keywords: Web accessibility, cognitive disabilities, assistive technology

1. Introduction

This paper explores Web accessibility for people with cognitive disabilities. It focuses on Web accessibility guidelines as a means to enhance Web accessibility. Cognitive disabilities are generally considered to include the disability categories of mental retardation, autism, traumatic brain injury, aphasia, dyslexia, learning disabilities and sometimes Alzheimer's disease, Attention Deficit Disorder (ADD) and Attention Deficit Hyperactivity Disorder (ADHD). These disabilities include deficits in memory, perception, problem-solving, conceptualization, and attention. Cognitive deficits pose a myriad of accessibility barriers to web use. Many individuals with cognitive disabilities experience difficulty in using the Web due to limited reading comprehension, complexity, slower learning, limited fine motor control, reduced spatial perception, lowered visual acuity, less hand/eye coordination and finger dexterity, and lowered information overload thresholds. Specific issues might include difficulty in recognizing the most appropriate choice when faced with a large number of options, distinguishing foreground images and text from background material [22], controlling the mouse, comprehending the screen, reading the text, navigating the screen, and locating and clicking on small items, i.e. icons and drop down boxes.

During the past several years, many steps have been taken to address Web accessibility for Web users with physical, visual, and sensory disabilities. While much remains to be done, enormous progress has been made in improving the accessibility of the Web for these segments of the disability community. However, in spite of this progress, Web accessibility for users with cognitive disabilities lags far behind the general population and behind Web access for other disability groups. Reason for this lack of progress include the difficulty of

*Address for correspondence: M.G. Friedman, PhD, Institute on Disabilities, Temple University, Ritter Hall Annex, 4th floor, Broad St & Cecil B. Moore Avenue, Philadelphia, PA 19122, USA. Tel.: +1 615 904 0308; E-mail: friedman@voicenet.com.

ISSN 1055-4181/07/$17.00

addressing the variety of the needs and deficits specific to the types of disabilities encompassed by the definition of cognitive disabilities, greater social stigma attached to limitations of cognitive functioning, slower adoption rates of use of information technology, and lowered expectations.

The accessibility of the World Wide Web (WWW) for people with disabilities has been considered important since its inception. In 1997, Tim Berners-Lee, the inventor of the WWW launched the World Wide Web Accessibility Initiative and stated its purpose as "removing accessibility barriers for all people with disabilities – including the deaf, blind, physically challenged, and cognitive or visually impaired [19]." In response to this imperative and the advocacy done with and on behalf of hundreds of thousands of persons with disabilities, efforts to improve Web accessibility have moved forward. These efforts have generally consisted of three approaches: 1) the development of screen readers, 2) specialized Web browsers, and 3) Web design guidelines.

Screen readers were developed in the early 1980's for people with visual disabilities to work with computers. Later, screen readers were modified for access to web pages with the incorporation of text-to-speech technology, alternate text tags and enlarged text zoom features. Specialized Web browsers have been developed as another form of assistive technology for users with vision problems and more recently, cognitive disabilities. Examples of cutting edge work currently in development include: IBM Web Adaptation Technology browser [12], Point and Read [23], WebTrek [6], Web reader for AAC users [11,30], EIA Web browser [21], and the Adaptive Web browser [5].

Web design accessibility guidelines were officially published by the World Wide Web Consortium, Web Accessibility Initiative in 1999 to encourage Web accessibility [29]. The Web Content Accessibility Guidelines (WCAG) explain how to make Web content accessible and defined target levels of accessibility. The Guidelines are important because they are widely taught to Web designers through college courses, books, and training sessions. The emphasis of the Guidelines is primarily focused on visual impairments [2,9,10,18]. Bartlett [3] attributes this to the fact that access by users with visual disabilities is relatively well-understood, people with visual impairments actively participate in computer accessibility issues, and there is a long history of activism to promote those interests.

While the WWW Accessibility Guidelines include issues relevant to cognitive disabilities, almost all of the elements relating to cognitive disabilities were assigned lower priorities [1]. The Guidelines include three priority levels for Web accessibility. Bartlett did a statistical analysis of the WWW Guidelines 1.0 version, and found that if you meet the highest priority, you are primarily meeting needs of blind users, while the second level of priority provides a broader range, and the lowest level of priority meets a wider cross-section "especially among people with limited input ability and cognitive impairments" [13].

Having the majority of the items critical to accessibility for users with cognitive disabilities being assigned lower level priority levels is particularly detrimental to achieving Web accessibility [20]. Web pages are allowed to legitimately display the coveted Bobby symbol showing compliance with the Guidelines if they have solely achieved the top priority items. Most Web designers, therefore, only attempt to implement priority one items in the Guidelines, even though by doing so, they have not addressed access features critical for accessibility by individuals with cognitive disabilities – a population of more than 22 million Americans.

Unfortunately, efforts to improve Web accessibility for users with cognitive disabilities have had only limited impact. Screen readers have been found overly complex and are expensive. Specialized Web browsers mostly remain in research labs, are expensive and relatively unknown. The current WWW Accessibility Guidelines assign cognitive disability issues lower priorities which generally remain unimplemented [1].

In order to begin to address solutions to Web accessibility for users with cognitive disabilities, an analysis of existing research was initiated by the authors to determine the "state of the state" regarding existing knowledge that might inform attempts to improve the accessibility of the Web for this diverse population of potential Web users. This paper focuses on guidelines as a means to improve Web accessibility. It identifies the existing Web accessibility design guidelines mitigating the impact of cognitive disabilities, and analyzes them for common features. Finally, recommendations for changes in public policy and avenues for advocacy are discussed.

2. Methods

In 2003, the National Institute on Disability Research and Rehabilitation (NIDRR) funded a research project on assistive technology and cognitive disabilities. This project was called the Partnership for Research and De-

velopment in Cognitive Disabilities and included the following partners: the Institute on Disabilities at Temple University, the Brain Injury Association, the University of Akron, and Spaulding Rehabilitation Hospital. A small portion of this grant had as its focus the development of an approach or instrument to test Web accessibility for people with cognitive disabilities, including but not limited to those with traumatic brain injury and those with intellectual disabilities.

The first step in the development of this accessibility evaluation tool for cognitive disabilities was to conduct an extensive literature review to identify the best practices of web access, and to determine if there is consensus on what features might improve the accessibility and usability of the Web for users with cognitive disabilities. An initial literature review identified that, unlike other areas of disability, agreement had not been reached on how to achieve Web accessibility for people with cognitive disabilities. In an attempt to advance the field of Web accessibility, a more comprehensive review of the literature was conducted to examine existing Web design guidelines for users with cognitive disabilities. The goal of this literature review was to ascertain the similarities and differences among identified Web design guidelines and to see what agreement could be identified between the various guidelines.

An extensive effort was made to identify all existing Web design guidelines for users with cognitive disabilities. An exhaustive literature review was conducted using multiple electronic research databases and the Web. Electronic research databases on social science, education, and technology were searched. These included WilsonWeb, Ebscohost, ProQuest, Library of Congress, Academic Premiere, Association of Computing Machinery (ACM) and IEEE. Disability and advocacy Web pages were searched using several Web search engines and numerous relevant search terms. The relevant references cited in each Guideline were examined to identify other potential guidelines for inclusion in this study.

Three limitations are inherent in this review. First and foremost, the term cognitive disability has not been well defined by the field of disabilities [27]. It is overly broad and there is significant disparity in definition within the professional rehabilitation community. Different authors of these guidelines reviewed included single, multiple and occasional conflicting types of disabilities within the term cognitive disability [7,8]. For example the term "learning disability" has very different meanings in the United States and in the United Kingdom. The second limitation is there is a dearth of outcome oriented research on the efficacy and usability of any of the included guidelines for users with cognitive disabilities [1,17]. A third limitation is the possible omission of relevant guidelines from these reviewed. Although the authors conducted an extensive literature review, it is possible some guidelines were overlooked.

3. Results

The criteria for inclusion in this analysis was that each Guideline: 1) addressed some type of cognitive disability and 2) included specific design recommendations. Twenty Web design guidelines that met the criteria were identified during the literature review on cognitive disabilities from research journals, and professional or advocacy Web pages.

Those disabilities specifically addressed by these guidelines included: cognitive disabilities (9), cognitive impairments (2), learning disabilities (4), dyslexia (3), aphasia (1), and mental retardation or intellectual disabilities (1). The authors of the guidelines came from Australia (1), the United Kingdom and (7) the United States (12). Each of the twenty guidelines was examined for specific recommendations. The identified recommendations, some of which were in narrative form, were compiled into a simplified list and placed in table form sorted by the authors. These guidelines yielded 187 separate design recommendations. Many of the 187 design recommendations overlapped and were duplicates of the same issue. For the purposes of analysis, the duplicates were combined, resulting in 86 unduplicated design recommendations. The 86 individual design recommendations were then compared to the twenty published design guidelines to see how often each design recommendation was cited. The design recommendations were rank ordered by the percentage of times each recommendation was included in the twenty published design guidelines. For purposes of analysis and discussion, only those design recommendations cited by more that 15% of the design guidelines were deemed to be significant. This resulted in a list of 22 Web accessibility design recommendations shown in Table 1. The remaining items cited by less than 15% of the guidelines are shown in Table 2. The top 22 ranked design recommendations covered elements of text size and shape, consistency of navigation and page design, use of icons, pictures, text writing, style, margins, hyperlinks, line spacing, and screen-layout.

Table 1
Top web access design recommendations for users with cognitive disabilities based on frequency cited by existing web design guidelines

Recommendation	Frequency cited Web Design Guidelines
1. Use pictures, icons and symbols along with text.	75%
2. Use clear and simple text.	70%
3. Consistent navigation and design on every page.	60%
4. Use headings, titles and prompts.	50%
5. Support screen readers. Use alternate text tags.	35%
6. Use larger fonts, fonts in minimum 12pt or 14pt.	30%
7. Uncluttered, simple screen layout.	30%
8. Maintain white space: Use wide margins.	25%
9. Website customizable, control of: type size, placement of navigation (right, left side) contrast, large print, sound.	25%
10. Use exit, home, help, next page buttons on every page.	25%
11. Use with sans serif fonts, such as Arial, Verdana, Helvetica, Tahoma.	20%
12. Navigation buttons clear, large, and consistent.	20%
13. Use numbered lists rather than bullets.	20%
14. Support font enlargement for Web browsers.	15%
15. Use color for contrast.	15%
16. Check reading level with automated tool.	15%
17. Don't right justify text; use ragged edge right hand margins.	15%
18. Use Lower case, no ALL CAPS.	15%
19. Provide voice captions (audio files) for text.	15%
20. Provide audio/voice-overs where the words are read aloud.	15%
21. Use navigation methods, i.e. 'undo' or 'back button' to help user recover when lost.	15%
22. Give feedback on a user's actions (e.g. confirm correct choices, alert users to errors or possible errors).	15%

4. Discussion

People with cognitive disabilities risk being left further and further behind as the importance of the World Wide Web continues to grow as a major medium for information, communication, and commerce. The digital divide for people with cognitive disabilities may actually widen and worsen over time without significant enhancements in Web accessibility. The identification and implementation of Web accessibility guidelines are a crucial step in achieving Web accessibility. Design guidelines represent a universal design approach to achieving equity. Universal design is the process to ensure that products are inclusive, accessible, and usable by everyone, including people with disabilities [15]. Frequently, universal design results in improving use by the general public as well (e.g., curb cuts for people riding bicycles or mothers pushing baby carriages) [26].

Other approaches to Web accessibility, such as specialized Web browsers or assistive technologies, while equally necessary, have limitations of expense and availability and require significant efforts on the part of the user with a cognitive disability. Many people with cognitive disabilities rely on governmental benefits and the cost of these assistive technologies can be beyond the financial reach of many individuals [22]. Ideally, in the future, we will see specialized accessibility features to address cognitive disabilities built into the existing Internet browsers in ways that are transparent to users who do not need them (e.g., "sticky keys").

Well designed Web pages based on Web design guidelines for users with cognitive disabilities are the equivalent of requiring buildings to have ramps or sidewalk intersections to have curb cuts. In these cases, the person with the disability is not expected to pay for or carry their own ramp just as the use of the Web guidelines should not require the use of expensive specialized Web browsers or other assistive technologies in order to use the Web. The potential power of the Web is its universality and it being available to everyone.

The following four recommendations based on this article are proposed:

1) The adoption by the general Web accessibility community of a set of Web design guidelines for cognitive disabilities. There appears to be much agreement on the elements of Web design that enhance accessibility for people with cognitive disabilities. However, as of yet, there is no public agreement or consensus with regard to a universal set of guidelines for Web users of cognitive disabilities. This lack of consensus limits advocacy efforts and progress on implementing these changes with any degree of uniformity or universality. The Design Recommendations shown in Table 1, or some similar subset which could be agreed upon, could potentially greatly enhance Web accessibility for people with cognitive disabilities.

Table 2
Additional Recommendations to Improve Web Accessibility (cited by less than 15% of the Guidelines)

Recommendations to Improve Web Accessibility	Frequency cited Web Design Guidelines
1. Use descriptive hyperlinks	10%
2. Use voice to read the text without screen readers.	10%
3. Use colors to assist clarity	10%
4. Simple navigation, way to backtrack, start over, single click mouse.	10%
5. Avoid or minimize scrolling	10%
6. No time based events	10%
7. Support Web style sheets	10%
8. Avoid background audio sound	10%
9. Use softer colors	10%
10. Avoid blinking or animated icons	10%
11. Don't use italics or fancy fonts, use bold instead	10%
12. Avoid animated graphics	10%
13. Transcribe audio tracks, visuals for all sounds	10%
14. Provide alternative methods for on-line forms. Use shorter forms for complex interactions.	10%
15. Include people with cognitive disabilities in the design, research, and development of new technologies. Test the site with people with cognitive disabilities	10%
16. Provide audio description of video	10%
17. Provide a Web site map	10%
18. Use of borders can clearly delineate sections of text and graphics.	5%
19. Use a maximum of 2 sentences per Web page	5%
20. Use a 1-column (or max 2 column with graphics) layout with generous margins on each side.	5%
21. Use more space between lines. Suggest 1.5 to 2 times line spacing	5%
22. Don't use Roman Numerals	5%
23. Maximum number of lines 60–70 characters per Web page	5%
24. Don't hyphenate words at the end of sentences	5%
25. Use boxes to highlight information.	5%
26. Text prints out easily	5%
27. Spell checkers in search engines	5%
28. Provide user control of auditory information	5%
29. Support screen magnification utilities	5%
30. Screen reading highlights text as read	5%
31. Question and answer format	5%
32. Convert photos to thumbnails where possible	5%
33. Consistent hyperlinks, i.e. blue underlined text	5%
34. Max of 6 links in navigation bar	5%
35. Place navigation bar horizontally to leave maximum area for text and white space.	5%
36. A text only accessibility option is not recommended	5%
37. Use video to supplement text	5%
38. Limit number of fonts used	5%
39. Use different background colours or identifiable graphics to distinguish one page from another.	5%
40. Mouse commands, large space	5%
41. Use breadcrumbs for navigation	5%
42. Reduce short-term memory load	5%
43. Provide multiple methods for access	5%
44. Support text browsers	5%
45. Do not use scrolling text. User may not read at same rate as scrolling feature.	5%
46. Reduce need for keyboarding/composing. Provide choices to select from instead of requiring keyboarding to respond.	5%
47. Accommodate greater range of skill levels and preferences, i.e. offer keywords for search terms as well as providing choices.	5%
48. Give each page a meaningful title. Users will be able to more easily identify a bookmark page.	5%
49. Limit length of animation or flashing text. Limits distraction.	5%
50. Avoid functions that require a response within a specified amount of time. User may not be able to read or respond as quickly allotted time.	5%
51. Provide definitions of terms and lingo. Some words have multiple meanings.	5%
52. Provide examples. Examples help to explain by linking prior experiences with new information.	5%
53. Transcribe audio tracks	5%
54. Layer functionality; hide less frequently used functions; let the user customize the environment to foreground frequently used functions.	5%

Table 2, continued

Recommendations to Improve Web Accessibility	Frequency cited Web Design Guidelines
55. Provide ways in which the user may recognize, rather than be required to recall, information.	5%
56. Avoid flash or display refresh rates that induce seizure.	5%
57. Use a two-step "select and confirm" to reduce accidental selections, especially for critical functions.	5%
58. Let the user set the pace of interaction with the system.	5%
59. Structure tasks, cue sequences, and provide step-by-step instructions.	5%
60. Provide concrete rather then abstract indicators. Use absolute reference controls rather then relative ones.	5%
61. Use goal/action structure for menu prompts.	5%
62. Provide defaults and make it easy to re-establish them.	5%
63. Searches should support query by example and similarity search.	5%
64. Users should be able to use word prediction and grammar and spell checkers in conjunction with all text entry.	5%

An example of a set of Web design guidelines that has achieved significant success is in the area of older adults and the elderly in which the National Institute on Aging published a set of widely agreed upon guidelines entitled "Making your Web Site Senior Friendly [16, 24]. These guidelines were based on a significant research project which compiled existing research studies in the field and published them as the report on "Older Adults and Information Technology: A Compendium of Scientific Research and Web Site Accessibility Guidelines" [13]. This compilation and other research led to the publication, acceptance and wide recognition of the Web design guidelines for older adults and seniors [16]. Becker recently used these guidelines as a basis to evaluate state and federal Web sites for accessibility barriers [4].

2) A second recommendation for addressing Web accessibility is for the design elements for users of cognitive disabilities to achieve a much higher level-of priority in the upcoming revision of the World Wide Web Guidelines 2.0 currently under final consideration and due for formal publication. While the World Wide Web Consortium has made a commitment to include cognitive disabilities to a much greater degree, significant problems continue to exist. For example, the design recommendation, "use clear and simple text," which is item two (70%) in this article's top Web access recommendations shown in Table 3, has been decreased in priority from the highest level in World Wide Web Accessibility Guidelines version 1.0 [29] to the lowest level in the newer proposed version 2.0 [28].

Achieving a higher priority in the revised version of the World Wide Web's Content Accessibility Guidelines 2.0 is important because these serve as the standard the world over and have been used as the basis for Web accessibility laws in many countries. The World Wide Web Content Accessibility Guidelines are utilized by authors and experts in the field of accessibility. An increased priority on design issues for users with cognitive disabilities would have a significant influence on the awareness of many others. This could include impacting the training of Web designers through accessibility training curriculums, books on accessibility, and college courses on accessibility.

3) A third recommendation is for those countries that do develop their own separate Web standards or adopt the World Wide Web's Content Accessibility Guidelines [28] ensure that these address cognitive disability accessibility issues. An example of this is the United States which has developed its own web standards, commonly referred to as Section 508 of the Rehabilitation Act. In these web standards the design recommendation 'use clear and simple text,' which is item two in this article's top Web access recommendation (Table 1), is completely absent. Individual country Web standards, when enacted, are critically important because they are frequently regulations which carry the force of law rather then simply guidelines to which compliance is voluntary. Also national governments are large purchasers of information technology and requirements for accessibility in governmental procurement practices can significantly influence future product design [25].

4) A fourth recommendation is the need for further research. Research is needed to identify the barriers experienced by people with different types of cognitive disabilities and how they can be effectively remediated. Specific research being recommended would measure the impact of different design recommendation on improved accessibility, the conditions of utilization, and the specific type of cognitive disability addressed. All of the guidelines for cognitive disabilities share the same limitation as more general Web accessibility design guidelines. These limitations have been described by the National Cancer Institute [14] as: "1) based on the personal opinions of a few experts, 2) not providing references for support, 3) not providing indications as to whether a particular guideline represents a consensus of researchers, or if it has been derived from a

one-time, non-replicated study, and 4) not giving any information about the relative importance of individual guidelines." Outcome-based scientific research is critical for decision-making and the determination of long-term benefits. This is particularly true since many decisions by Web designers are based on a market-driven cost/benefits analysis. Being able to show the benefits of the design recommendations would increase the likelihood of having them utilized in mainstream Web design. These research questions and the resulting research designs could serve as models for our future work as we move from trial and error to consensus to more evidenced-based practice.

Acknowledgements

This work was produced by the Institute on Disabilities at Temple University in partnership with the Assistive Technology Research and Development Collaborative on Cognitive Disabilities. The University of Akron is the Principal Investigator with partners Temple University, Institute on Disabilities, Spaulding Rehabilitation Hospital, and the Brain Injury Association of America. The research was sponsored by the National Institute on Disabilities and Rehabilitation Research (NIDRR) project number #H133A0101607A.

Guidelines

1. Green, S., and Pearson, E. Cognitive disability and the Web. Special Needs Computing Research Unit, University of Teesside. Retrieved Oct 4, 2003, from http://www.comp.lancs.ac.uk/computing/users/dixa/hci-education/cog-dis/green.html.
2. Dan's pages: Introduction to accessibility. Retrieved January 5, 2003, from http://www.danspages.com/pr_intro_access.htm.
3. Foundation for People with Learning Disabilities, UK. Designing websites for people with learning disabilities. Retrieved April 6, 2004, from www.learnigndisabilities.org.uk/html/content/webdesign.cfm.
4. Kolatch, E. (2000, April 19). Designing for users with cognitive disabilities. Retrieved April 6, 2004, from www.otal.umd.edu/UUGuide/erica.
5. Brown, D. J., and Lawton, J. (2001). Design guidelines and issues for web site production for use by people with a learning disability. Retrieved April 4, 2004, from www.learingdisabiliteis.org.uk/html/content/webdesign.pdf.
6. Zarach, V. (2002, August). Ten guidelines for improving accessibility for people with Dyslexia. Retrieved April, 6, 2004, from www.cetis.ac.uk/members/accesswibility/links/disabilitylinks/documents/dyslexia.
7. Graves, Gaye. (2000, July 9). Introduction to Assistive Technologies for the Web: Cognitive impairment. NASA Ames Research Center, WebDev Group. Retrieved January 4, 2004 from http://webwork.nasa.gov/policy/508/docs/ARC_assistive_tech.ppt.ppt.
8. Jiwnani, K.(2001, April). Designing for users with cognitive disabilities. Retrieved October 6, 2003, from www.otal.umd.edu/uupractice/cognition.
9. Francik, E. (1999, August 16). Telecommunications problems and design strategies for people with cognitive disabilities: Annotated bibliography and research recommendations. World Institute on Disability. Retrieved June 5, 2002, from www.wid.org/archives/telecom/Telecom.pdf.
10. British Dyslexia Association. (2003). Dyslexia style guide. Retrieved October 13, 2004, from http://81.89.134.99/main/information/extras/x09frend.asp.
11. High Plains Regional Technology in Education Consortium. (n.d.)World Wide Web and adult learners with special needs. Retrieved February 25, 2005, from http://scrtecne.unl.edu/SCRTECNE/TechTopics/AdultLearners/default.html.
12. Queensland University Aphasia Groups. Web developer's guidelines. Retrieved September 2, 2004 from http://www.shrs.uq.edu.au/cdaru/aphasiagroups/Web_Development_Guidelines.html.
13. Rowland, C. (2004, August). Cognitive disabilities part 2: Conceptualizing design considerations. Retrieved August 22, 2004, from www.webaim.org/techniques/articles/conceptualize.
14. Nielsen, J. (1996). Accessible design for users with disabilities: Alertbox for October 1996. Retrieved January 4, 2004 from http://www.useit.com/alertbox/9610.html.
15. National Center for the Dissemination of Disability Research. (2003). Tips on making printed materials more accessible. *Research Exchange Newsletter* **8**(3), 6. Retrieved August 20, 2004, from http://www.ncddr.org/du/researchexchange/v08n03/REv8n3.pdf.
16. Mirchandani, N. Web accessibility for people with cognitive disabilities: Universal design principles at work. National Center for the Dissemination of Disability Research (2003). Research Exchange Newsletter, 8(3). Retrieved August 20, 2004, from http://www.ncddr.org/du/researchexchange/v08n03/8_access.html.
17. Pennsylvania State University. Creating Accessible Websites: About accessibility-Multiple audiences. Section F: Cognitive or Neurological Impairment. Retrieved March 4, 2004 from, http://tlt.its.psu.edu/suggestions/accessibility/audience.html#usability.
18. Bohman, P. (2004, August). Cognitive disabilities part 1: We still know too little, and we do even less. Retrieved August 22, 2004, from www.webaim.org/techniques/articles/conceptualize.
19. Robertson, G. L., and Hix, D. (2002, April). Making the computer accessible to mentally retarded adults. *Communications of the ACM* **45**(4), 171–183.
20. Mencap. Making your web site accessible for people with a learning disability. Retrieved June 4, 2004 from, www.mencap.org.uk/download/webaccess.pdf.

References

[1] J. Abascal, M. Arrue, N. Garay and J. Tomas, Recommendations for enhancements in Internet-based services,

2003. Retrieved December 4, 2004 from http://www.iris-design4all.org/IRIS_DOC701/IRIS_D0701.htm.

[2] K. Bartlett, Beyond HTML: Web accessibility for the 21st century. Proceedings of Technology and Persons with Disabilities Conference 2003, 2003. California State University, Northridge (CSUN). Retrieved January 3, 2005 from http://www.csun.edu/cod/conf/2003/proceedings/76.htm.

[3] K. Bartlett, Analysis of WCAG and Section 508 by disability type, 2001. Retrieved January 21, 2005 from, http://www.icdri.org/Kynn/disability-comp.html.

[4] S.A. Becker, E-government usability for older adults, *Communications of the ACM* **48**(2) (2005), 102–104.

[5] C.N. Chu, M.C. Chen and T.Y. Li, A study on the design and evaluation of an adaptive web browser for students with reading difficulties, *Computers in Education* **2** (2002), 1234–1235.

[6] D.K. Davies, S.E. Stock and M.L. Wehmeyer, Enhancing independent Internet access for individuals with mental retardation through use of a specialized Web browser: A pilot study. *Education and Training in Mental Retardation and Developmental Disabilities* **36**(1) (2001), 107–113. Retrieved October 10, 2004 from, http://www.beachcenter.org/research/FullArticles/PDF/TUPID2_Enhancing%20internet%20access.pdf.

[7] D. Goodley, Learning difficulties, the social model of disability and impairment: Challenging epistemologies, *Disability& Society* **16**(2) (2001), 207–231.

[8] I.Z. Holowinsky, An international perspective on terminology, prevalence, and classification of cognitive disabilities, *The Journal of Special Education* **20**(3) (1986), 385–391.

[9] B. Harrysson, A. Svensk and G.I. Johansson, *How people with developmental disorders navigate the Internet*, Manuscript submitted for publication, 2005.

[10] B. Harrysson, A. Svensk, G.I. Johansson and K. Holmqvist, *Internet enabling design for people with cognitive limitations*, Manuscript submitted for publication, 2005.

[11] L.R. Kasday, D.N. Bryen and P.R. Bowman, Web browsing challenges, strategies, and tools for people with motor disabilities and users of AAC technologies, 2004. Retrieved October 7, 2004 from www.webaim.org/temple/aac/whitepaper.htm.

[12] A. Lee and V. Hanson, *Enhancing Web Accessibility*, ACM Press, November 2–8, 2003.

[13] R.W. Morrell, S.R. Dailey, C. Feldman, C. Mayhorn, K. Echt, B.J. Holt and K.I. Podany, *Older Adults and Information Technology: A Compendium of Scientific Research and Web Site Accessibility Guidelines*, Bethesda, MD: National Institute on Aging, April 11, 2003.

[14] National Cancer Institute, Research-based Web design and usability guidelines, October 27, 2003. Retrieved February 20, 2005, from http://www.usability.gov/guidelines.

[15] NCD, Design for inclusion: Creating a new marketplace. National Council on Disabilities, (2004). Retrieved October 30, 2004, from www.ncd.ogv/newsroom/publicatgions/2004/newmarketplace.htm.

[16] NIA, Making your web site senior friendly: A checklist, September 2002. *National Institute on Aging and National Library of Medicine.* Retrieved January 6, 2005, from http://www.nlm.nih.gov/pubs/checklist.pdf.

[17] M.A. Neerincx and J. Lindenberg, Support concepts for web navigation: A cognitive engineering approach. *ACM* (May 1–5, 2001).

[18] C. Nicolle and D. Poulson, Guidelines for developing an AAC-enabled World Wide Web, April 2004. Retrieved January 3, 2005, from http://80.60.189.118/wwaac/.

[19] M.G. Paciello, *Web Accessibility for People with Disabilities*, Lawrence, KS: CMP Books, 2000.

[20] L. Seeman, Inclusion of cognitive disabilities in the Web accessibility movement, June 8, 2003. Retrieved October 5, 2003, from http://www2002.org/CDROM/alternate/689/index.html.

[21] R.J. Seiler, A.M. Seiler and J.M. Ireland, Enhancing Internet Access for the People with Disabilities. *Proceedings of the 7th International World Wide Web Conference 1998.* NY: Elsevier Press, in press.

[22] J.M. Slatin and S. Rush, *Maximum Accessibility: Making Your Web Site More Usable for Everyone*, Boston: Addison-Wesley, 2003.

[23] B. Slotznick, Point and Read training project, 2003. Retrieved December 2, 2004, from http://www.simtalk.com/library/Report2.htm.

[24] Spry Foundation, Older adults and the World Wide Web: A guide for Web site creators, 1999. Retrieved January 7, 2005, from www.spry.org/pdf/website_creators_guide.pdf.

[25] J. Thatcher, P. Bohman, M. Burks, S.L. Henry, B. Regan, S. Swierenga, M.D. Urban and C.D. Waddell, *Accessible Web Sites.* Birmingham, UK: Glasshaus, 2002.

[26] G. Vanderheiden, Thirty-something (Million): Should they be exceptions, *Human Factors* **32**(4) (1990), 383–396. Retrieved October 30, 2004, from http://trace.wisc.edu/docs30_some/30_some.htm.

[27] WebAim, Types of cognitive disabilities, 2004. Retrieved April 21, 2004, from www.webaim.org/techniques/congitive.

[28] World Wide Web Consortium, Web Accessibility Initiative, Web content accessibility guidelines 2.0. W3C Working Draft, 19 November 2004. Retrieved December 5, 2004, from http://www.w3.org/TR/WCAG20/.

[29] World Wide Web Consortium, Web Accessibility Initiative, 1999. Web content accessibility guidelines 1.0. Retrieved September 24, 2003, from http://www.w3.org/TR/WAI-WEBCONTENT/.

[30] WWAAC. (n.d.). World Wide Augmentation and Alternative Communication: AAC and the Internet. Retrieved January 23, 2005, from http://80.60.189.118/wwaac/.