Web Accessibility for People with Cognitive Disabilities

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ABSTRACT
This pilot study investigated ***individuals with developmental cognitive disabilities (DCD) navigating W3C accessibility-compliant Web sites*** and the impact of four cognitive determinants: ***situation awareness, spatial awareness, task-set switching, and anticipated system response***. Participants were placed into one of two search conditions and were asked to complete information-finding tasks. The usability evaluation demonstrated that the ***majority of users with DCD*** were able to access the Web but they ***were unable to successfully use the W3C accessibility-compliant Web sites***. The use of navigation aids was examined, different ***Web navigation problems were identified*** as well as user satisfaction and perceived usability. It is clear from this study that ***current Web accessibility guidelines do not sufficiently address the needs of people with cognitive disabilities***. Additional research is needed to understand how cognitive disabilities affect using Web-based media.

Author Keywords
Universal access, Web navigation, Web usability evaluation, Web content accessibility, Web design, cognitive disabilities, assistive technology.

ACM Classification Keywords
K.4.2 [Computer and Society]: Social Issues---Handicapped persons/special needs, Assistive technologies for persons with disabilities; H.5.2 [Information Interfaces and Presentation]: User Interfaces---Evaluation/methodology; H.5.4 [Information Interfaces and Presentation]: Hypertext/Hypermedia.

INTRODUCTION
Individuals with mild to moderate levels of DCD are increasingly using the Web for recreational, social, vocational and consumer needs but cognitive disabilities remain the least studied in Web usability evaluation and human-computer interaction (HCI) research. While there is a small body of work [15] on how to teach computer skills to adults with DCD, much of the research can be divided into two categories: computer science literature on assistive technology [17] and educational and rehabilitation literature on the use of technology in a special education setting [16]. There are a number of usability and accessibility guidelines available to Web designers, yet there are few published, empirically-supported criteria specific to cognitive Web navigation issues.

Web sites continue to be built based either on artistic design parameters developed from personal experience, or on usability data with limited generalization to populations with cognitive disabilities. Site navigation is a critical element of an effective Web site [11] and there is a pressing need for researchers and designers to take a closer look at how users with cognitive disabilities access the Web. In this study we examine how individuals with mild to moderate DCD navigate W3C accessibility compliant Web sites [19] using a mixed method design (i.e., talk aloud protocol and guided walk though) [10], and focused on four cognitive determinants of successful navigation:

- Situation awareness - a person's momentary knowledge of his or her surroundings
- Spatial awareness - a person's awareness of how content is located in relationship to navigational devices
- Task-set switching - a person's ability to quickly move from one task to another
- Anticipated system response - a person's perception of how the system should appropriately respond to a user's action

BACKGROUND
Research of how individuals with cognitive disabilities navigate Web-based media is limited [15]. A number of studies in the last twenty years have had important implications for designing Web-based navigational interface schemes for users with cognitive disabilities. Navigational aids are critical in helping users traverse through information structures by compensating for errors related to a user's query or for deficiencies that result from the system itself [8]. Effective and efficient navigation requires require that users be aware of their location in the information space, be able to pick up a "scent" of what their next destination might be, and then follow the right trail leading to this destination [14].

Mapping Cognitive Abilities on to Navigation
It has yet to be determined how user tasks for navigating a Web environment map onto the cognitive abilities of individuals with DCD. However, within the HCI literature users' cognitive abilities are related to successful Web navigation [6].

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The most commonly used techniques recommend the provision of sufficient navigational aids like visual displays to orient users within the information space [7]. Contextual information establishes a sense of location, particularly in the spatial context, and helps users decide which trail to follow next [18]. One way to orient users is to provide contextual information that makes the users current status in the Web system transparent to them [13]. A number of studies have examined an array of navigation aids to help users is this regard, including tables of contents, indices, horizontal tabs, hierarchical chains [12], vertical lists of links [4], hierarchical menus [3] and other devices based on paper-based document metaphors. Other design factors impacting ease of navigation include menu dimension, task complexity, and the knowledge structure of the Web user [5].

An examination of individual navigational styles suggests that inexperienced users use weak navigational styles that are charaterized by high rate of home page revisit, high frequency of back button use and small number of page visited. It has also been suggested that more focus on graphics, audio, video, and animations may be the most effective way to improve communication for users with cognitive disabilities [2].

Building on previous research [10], four cognitive components required for successful Web navigation have been identified: (1) situation awareness; (2) spatial awareness; (3) task-set switching and (4) anticipated system response. ***Situational awareness*** is related to a user's perception, comprehension and projection of task requirements and requires strategies that encapsulate data to prevent information overload [9]. ***Spatial ability***, the ability to solve spatial problems mentally rather than in the physical world, is related to the time spent on completing a Web-based task [10]. ***Task-set switching***, the ability to focus and concentrate selective attention, is positively related to effective navigation [1]. ***Anticipated system response***, a users perception of how the system should respond to their query, has not been studied but it may be related to user situational awareness.

RESEARCH DESIGN

The methodology used in this exploratory study was a mixed method design using a convenient sample (n=27) of participants with mild to moderate DCD. Participants were recruited from developmental disability (DD) brokerage agencies and service providers. A series of five usability studies were held in various locations across the Portland, Salem, and Corvallis metropolitan areas in Oregon. The inclusion criteria for the study were:

1. Able to participate meaningfully in a group discussion
2. Relatively free of disruptive behaviors
3. Age 18 or older
4. Possess a developmental diagnosis that fell within the mild and moderate range

Sensitizing Variables

The sensitizing independent and dependent variables of this exploratory study were the participants performance on the task component of the study, the number of times the user voluntarily used the back button, and each participant's attitude. Attitude variables were constructed to collect subjective data about perceptions of "getting lost" in the Web sites as signaled by the verbalization "I need help." Data on demographic variables such as gender, level of cognitive impairment and age were also gathered.

Procedures

Prior to individual sessions with each research participant, the researcher set up the computer and browser for the usability test. The monitor screen resolution was set to 800 x 600. The browser was opened, maximized, and the browser history list was reset. Each participant was videotaped and audio recorded. The usability evaluation session was started by asking the participants to think aloud during the whole session and by giving an example of how to think aloud. During the session participants were prompted to think out loud when they forgot.

Before the first task was given participants were told that the investigator would ask questions about what they had done such as, "What do you think will happen if you press that button?" and "How do you want to move around the page?" A participant's evaluation of system response was assessed by asking, "Did you expect that to happen?" Next, participants were shown either the ADD-Up (www.addup.org) or MedlinePlus (www.medlineplus.gov) Web sites. We should emphasize that the AddUp.org Web site, which was funded by the Administration on Developmental Disabilities, was selected because it was developed and revised to meet the needs of all potential users regardless of their level of ability. Both the Medline Plus site and the AddUp.org Web sites were selected as they met our requirement of being W3C accessibility-compliant (Web Content Accessibility Guideline, version 1.0).

Each participant was asked to: (1) located and click on the site's header; (2) right click the mouse and use the arrow to move up and down the Web page; (3) left click the mouse and highlight a sentence on the Web page; and (4a) find a area on the page that was of interest and read this area, or (4b) since the readability of many Web sites posed a significant hurdle to individuals with DCD, find a area on the Web page that was of interest and describe what that part of the page was about. If a participant displayed difficulty with these basic tasks the investigator proceeded to "walk" the participant through the steps.

Participants with computer experience were asked to explore other features of the Web page. The tasks were ordered identically for each subject, who was given up to one minute to find the answer. When the subject believed they had found the answer, they notified the researcher. If the answer was not found within one minute, the participant

gave up, or if the participant went to the wrong place in the Web site, the investigator immediately corrected the navigational error. These responses were counted as an incorrect response. Immediately following the completion of the usability study, each subject was paid $30 for his/her participation. Most subjects completed the experiment in 10 - 20 minutes.

RESULTS / DISCUSSION

Study Sample

Most of the participants were in the mild to highly functioning moderate (77%) range of cognitive impairment. The most commonly reported co-occurring disabilities were corrected vision, cerebral palsy, obsessive-compulsive disorder. There was a 48% : 52% split on gender. Based on self-reported data gathered in the focus groups, 78% of the participants were occasional to daily users of computers. Across ability levels many of the participants experienced significant difficulty with the talk aloud protocol and after several prompts we proceeded with a guided walk thorough approach. On the preliminary tasks all but one of the participants could identify the mouse and most could center the mouse (77%) on a designated target. However, only 52% of participants could activate the mouse on a designated target with out prompting or help. When requested to type in URLs only one third (34%) of the participants could do so without prompting and the remaining participants required either extensive step by step prompting or the researcher to execute this step. Overall, only 19% of the participants could successfully navigate either site without extensive guidance.

Usability Evaluation Study

1. Spatial Awareness

Spatial awareness is the user's awareness of how content is located in relationship to navigational devices like scroll keys or mouse. Many participants experienced problems in finding key features of the Web sites (e.g., links to help menu, introductory links, About Us). Specifically, the ability to recognize hypertext and activate links was problematic. However, 52% of the participants could recognize hypertext links. In this group only 64% of the users could activate the hypertext link with out assistance and all knew they had arrived at the right page. Those individuals (i.e.,remaining 48%) who did not recognized hypertext links, could only select and activate the text with either step-by-step instruction or the researcher executed this step. Of this group, 42% recognized that they had arrived at the right page and the remaining 58% were informed that they were on the right page. With regard to this latter group, the most prevalent behavior was the random clicking of all text.

Across ability levels and experience with Web-based media, most of the participants (89%) can be described as using "hunt and peck" keyboarding skills. Lack of familiarity with the "Backspace" key was also apparent. Also, the lack of familiarity with the scrolling feature on the Web page was noted. Without prompting, only 48% of the participants would volunteer to use this feature.

With the exception of the five "expert" (19%) users, external hypertext links were very confusing. The MedlinePlus Web site relied heavily on external links that lead to the creation of a new browser window. When asked: "How do you return to the home page?" many of the participants tried to use to use the browser BACK button unsuccessfully and several closed the site.

2. Situational Awareness.

Situational awareness is a user's momentary knowledge of their surroundings and an awareness about what is required to link to one's previous experience. 48% of the participants identified themselves as using Web-based media. The relationship between internal versus external links was not clear. When asked: "How do you return to the Home page?" several participants closed the site when trying to return to the Home page. Two of the participants used the HOME button on the menu to return to the home page however most participants (44%) used the browser BACK button. The remaining 56% required the researcher to execute the step (22%), required step-by-step prompting (26%) or abandoned the task (8%).

The Help menu on the AddUp.org site was particularly troubling for the participants. In short, none could find it without prompting; none of the participants could activate its contents and the contents were counter intuitive (i.e., help with job location?). Lack of perceived click-ability, as mention above, was apparent on both sites. Many of the participants had difficulty locating icons or "line bars" to click.

3. Task-set Switching

The ability to quickly move from one task to another is an important part of an efficient and effective Web browsing strategy. This ability to task-set switch was most apparent in the participants with mild levels of cognitive impairment. This group composed of 4 females and 5 males distinguished themselves in that they: all identified themselves as computer users and all could locate and activate the mouse without prompting. This group also knew how to close external links, or use the browser HOME key, or select "Home" from the menu options. The movement from one task to another was not as labor intensive as it was in the latter two groups.

Persons with moderate levels of cognitive impairment composed 66% of the sample tested. Two-thirds of them were self-identified computer users. Moving from task to task was often labor intensive. For example, typing in and activating URLs required direct intervention for most of the participants (78%). Moving onto the browsing stage that required knowledge of hypertext, reading of text, centering and activating text, and recognizing that you have arrived on the right page to possibly start the process all over again

was daunting. Unlike the individuals with mild cognitive impairment, this group did not know: that hypertext was clickable; how to center the mouse over the hypertext link; or how to understand the system response. However, like the first group most of the participant in this group did recognize when they were on the right or target page.

4. Anticipated System Response

User anticipated interpretation of system response refers to the users perception of how the operating system or Web page should respond to a users request. Unclear navigational confirmation was particularly problematic when using the "email AddUp" feature. Most of the participants were not sure what steps were needed to activate (i.e., send) the message. Nor, was there any indication that the message had been sent. In general, most of the participants knew when the computer was "thinking." Some users would wave their hands to "push" the computer along while others would simple sigh and remark that their own systems were equally slow.

CONCLUSION

This study was exploratory research that examined the question of whether individuals with mild to moderate DCD can navigate the W3C accessibility-compliant Web sites, AddUp.org and MedLine Plus. Four determinants of navigation performance were explored, situation awareness, spatial ability, task-set switching and anticipated system response. It was found that the ability to navigate the AddUp.org and MedLine Plus Web sites was impacted by unclear navigational confirmation, inconsistent navigation, non-standard interaction techniques, lack of perceived click-ability, user willingness to scroll pages, and user ability/willingness to read instructions. We strongly believe that more research is needed to understand how cognitive disabilities affect using Web-based media.

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