Cognition, Age, and Web Browsing

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Abstract. The literature on Web browsing indicates that older adults exhibit a number of deficiencies when compared with younger users. But have we, perhaps, been looking at the question in the wrong way when considering technology skills of older users? What are the strengths of older users that can be leveraged to support technology use? This paper considers cognitive aging with respect to distinctions in abilities that decline, and those that do not, with age. A look at specific abilities and their interactions may serve to help designers create software that meets the needs of older users.

Keywords: older adults, Web, cognitive abilities.

1 Introduction

Currently there are neuroscientists who are investigating whether the high-paced constant bombardment of technologically-mediated input is changing the brains of today's youth [22]. While the focus of such work is on brain plasticity and changes in youth, the question can be turned around. That is, are the brains of older adults simply not able to cope with current technologies?

Subjectively, nearly every tech-savvy person has a story of an older relative or friend who has struggled with computers, mobile phones, or even the increasing technological sophistication of common household devices such as televisions and microwaves [17]. Is this inability to deal with technology an inevitable consequence of aging? Today's Gen-Xers believe that their ability to easily master current technology will not doom them to the same fate as the current generation of older adults. How realistic is this belief?

It is well known that aging brings about changes in a person's abilities. The fact of vision changes will cause most of us to begin to use glasses (often multi-focal) even if we have not previously done so. For others, vision changes will be more catastrophic, with major vision losses due to medical conditions such as macular degeneration that, in come cases, will lead to blindness. Similarly, losses in hearing as well as fine or gross motor skill will create a spectrum of difficulties for many as we age.

Of interest to the present discussion is the impact of cognitive aging on the ability to deal with technological complexity. Problems related to access and usability for people with vision, hearing, and physical disabilities are far from being solved, but are better understood than technologies needed for cognitive disability [2]. For example, guidelines exist for making the Web work with screen readers. When these guidelines are followed, people who use screen readers can access the Web [3]. This is not

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to say that all problems for screen readers users are thus solved. Even for pages that conform to these standards, there are demonstrated usability problems [16, 18]. Older adults who have lost their vision late in life, in particular, need more help with Web browsing than is specified in guidelines for screen readers alone [26]. Cognitive issues, such as those to be discussed below, make it difficult for such older users to develop mental models of the browsing task and learn the commands needed to navigate with a screen reader. While the guidelines do not completely address all accessibility and usability issues for users of screen readers, there is at least a consensus that audio renderings of Web content are needed for this population.

In contrast, there is no general consensus of how to support the cognitive declines that accompany aging.

2 Fluid and Crystallized Intelligence

In healthy aging, there are number of declines in cognition that can affect ability to use technology. Looking at the population as a whole, these declines begin in middle age and continue throughout the rest of one's life [6, 8]. There is a great deal of variability from person to person, however, in the onset and rate and of these declines related to a number of factors [6, 8, 21].

To best understand the nature of these declines, we can look to information processing theories that deal with mental activities such as selection, storage, manipulation and organization of information [1, 20]. In work with older adults, a difference between *crystallized intelligence* and *fluid intelligence* is often made. Both are part of a general intelligence as differentiated by psychologists, but the two are broad categories that cover separate cognitive abilities. Crystallized intelligence commonly remains intact throughout one's lifetime and is not likely to be impaired as a result of brain trauma. It is measured through tests of verbal ability and reflects knowledge that we have gained through education and experience. A large-scale study spanning 66 years illustrates the stability of this form of intelligence. Deary and colleagues tested a cohort of 77 year olds in a region of Scotland [10]. This group had all been administered a battery of "verbal tests" in 1932 as part of a government testing program. Sixty-six years later, these researchers contacted survivors in the area and re-administered the tests. Results showed a high correlation in cognitive abilities in these verbal indicators over this large span of years.

Fluid intelligence refers to a set of cognitive abilities that includes short-term memory, speed of processing, and problem solving ability. Critically for older adults, these abilities are associated with aptitude for learning new technologies. In contrast to crystallized intelligence, fluid intelligence has been shown to decline with age and is can affected by brain trauma. Age-related declines due to fluid intelligence may help us understand the underlying reasons for patterns observed in Web use by older adults. Fluid intelligence, for example, is one of the strongest predictors of Web experience [8]. Specifically, older adults who measure high on tests of fluid intelligence engage in more types of Web activities (such as e-mail, games, news information, shopping) than those who measure low on these tests.

Difficulties with complex page navigation are interpretable in terms of short-term memory and processing changes, and some specific remedies to support users have

been suggested. For example, consistent navigation of pages within a site and clearly structured information can reduce problems [3]. Providing feedback about the entire sequence of a multi-step event, such as when making online purchases could prove beneficial [11]. Searching can be improved for older adults by non-hierarchical interfaces [19]. Difficulties with browser basics such as the Back, History, Bookmarks and Search can all be understood as complex activities that tax limited cognitive systems. Better-supported information about visited sites and searched sites is crucial for older users. In terms of Web 2.0 content, difficulties of navigation are exacerbated by dynamic changes ("change blindness" being particularly strong for older adults), difficulty identifying clickable areas, lack of help for ever-changing content [4].

3 Technology for the Generations

A recent report found some surprising results in terms of Internet use by age: While there is still a digital divide between the youngest group studied (the Gen Y group, ages 18 – 32) and the older groups studied, the differences in use are shrinking [15]. For example, in 2005, only 26 % of the older adults ages 70 – 75 were online; today that number is 45%. Certainly this represents the gradual aging of the population, with the more technology oriented older users moving up the age scale. It does suggest, however, that ability to use the Web can continue even in the face of age-related changes.

What are these older users doing online? Not surprisingly, email is the number one use. This is followed by Internet searches, seeking of health information and making travel reservations [15]. Looking at the somewhat younger cohorts, we see that the boomers (ages 45 – 63) are more likely than their older counterparts to use the Web for online shopping and banking. Social networking appears relegated to the younger generations, however.

Changing demographics worldwide have created a workforce in which older workers are critical [9, 13]. The individual reasons for remaining in the workforce vary, including both financial needs and various needs for self-fulfillment [14]. Remaining in the workforce may be an important element of remaining technically savvy that is not typically considered [12]. Employment often requires workers to keep their skills up to date. Once retired, the pressures to keep up with the latest advances in technology are less. Use of technology by retired persons is for personal interests rather than an external demands by employers. For many older adults, the lack of use of the Internet and other technology is simply the fact that they see no need to use it [25]. Remaining in the workforce is one powerful motivator to stay current with technology.

The demographic make-up of today's workforce may well re-shape how technology, including the Web, is used [5]. In looking, for example, as the use of Instant Messaging (IM), the recent survey found IM used little (39% or less) by Boomers and older users [15]. In contrast, IM was reported used by 70 – 79% of the Gen Y users. For some workplaces, however, IM is a part of the work culture and employees, regardless of age will be using it. In one recent study at a large industrial company, administrative assistants were asked about their workday and the technology tools they used to perform their job [24]. All interviewed, regardless of age, used IM as a regular part of their day.

4 Uniquely Older

The literature on Web browsing suggests that older adults exhibit a number of deficiencies when compared with younger users. But have we, perhaps, not been looking at the right question? Of interest here is recent evidence that cognitively older adults bring specific skills and approaches to the task. A couple of recent studies about Web navigation by older adults will serve to illustrate this point.

In eye-tracking work, Tullis found that older and younger adults attend differentially to Web pages and parts of Web pages [23]. The task used by Tullis required participants to determine information about personal finances on a mock website. The older adults (ages 50 – 69) spent more time viewing nearly all Web pages than the younger participants (ages 20 – 39). They spent more time viewing both upper and left-side navigation areas on pages than the younger users. They read more text on pages than younger users. Overall, they looked at parts of the Web pages that younger users seemed simply to ignore.

Tullis was not able to determine the underlying reason for this browsing difference between his two age groups, but he considered possibilities such a caution in selection and attentional issues associated with aging. While such factors may play a role, we can look at another study to get an additional interpretation. Fairweather examined the navigation paths of a group of users (ranging in age from 18 to 73 years old) [11]. The user task was to look for job openings in an online newspaper. This study showed that older and younger participants were not differentiated by their success on this task, but they were differentiated by how they arrived at the goals. Specifically, their paths through Web pages followed different courses.

Fairweather's hypothesis about his findings takes a new look at issues of cognition and aging. Specifically, he noted that the solution of the job task relied a great deal on participants' specialized knowledge, experience, and vocabulary about the domain, all of which are aspects of crystallized intelligence that generally do not decline with age.

Considering these two studies together, it is tantalizing to speculate as to the reasons for older participants' increased time attending to navigation, links, and text on a page. It may well be that this is related, at least in part, to their thinking about the problem task. In this, it might be considered that these users are savvy enough to use their strengths to support lesser abilities. Understanding such interactions, rather than simple statements of disability, may eventually prove crucial in being able to well support the technology needs of older adults.

5 Summary

Demographic trends show that people, worldwide, are living longer, with the greatest increase being in what could be considered the "oldest of the old". The impact of this is a clear need for technologies that are usable by older adults. The Web, as a technology that is becoming important in all aspects of life including social activities, commerce, and government services, provides an important application that needs to be understood from the perspective the abilities of older adults. Given specific cognitive changes that happen throughout life, cognitive factors in their relation to browsing represent an important and, to date, relatively little investigated issue for older users.

Recent suggestions that older adults are not simply deficient younger users may well re-define how technologists develop for older adults. Considerations of cognitive strengths and weakness are needed, with research investigating how older adults currently use their strengths to mitigate problems. This also suggests that technologists might consider how to design devices and interfaces, such as pages, that could use these strengths to help older users.

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