

Aging Well: The Use of Assistive Technology to Enhance the Lives of Elders

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Abstract. Eighty percent of seniors have some type of functional impairment that impacts one or more activities of daily living. This paper focuses on the use of assistive technology devices to support elders with successful aging. A variety of assistive technology devices and their utilization by elders are explored.

Keywords: aging, disability, assistive technology.

1 Introduction

Successful aging has been defined as living on your own terms, adding value to society, family, or friends, maintaining cognitive function, maximizing mobility, retaining function, and reducing the impact of chronic disease/dysfunction [1]. Assistive technology (AT) devices have the capacity to facilitate successful aging; however negative stereotypes and myths surround the acquisition and use of technology by elders. One of the most prevailing myths is that seniors struggle with both technology and change. However, a review of the past hundred years tells us a different story.

Between 1900 and 1910, centenarian's witnessed the first airplane flight, the first Model T car, air conditioning and live radio broadcasts. By the 1920's, the world was experiencing rockets, frozen food and television. The defibrillator was launched in the early 1930's, along with nylon and digital computing. In the 1940's the first jeep was invented, atomic reaction and the atomic bomb, Polaroid camera and the electric guitar. By the 1950's, we were experiencing the heart-lung machine, a cure for polio, and nuclear submarines. By the 60's, men were landing on the moon, the laser; operating systems for the computer and the mini computer were available. In the 1970's we saw optical fibers, Microsoft, video games, bar codes, the Super Computer and human powered flight. In the 80's we experienced the space shuttle, the artificial heart, the personal computer (pc) and genetic engineering. During the 90's we launched the Hubble Telescope. In other words, today's elders have experienced the launch of modern technology, the exponential change and growth of their environment and were in fact, the very architects and change agents who created these fantastic opportunities in our world.

Population aging is more advanced in the most highly developed countries. Among countries classified by the United Nations as more developed (with a population of 1.2 billion in 2005), the median age of the population rose from 29.0 in 1950 to 37.3 in 2000, and is forecast to rise to 45.5 by 2050. The corresponding figures for the world as a whole are 23.9 for 1950, 26.8 for 2000, and 37.8 for 2050. In Japan, one of the fastest aging countries in the world, in 1950 there were 9.3 people under 20 for every person over 65. By 2025, this ratio is forecast to be 0.59 people under 20 for every person older than 65 [2]. So what does that mean in relationship to the use of assistive technology devices and services?

2 Aging, Disability and Assistive Technology

Eighty percent of seniors have some type of functional impairment that impacts one or more activities of daily living. Examples might include reaching, grasping, seeing, hearing, taste, etc.

2.1 Vision

Even though changes to the eye take place as a person ages, many older people have good-to-adequate vision. Nevertheless, beginning in the late 30s and early 40s, an individual may begin to notice some changes. The flexibility of the eye decreases and it takes an older person more time to accommodate to changes in light. The most functionally important changes seem to be a reduction in pupil size and the loss of accommodation or focusing capability. The area of the pupil governs the amount of light that can reach the retina. The extent to which the pupil dilates also decreases with age. Adaptations in lifestyle and behaviors must be made to cope with this change. An individual might give up driving at night. Placing more lights evenly around the room so that the entire room is lit is also helpful.

Degeneration of eye muscles and clouding of the lens are associated with aging. Several changes in vision result from this. Older people tend to have trouble focusing on near objects, but eyeglasses may correct this problem. In addition, the ability to see colors changes with age as the lens yellows. Red, yellow, and orange are easier to see than blue and green. This is why fabrics in warmer shades may be more appealing to the older person. Serious vision impairments such as cataracts, glaucoma, and blindness affect between 7% and 15% of older adults. If someone you know must learn to cope with blindness or near blindness, you can play a critical role in helping them maintain their independence [3, 4].

There is a wide range of AT devices and strategies to help elders (and others) with visual impairments perform daily activities such as reading, writing, personal care, mobility and recreational activities. Among low-tech solutions are simple handheld magnifiers, the use of large print, or mobility devices (e.g., a white cane) for safe and efficient travel. High-contrast tape or markers can also be used to indicate hazards, what an item is, or where it is located.

Other low-tech solutions include items such as using wind chimes to help with direction-finding, using easily legible type fonts such as Verdana (16pt or larger) and using beige-colored paper rather than white to improve the visibility of text. In

recreational activities solutions include beeper balls, three-dimensional puzzles and outdoor trails with signage called “Braille Trails” designed to improve access to wilderness and other outdoor activities.

Brailled text, though less used than in years past due to the advances of computer and other technologies, is still the first choice of many individuals for reading. Many restaurants now provide large-print, Braille and picture-based menus for customers with a variety of abilities.

Books-on-tape are another resource for individuals with severe visual impairments. In addition to commercially available tapes for sale and at public libraries, special libraries provide print materials in alternate formats for persons with visual, physical and learning impairments. Borrowers can arrange to have textbooks and other materials translated into alternate formats. For more information, contact the American Federation for the Blind or the National Library Service for the Blind and Physically Handicapped (<http://www.loc.gov/nls/>)

Numerous high-tech solutions exist for persons with visual impairments. Computers outfitted with a speech synthesizer and specialized software such as Jaws™ or WindowEyes™ allows navigation of the desktop, operating system, applications and documents as well as the entire Internet. Any digital text can be heard aloud by the person using this software. For text that is printed such as menus, memos, letters, etc. using a technology called optical character recognition (OCR) allows a page scanner and software to convert print into digital form where it can then be listened to through the computer’s speech synthesizer or converted to Braille or large print.

Another category of high tech aids are portable note takers with either Braille or speech synthesizer feedback for the user. These devices are specialized personal digital assistants (PDAs) with calendars, contacts, memo and document capabilities and can be purchased with either a QWERTY or Braille keyboard.

For individuals with some degree of visual ability, screen magnification software such as Zoomtext™ and MAGic™ enable the user to choose the amount (2 xs to 20 xs) and type of magnification preferred for optimal computer access. Many magnification applications combine enlargement with speech synthesis or text-to-speech. A recent addition to the list of screen magnification software is called Bigshot™. This software is less expensive (\$99) and provides fewer features than some other programs. However, it appears to be an alternative for users who do not need access to the more sophisticated computer functions, and it is highly affordable.

2.2 Mobility

Impaired balance and gait are the two most significant risk factors for limited mobility and falls in the elderly [5]. Mobility impairments caused by disorders such as osteoarthritis might keep an elder from actively participating in social groups with their peers, playing with grandchildren or taking care of routine household tasks. Fear of traversing unknown or uneven terrain often keeps elders at home rather than out in the community.

Upper body impairments that impact reaching, grasping, and carrying objects can interfere with everyday activities such as bathing, dressing, cooking and hobbies.

Elders can become frustrated, depressed and severely isolated by these types of disabilities. Given the importance of computer use in today's world, many AT devices have been developed to give individuals with upper-body mobility impairment such as poor hand control or paralysis access to computers. But, what if someone is unable to use a standard mouse and keyboard?

Alternate computer keyboards come in many shapes and sizes. There are expanded keyboards such as the Intellikeys™, which provides a larger target or key surrounded by inactive space than a standard keyboard. Options such as delayed activation response help individuals who have difficulty with pointing accuracy or removing a finger after activating a key. Individuals unfamiliar with a standard QWERTY keyboard layout, have the option for alphabetical layout. This is often helpful for elders who have never learned to type.

There are also smaller keyboards (e.g., Tash Mini Keyboard™) designed for persons with limited range of motion and endurance. They are also helpful for individuals who type with one-hand, or use a head pointer or mouth stick to type. These keyboards use a "frequency of occurrence" layout. The home or middle row in the center of the keyboard holds the space bar and the letters in English words that occur most frequently, (e.g., "a" and "e"). All other characters, numbers and functions (including mouse control) fan out from the center of the keyboard based on how frequently they are used in common computer tasks.

Voice recognition (VR) is a mass-market technology that has become essential for computer access for many persons with motor impairment. Instead of writing via the keyboard, VR users write or speak words out loud. The computer processor uses information from the user's individual voice file, compares it with digital models of words and phrases and produces computer text. If the words are accurate the user proceeds, if not, the user corrects the words to match what was said. As the process continues, the computer updates its voice file and VR accuracy improves. This software is cognitively demanding yet can offer "hands free" or greatly reduced keyboarding to many individuals with motor impairment.

Another group of computer input methods include devices that rely on an onscreen keyboard visible on the computer monitor such as the Head Mouse™ and Tracker 2000™. The user wears a head-mounted signaling device or a reflective dot on the forehead to select keys on the onscreen keyboard, choose commands from pull down menus, or direct mouse movement. On-screen keyboards are typically paired with rate enhancement options like word prediction or abbreviation expansion to increase a user's word per minute rate. Because so many tasks can be accomplished through computers, elders with disabilities – even those with the most severe motor impairments – can fully participate in everyday activities.

2.2.1 Lower-Body Mobility Devices

AT solutions for individuals with lower body mobility impairments may include crutches, a rolling walker, a powered scooter or a manual or powered wheelchair. Simple environmental modifications or adaptations such as installing a ramp instead of stairs, raising the height of a desk or widening doorways can be critical facilitators for these individuals and may be all that is needed. For other activities or to increase participation, adding automobile hand controls, adapted saddles for horseback riding or sit-down forms of downhill skiing are possible.

There are literally thousands of low-tech assistive devices available for persons with motor impairments. Commonly referred to as aids or adaptive devices for completing Activities of Daily Living (ADLs), these devices include weighted spoons and scoop plates to facilitate eating; aids for personal hygiene such as bath chairs and long-handled hairbrushes; items for dressing such as sock aides and one-handed buttoners; adapted toys for play; built-up pencil grips for writing and drawing; and many others. Many low-tech mobility aids can be handmade for just a few dollars, while others, such as an adult rolling bath chair, may cost several hundred dollars. All share the common goal of reducing barriers and increasing participation in daily life.

2.3 Memory Loss

One of the key concerns of older adults is the experience of memory loss, especially because it is one of the most clearly recognized symptoms of Alzheimer's disease. However, memory loss is qualitatively different in normal aging from memory loss associated with of Alzheimer's disease [2] and not all memory loss can be attributed to a disease process. Recent research has identified mild cognitive impairment (MCI) as a transitional state between the cognitive changes of normal aging and Alzheimer's Disease (AD). Many elders experiencing mild cognitive impairment have a much higher risk of developing Alzheimer's disease. Studies indicated that MCI individuals are at an increased risk for developing AD, ranging from 1% to 25% per year; 24% of MCI patients progressed to AD in 2 years and 20% more over 3 years, whereas a recent study indicated that the progression of MCI subjects was 55% in 4.5 years [6, 7].

Most elders experiencing cognitive decline such as memory loss have not had the benefit of using AT devices because relatively few products have been specifically developed for persons with memory impairments. In addition, caregivers, allied health professionals, and others providing support services for elders with cognitive impairments have generally not been aware of its usefulness. Most have looked to simple solutions for persons with cognitive impairments using strategies like colored highlighter tape, pencil grips, enlarged text, reminder lists, and calendars. Others try low tech adaptations like using a copyholder to hold print materials for easy viewing and making cardboard windows to help eyes follow text when reading.

Recent mainstream technology developments include handheld Personal Digital Assistants or PDAs. Assistive technology software developers (AbleLink Technologies, Inc.) have used this technology and developed software applications (PocketCoach™) that provide auditory prompts for individuals with cognitive disabilities. This software can be set-up to prompt an individual through each step of a task as simple as mopping a floor, up to the complexity of solving a math problem. The latest version of this software combines both voice prompts with visual prompts (Visual Assistant™). The individual setting up the system for a user can simply take a digital picture with the accompanying camera and combine them with digitally recorded voice prompts to further facilitate memory and cognition.

The U.S. Department of Education, National Institute on Disability Research and Rehabilitation (NIDRR) recognizing the need to increase assistive technology development for persons with cognitive disabilities, funded a Rehabilitation Engineering Research Center for the Advancement of Cognitive Disabilities (www.rrc-act) in 2004. Located at the University of Colorado Health Sciences

Center, this RERC-ACT is focusing on developing a wide range of assistive technologies focused on developing vocational and literacy skills, service provision and enhanced caregiving supports for persons with significant cognitive impairments. This new field of 'cognitive technologies' promises numerous advances during the next decade.

2.4 Hearing

About 33% of those between the ages of 75 and 84 have a hearing loss and about half of those over 85 have a hearing loss. Hearing loss affects the older person's ability to talk easily with others. For example, they often have trouble hearing higher pitched tones. They also may not be able to make out sounds or words when there is background noise. Elders may be frustrated or embarrassed about not being able to understand what is being said. As a result, the older person may withdraw from friends and family and outside activities [8].

Individuals who are deaf or hard of hearing deal with two major issues: lack of auditory input and compromised ability to monitor speech output and environmental sound. Assistive technology devices such as hearing aids and FM (frequency modulation or radio wave) systems can be used to facilitate both auditory input and speech output. Other types of AT devices provide a visual representation of the auditory signal. These include flashing lights as an alternate emergency alarm (e.g., for fire or tornado) or the ring of a phone or doorbell.

Another recent adaptation for persons with significant hearing impairments is computer-assisted real-time translation or CART. This AT solution involves a specially trained typist or stenographer who captures what is being spoken on a computer. The text is then is projected onto a display, resulting in close to 'real-time' translation. The advantage of this technology is that it can be used by hearing impaired individuals who are not fluent in sign language as well as others who may need listening help such as those who use English as a second language. In addition to use in group environments like conferences or meetings, a variation of this technology can be used to assist a single student or employee in a small setting.

For individuals who wear hearing aids, there are additional technologies that can facilitate hearing in large rooms or in noisy, crowded environments such as a restaurant. The Conference Mate™ and Whisper Voice™ are especially designed for these environments. In the case of the Conference Mate™, the person with the hearing loss wears a "neck-loop" which acts as an antenna and is capable of broadcasting directly to a hearing aid a microphone placed near the speaker, transmits directly to the neck loop eliminating background sound. This is also an excellent solution for office and school environments. The Whisper Voice™ is similar, except it uses a smaller microphone and is more portable. It can be passed from speaker to speaker with sound transmitted to the neck loop and then onto the hearing aid for amplification.

Environmental adaptations can frequently support individuals who are deaf or hard of hearing. For example, a person speaking to someone who has difficulty hearing can take care not to stand in front of a light source (windows, lamps, etc.) and not to over-exaggerate or hide lip movements. In addition, gestures may be helpful.

The world of AT is moving at a very rapid pace fed in large part by the growth in mainstream technologies and the culture of inclusion that is changing traditional concepts about disability and impairment. Space travel, satellite supported telecommunications, wireless networks, new materials with advanced performance properties, miniaturization of integrated circuits and innovation in batteries and power sources are all crossing over into the field of AT. In the United States, Federal funding supports Rehabilitation and Engineering Research Centers for the development and testing of new assistive technology concepts. Funds also support the transfer of technologies from the Federal laboratory system to assistive technology manufacturers. The convergence of these factors is leading to AT products more likely to meet the needs of persons with disabilities, including the elderly.

We know that seniors have unique needs that must be addressed to enable adoption of new and existing technologies. We also know that benefits of technologies for seniors include:

1. connecting isolated seniors to the world around them;
2. easier access to health and care information;
3. providing access to entertainment, recreation and social interaction;
4. enables elders to continue to contribute to society through personal web-sites, email, chat rooms, etc.; and,
5. makes lifelong learning (and teaching) possible through distance education.

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