

The Impact of Computer Technology on the Elderly

Marek van de Watering

Vrije Universiteit, Amsterdam, The Netherlands

rvdwate@few.vu.nl

Abstract

The impact of computer technology on elderly people is discussed. This is done by describing the effects of computer use by elderly people and by considering age-related changes. Also, the barriers elderly people encounter previous to or during the use of a computer are examined. Various positive effects are addressed, such as decreased feeling of loneliness by using e-mail and a slower decrease of cognitive abilities by playing specific computer games. Finally, the business perspective as well as future possibilities in this area are discussed, in order to show that this impact can and should be even greater.

1 Introduction

Computer technology is embedded in our Western society in a way that the majority of people seem to forget that it is a relatively new development. The mainstream of this society has quickly adopted computer technology as part of their daily life, and in doing so opened up to all the possibilities this technology has to offer. The ever growing group of elderly people (age 60 and older) in our society, which will grow from being 20 per cent of the population in developed countries to being 32 per cent by 2050 [1], seems to have been forgotten in this matter. With this growth and the fact that we all grow older in mind, the opportunities that computer technology could give this group should be considered. The ongoing advance of technology suggests that younger people's experience with computers will not be a crucial advantage when they grow older. It is not hard to imagine that, looking at a random website or input devices such as the mouse and keyboard, elderly people might have trouble in using them.

Heller et al. [2] say about aging: "As people grow older, their abilities change. This change includes a decline in cognitive, physical and sensory functions, each of which will decline at different rates relative to one another for each individual." This makes it hard to define "the elderly" as one consistent group, and presents a challenge for designers of computer technology. Facing this challenge, however, can ultimately provide benefits for both elderly people and the society.

I have chosen to write this essay about computer technology and elderly people because, as a student in Information Science, I have the opinion that it does not get enough attention from Information Science students. It is a subject that offers great potential in helping people in a all sorts of ways with and trough the use of computers, therefore standing out against the business-focused majority of research subjects in Information Science.

This paper will describe the effects of computer technology on elderly people, and give an outline of possibilities in this area. First age-related changes and their effects on computer use

by elderly people will be described. Then an outline of barriers that older people face when using a computer is given. After that, the concepts of assistive technology and Universal Design and the business perspective of computer technology for elderly people will be described and discussed. Finally, further research is proposed and conclusion is drawn.

Being a wide area of research, with a great number of related publications, this paper is not intended to give a complete and extensive overview of all the topics involved. Rather, its goal is to stimulate further research on this topic, and to make its importance clear to people outside this specific area of research.

2 Age-related changes

To understand the use of computers by elderly people, we first need to understand what changes occur when a person gets older. In this section, I will give a brief description of these changes, their influence on the use of computer technology, and the way they can be addressed by computer technology. Often, impairments related to these changes are minor, but the combination of various minor impairments can become a significant disability [3].

2.1 Sensory and Motor Changes

The aging process causes gradual losses to the sensory and motor systems [4, 5]. Most dominant in these changes, when related to the use of computers, are vision, hearing and motor changes.

2.1.1 Vision

One of the possible changes in the sensory system when growing older is the gradual decrease of vision. Elderly people show a reduction in [6]:

- The width of their visual field
- Light sensitivity
- Color perceptions
- Resistance to glare
- Dynamic and static acuity
- Contrast sensitivity
- Visual search and processing
- Pattern recognition

These factors, of course, should be considered when elderly people are to use computers. Basic sets of design guidelines for interfaces (including websites) are given by various authors [3, 6, 7]. Web design guidelines such as [7] and [6] give recommendations on colors, fonts, navigation, sound, content and layout and style, and in doing so reflect on these factors. Examples are that it is recommended to offer text alternatives for all non-text content [7], to use large areas of white space and small blocks of text, or to maximize the contrast between foreground and background colors [6].

2.1.2 Hearing

Decrease in hearing already starts around middle-age [8], gradually progressing from then on. This mostly results in difficulties in hearing high frequency sounds and hearing sounds in general around the age of 50 or 60 [4, 8].

In the design of an interface or website for elderly people, this means that when sound is used, this should be in lower frequency ranges than usual [6].

2.1.3 Motor skills

As can be seen when observing elderly people, age brings changes in motor skills. Some of the motor changes are [9]:

- Decreased speed of movement
- Subtle decline in strength and endurance
- Changes in balance and coordination
- Possible extrapyramidal signs (involuntary movement, tremor, restlessness, etc.)
- Flexed posture

All measurements of motor skills described by Dix et al. [10], being movement time, reaction time and accuracy, decline as a person reaches old age [5].

The way people move affects the way in which they use a computer [10]. Therefore, the mentioned changes need to be addressed when designing for elderly users of computers. Dickinson et al. [3] describe that this can be done “by removing, where possible, the need to carry out complex actions using the mouse, presenting larger targets and removing menus.” Langdon et al. [11] give an option for adjusted targeting, namely the use of an “attractive basin”, which is a “circular region around the (on-screen) target that causes the cursor to become subject to a constant spring force towards the centre” and helps users with haptic/involuntary and inaccurate movements. Also, input devices could be modified, as Hwang et al. [12] propose in their example in which force-feedback technology is used to aid motion impaired computer users (which however is not always beneficial for slightly motion impaired users [11]).

2.2 Cognitive changes

As people reach old age, in general, their cognitive skills deteriorate, which affects their learning capability [13]. Some claim this is not universally age-related [14], but the research described in this shows that within the use of computers by elderly, the previous assumption can be made.

According to Zajicek, specifically age related memory changes and their effects on learning are the main reason for the difficulties older people have in using computers [13]. Research in this so called Age Associated Memory Impairment (AAMI) shows that it affects the “fluid” memory mostly and that it leaves the “fixed/crystallized” memory (knowledge and skills) relatively untouched. This fluid memory, which is described by Stuart-Hamilton as “the ability to solve problems for which there are no solutions derivable from formal training or

cultural practices [13]”, is exactly the type of memory that is needed for learning the use of computers [13].

As Zajicek points out, other research shows that older people have more difficulties in retracing and navigating a route, which can be compared with the type of navigational skills that are needed on the Internet [13].

Elderly people do however compensate for AAMI by developing a number of strategies that are acquired through experience [3, 13]. One of those strategies is the use of a mental model that is related to another type of technology which they understand. When using a computer application, for example, the older user could think of a video recorder [13], and when in need of remembering a sequence of actions, they write them down on paper [3]. The latter strategy could take time, but has good results [3]. With the first example however, I think it has to be made sure that not a wrong mental model is adopted, a model that limits the understanding of the new technology (in this case the computer).

Learning styles of people with learning difficulties could apply to elderly users of computers, as we have seen that most elders suffer from working memory impairments. The assumption that a computer user will learn by exploring and drawing related conclusions which are fed into a mental model, does not count for users with learning difficulties [3]. These users work more slowly and randomly, do not explore because they do not know what to do and when exploring, they are not able to store conclusions effectively in a mental model [3].

Zajicek however, draws the conclusion that elderly people are still able to learn, but “that knowledge of AAMI indicates that a different type of interaction, one that uses aspects of cognition that are less likely to be impaired” [13].

Promising learning possibilities for elderly computer users are online learning courses [15] and, when learning computer skills, environments in which young and old users are mixed [16].

Interestingly, computer use may raise the declining level of cognitive and motor ability of elderly people. This is made clear in studies such as [16], in which the effect of computer games on elderly people is examined. Next to being a new recreational activity, playing computer games was shown to positively affect information processing, reading, comprehending and memory. It can also result in a faster reaction time, and an increase in attention span and hand-eye coordination [16]. This in turn can help these people in their daily lives [16]. As an additional effect, playing computer games gave nursing and support staff clues about physical and mental disabilities that had not been identified before [16].

These computer games should comply with certain requirements, such as certain visuals and immediate feedback from the game in order to stimulate learning abilities, and have to be carefully selected based on these requirements and the desired effect the game should have.

2.3 Social changes

The social environment is sometimes claimed to be underrated in this area [17], as most attention has been given to cognitive, physical and sensory aspects. It has however become clear that the use of technology by elderly people can be directly influenced by their social

environment [17]. Moreover, computer technology can have a significant influence in the social life of elderly people.

The most significant impact of computer technology on the social life of elderly people is that of computer-based communication, the Internet being the foremost example. In social sciences there is an ongoing debate whether this type of communication can enhance the so called social capital. This social capital generally declines with age [18]. Social capital refers to “the institutions, relationships, and norms that shape the quality and the quantity of a society’s social interactions” [18]. It can be described in the following forms [18]:

- Network capital, or relations with friends, neighbors, relatives, and workmates that provide companionship, emotional aid, goods and services, information, and a sense of belonging;
- Participatory capital, or involvement in organizations that afford opportunities for people to bond;
- Community commitment, or a responsible sense of belonging that mobilizes one’s social capital effectively.

This is important to note, as various studies, such as [18] show an increase in these forms for elderly people when using computer-based communication technology.

As written by Karavidas et al. [19], “computers can present unique opportunities for older adults to socialize and establish social networks that can help alleviate loneliness and alienation.” For older people with mobility problems or older people that live geographically far away from their family members, the computer-based communication such as e-mail or instant messaging, can provide needed “virtual” social support from these family members. Being an example from my personal experience, my grandmother lives in Poland and does not feel physically capable of getting on the airplane every few months. Now that she and her daughter (my aunt) can make use of e-mail, we can exchange small messages (as opposed to using the phone) about how things are going, which could help her with various age-related difficulties and her overall well-being.

Computer-based communication gives elderly people a chance to participate in a wider part of society, making it possible to connect with people that are either similar in experience and interest or diverse [18], thus increasing participatory capital and possibly community commitment.

In [18] Blit-Cohen et al. describe that elderly people have much to gain from this type of communication, most importantly that they can seek new information and disseminate their own ideas to others, they can acquire new social ties and discard old ones at will. Additional characteristics are that travelling through cyberspace does not require physical movement (which is a factor in increased social isolation among elderly people [19]), elderly people can maintain virtual social networks from their homes that they are not typecast according to physical appearance and that participation is not bound by time or place [18].

The result of this is that, in contrast with the general population [18], the use of computer-based communication by the elderly generates greater social connectivity among that group.

What should not be forgotten is that online participation of elderly people is not only beneficiary to these people, but also to the society. Elderly people have a vast amount of knowledge and experience in life that they can share by using this technology, by being involved in for example online communities.

Not only communication using computers can stimulate social activity by the elderly. In various studies on the group-wise learning of computer use, the observation was made that the participants communicated *about* computers [16]. Being a new experience for most of them, and having to go through it together, stimulated social interaction within the group.

3 Designing with these changes in mind

Ogozalek shows that elderly people prefer multimedia interfaces (that i.e. consist of video presentation aspects) from printed text and all-text interfaces, concluding that certain aspects of an interface can make information more accessible for elderly users.

Next to the possible solutions to address the age-related changes that have been mentioned in the previous section, Dickinson et al. [3] give an overview of aspects to cope with when designing interfaces for people with disabilities and older people. They consider the following problems regarding traditional WIMP (Windows, Icons, Menus, and Pointers) interfaces:

- Excess interface complexity due to excess functionality. A possible solution to minimize the number of functions is that of removing all of them and carefully re-introducing functions that are deemed to be vital. Also, when there is no evidence of usefulness of a function, it should be discarded.
- WIMP interfaces often use layered menus, which can be a problem to older or (both memory and motor) impaired users, as users must remember the existence of 'invisible' options and the sequence of actions that lead to them, and physically carry out these actions. This can also be addressed by minimizing functionality and by representing functions as simple icons on the desktop in a minimal tree-structure. This might not always be possible, this being a topic for future research.
- "Drag & drop" has traditionally been used to interact with a WIMP system. This is complicated for people with restricted motor control and for novice users. Variations, such as selecting a piece of text, are even more demanding. Changing the "drag & drop" principle proved to affect people with computer experience, so the solution might be found in making it possible to manipulate objects not only by using the mouse, but also by using for example the keyboard.
- WIMP systems normally do not give immediate feedback, due to the complexity, like the sequence of actions needed to change font colors in Word. Users only get to see the change they make after confirming the final step in the sequence, which can be confusing to novice users. This can be countered depending on the target users, by for example "direct manipulation", by which the effects of an action are immediately shown on-screen.
- Especially for older users, the interface should be consistent throughout the application or website, to minimize confusion in navigation.

Additional guidelines have been suggested for even more specific use, such as spoken interfaces [20].

4 Barriers in computer use

Next to physical, cognitive and social changes, there are a number of other factors hold elderly people from actively using computers. Some are interlinked, others hard to define, which gives an indication of the multiple scientific disciplines that are at work in this field of research. In this section a number of these barriers, together with the possibilities of reducing them, is given.

4.1 The relevance of computer technology to elderly people

Elderly people in general do not feel that computers (and the Internet) are meant for their use [13, 21], or that it is relevant to them. Zajicek [13] describes that the information about the Internet, for example, is and has been explained in terms that are not familiar to them. The majority of literature and magazines on the topic is unlikely to appeal to the an older reader. Even commercials are targeted at everyone except the elderly user. This results in elderly people not hearing about possible benefits of computer use, and possibly making them focus on negative coverage of computer use and the Internet (such as personal details being put online). According to Zajicek [13], even those that are propagating the use of computers and the Internet tend to emphasize its convenience, totally lacking the understanding of how much an older person's world may have been reduced already by physical, psychological and social factors.

Ogozalek [21] also noted that quite a few elderly participants in her study on text and multimedia interface use by elderly felt that computers are for younger people and “that many elderly people might have trouble getting used to new technology”, but additionally points out that these age differences may however be minimized by the interface design itself.

Concluding from this, an important part of giving the elderly the possibility to use computer technology is to convince them that computer technology *can* be relevant to them if they want it to be. We have seen that elderly people are mostly still able to learn how to use computers, even more so when modified interfaces are used, and we will see that they can greatly benefit from doing so. This should be made clear to older people, for example by giving education on the topic at retirement homes and organizations for the elderly.

4.2 Experience in computer use

A factor that can be related to the one mentioned above, that older people often do not have experience with the use of computer technology. This has two implications:

- Elderly people cannot derive the relevance of computers to them from previous experiences.
- Elderly people that want to use computers need to acquire computer skills, which, as Blit-Cohen et al. [18] describe, “requires new learning of an unfamiliar mechanism”.

This means that elderly people that are willing to learn how to use a computer should find and gain access to opportunities in the community for learning computer skills, which can be a major difficulty [18]. As has been said previously, when taking into account possible learning

barriers related to getting older (which are later discussed), elderly people are capable of learning these new skills [13].

4.3 Income and education

Income and education are claimed to be the most important factors in computer usage among all adult age groups [15]. Browne [15] notes that these factors are, therefore, important in a way that they describe low computer usage among elderly people. This has not been researched for elderly users specifically, so only future research might prove this in practice.

4.4 Anxiety

Most elderly people initially show anxiety about using computers [16]. When having gained experience in using computers, elderly people show a less negative attitude towards using them [22]. Karavidas et al. [19] show that elderly people who are more computer savvy are more satisfied with their life. This satisfaction is derived from higher self-efficacy and lowers computer anxiety as users learn more about computers [19]. Ultimately Karavidas et al. [19] conclude that implicit benefits of having computer knowledge, such as being more independent, staying informed about health matters and maintaining a social network, result in higher life satisfaction.

4.5 Gender differences

Adding to the variations in the group of elderly people, some studies show that gender differences can play a substantial role in computer use by elderly people. Both [19] and [22] give indications of females having more anxiety, less confidence in using computers and less computer knowledge than males. Being an old stereotype, but still a recent area of research, future research is proposed on this “gender gap”. This in turn might give indications on how to incorporate this factor in the design for elderly people.

5 Two types of design for the elderly

In the previous sections, it has been described that regarding computer use by elderly people, there are certain changes in ability and barriers that have to be considered. In some cases, a possible solution has been described. Here, two of the main areas of design that address some of the issues regarding elderly and disabled people will shortly be discussed. These areas are:

- Assistive computer technology, and
- “Universal design”, computer technology for all

5.1 Assistive technology

Assistive technologies enhance the functional abilities of elderly people, thus trying to fill the gap that is caused by the decrease in functional ability. Elderly people using these

technologies often rely on it in many of their daily activities and routines [17]. Examples range from mobility aids and home modifications to special computer access and sensory enhancements.

Using a computer as assistive technology can give people with disabilities a wide array of opportunities that would be impossible without it. It could give the possibility to draw, write and communicate in a way that is modified for specific and thus nearly optimal use by that person or group of persons. It gives the user the possibility to take charge of his own life, within the best possible margin, resulting in empowerment and greater independence.

5.2 Universal design

Universal design, also called “design for all”, is rooted in the concept of “universal accessibility”, “the global requirement for access to information by individuals with different abilities, requirements and preferences, in a variety of contexts of use [23].” It represents the principle of designing (computer) technology for the broadest range of users possible.

Stephanidis et al. [23] give the following description of universal design: “the term is used to reflect a new concept, or philosophy for HCI design that recognises respects, values and attempts to accommodate the broadest possible range of human abilities, requirements and preferences in the design of all computer-based products and environments. Thus, it promotes a design perspective that eliminates the need for ‘special features’ and fosters individualisation and end-user acceptability.” They also state that “this does not imply a single design solution suitable for all users. Instead, it should be interpreted as an effort to design products and services, in such a way, so as to suit the broadest possible end user population. In doing this, it is more than likely that there will be different solutions for different contexts of use [23].”

The proposed paradigm to support universal design is called Design for Dynamic Diversity (DDD or D3) [24]. Traditional User Centered Design (UCD) does not support this paradigm, as the focus of UCD is placed on the “typical user”. As has been described, “the elderly” encompasses a very diverse group of users in which individual requirements change over time, making it a group that UCD has difficulties coping with. That is why a new methodology has been introduced to accommodate Design for Dynamic Diversity: User Sensitive Inclusive Design (USID) [24]. USID tries to cope with a greater variety of users, conflicts in interest between user groups, and a range of other difficulties when designing for such a variety [24].

Universal design is often presented as the way to design computer technology for elderly people that can manage the wide diversity in this group [13] and that is rewarding for other user groups as well. As will be describes in the next section, this feature could give universal design a good chance on the market, making it more widely accepted and cost-effective in the long run by the width of the target user group. In combination with the fact that it considers the difficulties of elderly users regarding computers makes it a promising area of research. Stephanidis et al. [23] offer a good starting point for testing this by offering user interface design guidelines and related requirements based on universal accessibility.

6 Business perspective

An issue that seems to be underrated and underresearched is the business perspective of computer use of the elderly. This issue, however, can be of crucial importance in getting a wider audience to see the importance of the topic, as economic profitability could be a major reason for IT companies to steer technology in a direction that provides access to computing for those with disabilities and the elderly [25, Section 1.2].

What has to be said first is that discussing the economic aspects of elderly people and computer use will most likely become a necessity. This is due to the following reasons:

- The increasing percentage of elderly people in most countries [1, 2].
- The increasing number of disabilities related to a longer lifespan.
- The fact that elderly people are the largest user group within the public health and care services.

The combination of these factors means that the society will need to find ways to cope with the growing number of elderly and the increasing reliance on related services.

Compared to the attention given to for example cognitive aspects, only a small amount of articles has been written on the economic possibilities of designing for elderly and the use of computer technology by the elderly. Remarkably, one of the oldest articles on computer technology and elderly users (identified in [26]), dated 1973, includes a statement that is still relevant today [27]: “The powerless and helpless feeling of the aged is due not only to increasing infirmity but to society’s failure to set up institutions and systems that would make it possible for the elderly to overcome the handicaps they have. [The] benefits to society as a whole would be enormous as there is no greater cost in our society than the cost of personal service. An elderly person with a maximum amount of ability to care for himself/herself would save society huge sums of money. The costs of institutionalization are already exorbitant and this will not change. Technological innovations in these areas will help the senior members of society to continue as viable participants in its processes.” This addresses the third reason stated above.

Another important fact is that technologies that are developed for special markets, such as for elderly people, often prove to be beneficial for other market-segments as well [2]. Speech recognition, for example, can be used to aid elderly people with movement disabilities to use a computer, but it can also be used by people that have to take notes and work with their hands simultaneously, such as surgeons. Jani et al. [28] even show that making business software more accessible for people with disabilities can be beneficial for non-disabled and even non-disabled expert users. The size of the market for any assistive technology is therefore not confined to those with disabilities [25, Section 1.2].

Given the ongoing decrease in costs in the computer technology industry, it should allow affordable solutions in this area [25, Section 1.2]. So it can be claimed that entering this market in a free enterprise environment will be rewarding, not only ethically, but also economically.

7 Future work

Regarding assistive technology, based on Hirsch et al. [17], future research on the emotional and social aspects of this technology should be considered. Not only should assistive technologies bring aid, they should also be emotionally and socially acceptable to its users. Possibly being important factors in the adoption of assistive technology, these should be researched more extensively.

Topics for future universal design research can be pointed out from related articles such as [2]. These topics include the research on user models, architectural models and task taxonomies [2], in order to match design architectures with the wide variety of users that universal design wishes to include. Current design models do not offer the flexibility that is needed to provide, for example, multimodal input and output [2]. Related to this is the research on the possibility of an interface that can redesign itself based on user requirements [29], which could be a huge leap forward for the implementation of universal design in computer technology.

Another proposal from literature for future research is the making and standardizing of a rating system for interfaces that can be used to see if an interface is suitable for a specific user. In a broader scope, this could also be done for the accessibility of computer technology in general, examining accessibility standards for both hardware and software.

In my opinion, research in “universal design” should look at past and present initiatives for certain groups of computer users (i.e. interfaces for people with learning problems) and examine the way in which they can be useful for other groups, and above all, make this clear to as wide an audience as possible. This could lift the principle of universal design from a small group of supporters to the targeted group of potential users.

Regarding universal design, it is important to recognize that this is not always desirable or attainable [3]. I think that future research should be done on the boundary at which the principle of universal design becomes a restraint rather than a possibility.

Finally, future research on the role of gender differences in the use of computers by elderly people is suggested in Karavidas et al. [19], Ogozalek [21] and Dyck et al. [22]. All of these give the indication that gender is an additional factor that needs to be considered when designing for elderly people, but extensive research on this should come from future research.

8 Conclusion

First age-related changes and their influence on computer use have been described. This indicated that interfaces and input and output devices should and could be modified in order to make the use of computers less troublesome for elderly people.

Elderly people also encounter a number of barriers that hold them from the use of a computer, such as anxiety towards computers and the feeling that computers are not relevant to older people.

However, throughout the document, counter-measures to age-related changes and barriers have been addressed, such as design guidelines for interfaces and the principle of Universal Design. It has been shown that as these aspects are considered by designers, computer technology, and above all computer-based communication, can have a positive impact elderly people and society. Some of the rewards are a higher level and sense of independence, the ability to retrieve and share information, and the possibility to engage in different social communities, which in turn results in an increase in life satisfaction.

Solutions for elderly people have also been shown to be beneficial to other groups of users. This might become clear when IT industries adopt universal accessibility and the related universal design. Only then it seems, the society as a whole will really understand the need for considering the limitations of special groups of users, and the way in which the search for solutions can be rewarding for both.

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