Older adults, computers, and the Internet: Future directions

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B.Xie. Older adults, computers, and the Internet: Future directions. Gerontechnology 2003; 2(4):289-305. This article reviews existing literature on older adults' interactions with computers and the Internet, and proposes questions and directions for future gerontechnology research. The first section of this paper briefly reviews existing human factors research on older adults' interactions with computers and the Internet. The next two sections review research on barriers to and aids of older adults' learning and use of computers and the Internet, and older adults' attitudes toward, perceptions, and general usage of computers and the Internet, respectively. The fourth section summarizes available research on older adults' interactions in computerized community networks. Finally, based on existing literature on this topic and informed by general theories of the interdisciplinary field of science and technology studies (STS), the fifth section proposes new questions and directions for future gerontechnology research.

Keywords: aging, computers, the Internet, Science and Technology Studies

The 'twin challenges' of the aging of the population and the development of new information and communication technologies (ICTs) is becoming a new research topic in recent years. Existing research on aging and new ICTs often focuses on such topics as the effects of age-related changes in visual, perceptual, motor, and cognitive abilities on older adults' learning and use of computers and the Internet, barriers to and aids of their learning and use of new ICTs, and older adults' attitudes toward, perceptions, and general usage of computers and the Internet. This current research focus, however, is very limited; many crucial issues are understudied or, in some cases, completely ignored. For instance, what social, political, economic, cultural, and technical factors have, either independently or synergistically, caused or facilitated the uneven computer and Internet usage between older and younger adults? What effects do various variables – nationality, gender, ethnicity, cultural background, education, class, profession, health status, age, etc. – have on older adults' experiences with ICTs? What power asymmetries and social relations are embedded in the current technical design of ICTs? What impact might the dramatic development of ICTs have on the rapidly increasing older population? And, what are the potential influences of an aging population on the design and development of computers and the Internet? To answer these questions, this article argues, it is important to pay more serious attention to social and cultural factors that affect older adults' interactions with computers and the Internet in various ways. The first four sections of this article review existing literature on aging and new ICTs. The fifth section, informed by general theories of the interdisciplinary field of science and technology studies (STS), proposes a list of new research questions for future gerontechnology research.

HUMAN FACTORS RESEARCH

Currently, the majority of research on aging and new ICTs takes the human factors

approach. Human factors or ergonomics research is an interdisciplinary field. In general, it focuses on human-technology interaction[1,2]. In particular, human factors researchers working at the intersection of aging and ICTs explore the effects of age-related changes in visual, perceptual, motor, and cognitive abilities on older adults' learning and use of various computer and Internet applications and related devices. Furthermore, based on their understanding of age differences in technology learning and adoption, human factors practitioners are devoted to exploring the interventions that may help older adults to overcome these age-related obstacles.

Age-related differences

A large number of human factors studies have found age-related differences in older adults' learning and use of computers and the Internet. For instance, studies observed that older adults made more errors than their younger counterparts in learning computer text-editing software[3-5]; they required more time and assistance than younger adults to learn and use computer software[3, 6, 7]; they had more difficulty than their younger counterparts in learning to use electronic bulletin board systems[8], and they had more difficulty using a computer mouse[9-12]. Human factors researchers suggest that the difficulties older adults experience when learning and using ICTs are related to age-associated changes in visual, perceptual, psychomotor, and cognitive abilities. For instance, a number of studies suggest that age-related changes in psychomotor abilities affect older adults' use of computer input devices such as the mouse and the keyboard[9,13-16], while impaired eyesight affects older adults' use of computers and the Internet[13,17-19]. Due to their reduced perceptual and cognitive abilities, older adults often experience more difficulties in learning computer software[8,13,20-23], and navigating, browsing, searching for, and retrieving information on the World Wide Web[19,23-25].

Design and training interventions

Two types of human factors interventions are often addressed in the published literature: guiding principles for designing senior-friendly physical interfaces and software[18,19,26-36], and guidelines for designing age-appropriate training instructions and materials[6-8,18,19,23,25,32,37-43]. Overall, available human factors research appears to suggest that, on the one hand, age-related changes in visual, perceptual, motor, and cognitive abilities make it more difficult for older adults to learn and use new technologies; on the other hand, those difficulties can be at least partly compensated by senior-friendly design of technological interfaces and software, and age-appropriate training materials and strategies.

BARRIERS AND AIDS

Age-related changes in visual, perceptual, motor, and cognitive abilities, coupled with poor design, are some of the major barriers to older adults' learning and use of computers and the Internet. Other major obstacles include lack of access to computers and the Internet[17,44], lack of prior experiences with new technologies[45], and negative social stereotypes of older adults[44]. Often it is the synergistic, rather than independent, effects of these barriers that inhibit older adults' learning and use of ICTs. For instance, available research indicates that lack of access to a computer and lack of knowledge about the Web are two primary predictors for not using the Web[46]. The use of large-size display screens (capable of displaying large-size characters), assistance from a trained computer demonstrator, and small group settings (rather than large groups or individual settings) are important facilitators of older adults' experiences with computers[47]. While attitude towards computers is the strongest predictor of participation in an electronic bulletin board system, success at initial training is the most important predictor of continued

use of the system[37]. Multiple sources of instruction – including class presentations, individual lessons, functional "cue cards", manuals, expert peers, and periodic meetings – must be given to facilitate elders' learning of computers[48-50]; and a careful and supportive environment is important to older adults' acceptance and use of new technologies[51].

ATTITUDES, PERCEPTIONS, AND USAGE

A number of studies focus on older people's attitudes toward, perceptions of, and general usage of computers and the Internet. The results, however, are at most ambiguous, and, not unusually, conflicting. For instance, a telephone survey found that, compared to their younger counterparts, older adults had less positive attitudes toward and less usage of a variety of technologies such as computers[52]. Another survey found that participants' attitudes toward and usage of computers were influenced by their age, gender, and prior experience with computers. In particular, age was negatively related to computer usage. Men reported more computer usage than women and had more positive attitudes toward computers than women. Also, prior experience with computers in everyday life was positively related to attitudes toward computer technology[53]. In May 1986, a survey was conducted among visitors of the Technology Center of the Biannual Meeting of the AARP. About 10% of the visitors of the Technology Center (N = 458) volunteered to complete the questionnaire. The results of this survey generate more questions than answers: on the one hand, 84% of participants reported feeling "fascinated" and 78% feeling "excited" when they thought about computers; on the other hand, 50% of participants stated that they felt "confused" and 61% felt "ignorant" when they thought about computers. Although the survey itself has limitations – for instance, the participants were self-selected, and there were no control groups, it does show that, on the one hand, at least among the 10% who were visitors of the Technology Center, the majority of older adults were very positive about computers. On the other hand, however, at least half of them were having difficulties with computers[51].

On the other hand, other studies appear to suggest that there are no age differences in attitudes toward computers[3], or that older adults are quite positive about new ICTs[47,54-57]. For instance, a study found that the general response from the respondents was positive, and older computer users reported a trend of declined loneliness[54]. Interviews with a small number of older Internet users in New Zealand found that older adults' attitudes toward information technology are mostly positive[55]. A two-year ethnographic study of a group of older computer users at a senior center in California shows that older adults are positive about and capable of using computers, and computers have enhanced the quality of life for older users[56]. In a quasi-experimental study conducted at an urban retirement center, respondents' attitudes toward computers were examined before and after a three-week period. Older users reported that, after three weeks of learning computer games and computer-based communication, their self-confidence was significantly higher than before. Also, respondents stated that they were more willing to play with computers at the end of the three-week period[47]. An experiment found that older adults were willing and able to interact with the computerized questionnaire. Also, their acceptance of computer-generated recommendations was high, which indicated that older adults' attitude toward computer technology was quite positive[57].

The ambiguity of existing results is to a large extent due to the fact that studies are

conducted during different time periods, testing different computer technologies, using different research methodologies, and evaluating different samples. Consequently, the results of available studies on older adults and new ICTs are not comparable. The lack of comparable research calls for more empirical work.

COMPUTERIZED COMMUNITY NETWORKS

Currently, the majority of social research that explores the relationship between older adults and ICTs is limited to the individual level, as the above discussion has shown; the issues of how computerized networks have changed people's sense of community, and the dynamics of interpersonal relations, community networks, and social structures in the new information era, are significantly understudied. This literature review has found only a handful of relevant studies on the intersection of older adults and computerized community networks[55, 58-62].

Surprisingly, the most exciting findings on older adults and computerized community networks often have come unexpectedly or when researchers did not seem to have a notion of 'community' in mind ('communities' came into the picture as a byproduct of other research purposes). For instance, in a study that was originally designed to explore older adults' interactions with computer games, researchers unexpectedly found that participants favored interacting with other people via computer networks, an unplanned activity, more than playing computer games[47]. This study, conducted more than twenty years ago, is one of the earliest studies that has revealed older adults' interest in and interaction with computerized community networks.

In a yearlong study, researchers explored the contributions of computer networks to social structures and interpersonal interactions at the workplace and among retired individuals[48-50]. In this study, eighty retired and working employees of a governmental agency were recruited and randomly assigned to either the "electronic group", or the "standard group". Each group consisted of an equal number of recent retirees and current employees, and each was assigned the same task force project. The major difference between the two groups was that the former were given access to networked computers, while the latter did not have access to computers. Researchers found that the primary use of the computer was for communication via electronic mail – members of the electronic groups enjoyed sharing information and working with other members of the group via computer networks. Use and perception of computers among members of the electronic group, however, were not necessarily associated with age. Indeed, the most striking finding was that the 'electronic retirees' had the highest participation rates by the end of the year. Researchers suggested that the difference between electronic retirees and working employees was due to 'office pressures': employees were directly or indirectly told by their managers to use the computer only when they had 'free time' (and few employees would admit that they had 'free time' when they were on duty). At the end of the experimental time, the electronic group formed their own online community: the DEPCNET[48-50]. This study, although conducted nearly two decades ago, is still valuable to today's research, not only because it is one of the earliest studies that has shown ICTs have the ability to diminish the social isolation of those who are retired and increase the social 'connectedness' of retired people, but also because it indicates that, contrary to the widely circulated stereotype, advanced age is not the determinative factor of slow adoption of new technologies; other factors – in this case, how much 'free time'

one had to practice – play important roles in adopting new technologies.

Mary Furlong started a notable online community -- SeniorNet -- for older adults in the mid-1980s. SeniorNet was first launched in March 1986, and it soon evolved from a small on-line network that mainly provided information to an expanding electronic community where older adults can communicate and interact with each other[58,59]. According to SeniorNet, the online community now has over 39,000 members from various nations and over 600 active discussion groups that cover a wide range of topics[63]. Since its launch, SeniorNet has been a very useful research site for researchers who are concerned about the influences of computerized networks on older adults, as a number of empirical studies have shown[55,58-61]. For instance, in a study that explored computer-mediated social support among older adults, the qualitative analysis of downloaded SeniorNet conversations and the open-ended questions of an online survey found recurring social support themes[60]. The quantitative part of this study – based on an online survey -- also generated interesting results: for instance, satisfying online relationships positively correlate to frequency of use -- namely, the more older adults use the Internet, the more satisfied they are with their online support network, and vice versa[61].

Overall, although several researchers have explored how computers and the Internet may affect older adults' online and offline social networks, research on older adults' experiences in computerized social networks is still an understudied area so far and further attention is needed.

FUTURE DIRECTIONS

As demonstrated above, the new field of aging and ICTs currently focuses on a very limited number of topics. Many crucial social and cultural aspects are understudied or, in some cases, completely ignored. This section proposes a list of research questions that deserve more attention. The intention is not to offer a complete list but to stimulate more conversations and discussions on aging- and ICT-related issues.

What positive and negative effects can ICTs have on older adults?

A number of existing studies have addressed the positive effects of ICTs on older adults' independence, social networks, psychological well-being, and social status. For instance, researchers propose that information technology has the potential to empower older adults[64], to enhance their social status (and, consequently, the quality of the aging experience)[65], and to increase their independence, integration in society, interpersonal contact, opportunities to contribute productively to society, control over their environment, self esteem, and the quality as well as the length of life[66]
Overall, ICTs can be used not only to treat *illness* of older adults but also to maintain their *wellness*[44]. However, more empirical work that systematically examines these theoretical hypotheses is necessary.

How can ICTs help older adults to contribute their time, energy, and intelligence to society and the environment? An innovative Internet-based program suggests that ICTs can facilitate older adults' participation in environmental protection. The program, developed by the Environmental Alliance for Senior Involvement (EASI) and with the collaboration of the Department of Environment and Aging of Pennsylvania, involves an online database that contains water and habitat monitoring information. Older volunteers are trained to conduct relevant scientific tests to monitor the water quality at over 500 sites in Pennsylvania, and to input the results into

the online database[67]. In another project, the Internet is used to connect middle-school students who are studying recent history, with older adults who have lived through and can provide knowledge about recent history. The results suggest that online interactions between older and younger people have changed the latter's attitudes toward studying history and empathy for older adults[68]. These two programs offer good examples of how ICTs may help older adults to keep making contributions to society even after retirement.

Among empirical work that examines the positive effects of ICTs, an ethnographic research project explored how adult children and elderly parents in dispersed families interact via email, the telephone, and transportation technologies. In particular, the study explored technology-based interactions between adult Jewish Americans who immigrated to Israel and their senior parents who remained in the US. The findings suggest that ICTs have helped to reinforce family ties and intergenerational affections in distant living and dispersed families[69].

However, previous research tends to neglect the possibilities that technology might negatively affect older adults. "How can our society assure that older persons exercise sufficient judgment in using information technology?" [44, p.435] In other words, how can our society ensure that older persons would not be overdependent on technology? Unfortunately, critical questions like this are rare in the published literature. Often positive effects of technology are the default setting of research; potential negative influences are ignored. This literature review has found that few studies address the potential negative effects of ICTs on older adults. One exception is a study on older adults' use of the computer mouse, which warned that use of computer input devices such as the mouse that requires fine motions of the wrist might cause physical damage to older adults[15].

What are the causes and consequences of the digital divide between older and younger adults?

It is important to realize that improved design and training can only affect the experiences of those older adults who have access to computers and the Internet. For older adults who do not have computer and Internet access, the first thing to do is to provide access for them. Statistics in various countries have shown that older adults' access to computers and the Internet are significantly lower than their younger counterparts. Therefore, one ought to ask, why? What kinds of forces -- social, cultural, economic, political, technical, physical, synergistically or independently -- have inhibited older adults' access to new technologies? And, what can be done to ensure that older adults will have equal access to new technologies? These are the first questions social scientists needs to ask, and, unfortunately, these are also currently understudied issues.

Public access at public facilities like libraries and museums is a good way to provide older adults with free access to computers and the Internet[17]. However, this will not be so helpful for older adults with walking disabilities, which accounts for a large number of the older population. Also, public facilities often have time constraints (they open and close at certain times), which means older adults whose only access to ICTs is at those public locations cannot have unlimited access to computers. This significantly weakens the so-called 'any where, any time' value of the Internet. Without this convenience, older users' experiences with ICTs will be less satisfactory, and, consequently, they will be less motivated to learn and use ICTs.

Recent research on the digital divide has expanded from the original focus on access to include the ways the Internet is used[70,71]. For instance, a recent review article defines the 'digital divide' as 'inequalities in access to the Internet, extent of use, knowledge of search strategies, quality of technical connections and social support, ability to evaluate the quality of information, and diversity of uses'[70]. Therefore, for those older adults who already have access to computers and the Internet, one needs to consider, what are their actual experiences with learning and using computers and the Internet? How is older adults' use of new ICTs different from that of younger adults? As discussed above, existing research, especially human factors research, has made significant contributions to exploring this question. However, human factors research often takes place in the well-controlled laboratory or quasi-experimental setting, which is very different from the actual settings where older adults interact with computers and the Internet. Therefore, more empirical and theoretical research that takes an ethnographic approach and conducts deep qualitative analysis to explore older adults' actual experiences with ICTs in various social settings is necessary.

What can be done to ensure that older adults' learning and use of ICTs will be easier?

Human factors researchers suggest that senior-friendly design and training interventions, guided by theories of psychology and cognitive aging, can facilitate older adults' learning and using of ICTs. Therefore, they are dedicated to exploring various guidelines for interface and system design, and training materials and strategies that take into serious consideration older adults' special visual, perceptual, motor, and cognitive conditions. This approach has produced valuable results, as the above discussions have shown. However, it is important to keep in mind that most existing design and training recommendations have not been tested systematically and thoroughly, as some human factors practitioners have warned[28-29]. Therefore, more systematic – empirical and theoretical -- exploration of new guidelines and thorough examination of existing ones are still necessary.

Furthermore, human factors researchers propose that theories of psychology and cognitive aging can, and should, guide technical design and training[23,72]. However, this approach itself cannot offer any guarantees that designers will necessarily follow the proposed guidelines. To do so, certain social mechanisms, such as policy interventions, are necessary. Also, in most cases young designers fail to develop senior-friendly products not because they do not want to but because they are not aware of older people's special needs. Therefore, intergenerational educational settings, where older and younger students can sit in the same classroom and take the same course at the same time, may help designers to design senior-friendly interfaces and software. The success of such a program -- the "Elder Connection" intergenerational program -- supports this point[73]. Clearly, in this program, integrating older adults into higher education systems facilitates intergenerational interactions between older and younger people. Consequently, younger students – future scientists, engineers, designers, and manufactures – become more aware of the existence and special needs of older adults at a very early stage of their professional development, and, later in their careers, are more likely to design and develop technologies that better satisfy older adults.

These kinds of intervention are clearly beyond the scope of the human factors approach – after all, older adults'

interactions with technologies are also affected by social and cultural factors (e.g., changes in their social and financial circumstances due to retirement), which cannot simply be resolved by technical interventions as human factors practitioners have suggested. Therefore, it is important that other disciplines such as political science and education pay serious attention to the field of aging and ICTs.

Also, to facilitate older adults' learning and use of ICTs, it is important to develop computer applications that match older adults' special interests. Older adults, due to their special situation, have different needs and interests for computer applications. For instance, research indicates that older adults are more likely than their younger counterparts to search for health and medical information on the World Wide Web, and develop such hobbies as genealogy[46,74]. Are there any other particular computer applications that might satisfy older adults' special needs? Previous research that examines older adults' use of common computer tasks is too general in this sense; more research that aims at exploring and developing 'senior-appropriate' applications is necessary.

What influences can older adults have on technological developments?

Currently, most research that explores the relationship between older adults and ICTs are conducted in such fields as psychology, cognitive and behavioral science, and gerontology. One common feature of those studies is that they often explore the impact of technology on older adults, yet ignore the possibilities of how the aging population might actively shape technological choice and development. In the language of science and technology studies (STS), the trend of current research on the influence of technologies on older adults reflects the tradition of technological determinism: because technologies are independent of society and their impacts on society are inevitable and irresistible, it is *only* necessary and possible to study the impact of technologies on those people. This vision ignores various social forces that shape technological innovation and development, and, consequently, leaves older people in a passive and vulnerable position. On the contrary, social constructivism, a major theoretical approach of STS, considers how various social forces shape technological innovation and development. By examining the technological content or the "black box" of technology, social constructivism challenges the distinctions between the social and the technical. It suggests that technological development, contrary to the claims of technological determinists, is embedded in, rather than separate from, the larger social context. Social constructivism reveals the possibility of social selection among various technological choices or alternatives. In other words, technologies do not follow predetermined developmental patterns that are out of human control; rather, technologies are shaped by various social factors and, as such, are potentially subject to social constraints. By fully acknowledging the active and creative role that social forces have played and are playing in technological innovation and development, social constructivism has revealed the possibilities of democratic technological choice and control[75-79]. In sum, based on the rich literature on the social shaping of technology, it is also necessary and important to ask, in addition to how technologies affect older adults: how can older adults shape the design and development of technologies? As Mary Furlong, the founder of SeniorNet, suggests: "Perhaps the greatest challenge will be envisioning how these technologies can harness the wisdom and talents of our older adults. Not only are

they a growing demographic group but they are also an important resource for the continuing vitality and collective memory of our society." [58, p. 152]

How can older adults help to guide the design and development of ICTs?

Cyril Brickfield asks: 'To what extent can older people help guide technological developments that may impinge on their daily lives?' [52, p. 31] His own answer is that older people could serve as 'consumer advisers' to help designers and manufacturers to understand the needs of older adults and to produce more desirable products, and that older people could be 'instructors' to help their age peers to diminish fears or skepticism of new technologies. Also, Brickfield suggests that retired scientists and engineers as well as other older professionals can help guide technological development. One such example is 'Senior Scientists and Engineers (SSE)', a Washington DC-based volunteer organization consisting of older professionals. At the time when Brickfield wrote the article, SSE had just started constructing a small (offline) community that could support and facilitate their missions. In 1998, with a grant from the National Science Foundation, the group built an online community that allows members to interact across time and space[80]. This form of (online and offline) community is another way that older adults can help to shape technological innovation and development.

Brickfield has asked the right questions – older adults are not only affected by new technologies in various ways but also can, and should, contribute to steer technologies; and his suggestions are a good start for this long journey. For instance, researchers at the Center for Applied Gerontology at the University of Birmingham in the United Kingdom have established a panel of older adults – the 'Thousand Elders' – to serve as consumer advisers to improve the design and development of domestic technologies[81]. However, it is important to keep in mind that this approach – that older adults could/should serve as consumer advisers or peer instructors -- is not sufficient, because this approach does not touch and therefore cannot change deep, structural factors that have caused older adults' marginalized position in technological design and development. In other words, Brickfield's approach still leaves older adults in a vulnerable position: for instance, how seriously designers and manufacturers will take senior advisers' suggestions is a big question. Also, being a consumer adviser or peer instructor still means that older adults cannot participate in the early stages of the design and development process of new technologies; consequently, the choices that older adults have are limited. More importantly, the SSE is a good way to organize older scientists, engineers, and other professionals; but it has left behind 'lay' older people. After all, it is not just the responsibility (and right) of experts – old or young – to contribute to and guide technological developments.

To ensure older adults' participation in the design and development of technologies, it is important to overcome structural – social, political, economic, institutional, and ideological – barriers that prevent older adults from participating in technological design and development. Richard Sclove's approach is valuable for this purpose[82]. Sclove is an STS scholar who emphasizes the importance of citizen participation in every stage of the design and development of democratic technologies. One of his main arguments is that technologies qualify as a type of social structure in that they function politically and culturally in a manner comparable to other, more commonly recognized kinds of social structure such as laws, dominant

political and economic institutions, and systems of cultural belief. Combining this vision with Benjamin Barber's notion of 'strong democracy', Sclove develops the theory of a 'democratic politics of technology': 'If citizens ought to be empowered to participate in determining their society's basic structure, and technologies are an important species of social structure, it follows that technological design and practice should be democratized' [82,p.26-27]. This theory entails two corresponding elements: a) democratic procedures for developing b) democratic technologies. Procedurally, Sclove suggests, citizens ought always to have extensive opportunities to participate in technological research, development, and design to shape the evolving technological order. Substantively, the resulting technologies ought to be compatible with strong democracy.

Are 'lay' citizens capable of participating in and shaping technological design and development? Sclove holds that nonexpert citizens are, indeed, 'in every sense the experts.' Although he does not specifically address older people, his framework certainly can be applied to this population. Pierre Levy's notion of 'collective intelligence' also supports the idea that everyone, including older adults, possesses particular knowledge and expertise that technical experts do not have[83]. Levy addresses the significance of collective intelligence in the newly formed knowledge space. In the information era, he argues, knowledge becomes the primary driving force of society and history. This creates a new anthropological space -- the knowledge space. In this new space, the rules of social interaction and the identities of human beings are reconstructed. The redefined social bond will be based on reciprocal apprenticeship, shared skills, imagination, and collective intelligence. This is because, Levy suggests, "all knowledge resides in humanity": "No one knows everything, everyone knows something… If you are tempted to judge someone as ignorant, look for the context in which his knowledge can be turned into gold" [83, p.13-14]. As a result, 'the other', no matter her/his social status, profession, and educational background, is a source of knowledge: s/he knows something that I do not know, and therefore can contribute to, in one way or another, the constructing of intelligent human communities. For Levy, in the knowledge space, the ethical and aesthetic aspects of collective intelligence are of the same importance as its technological and economic dimensions. Although Levy does not specifically address older individuals, his framework certainly applies to this social group.

What are the major barriers that currently inhibit older adults' involvement in steering technological development?

Human factors research reminds us that current technical design and training is not age-appropriate. To move one step further, one ought to ask, why weren't senior-friendly design and training available in the first place? Or, to say it slightly differently, why was the older population excluded from the design and development of technologies?

STS scholars suggest that an understanding of power asymmetries and social relations among different social groups can help us to understand the shaping of technological development[84-86]. For instance, one major approach of social constructivism -- the social construction of technology (SCOT) approach -- holds that the negotiations among 'relevant social groups,' which refer to those institutions, organizations, and organized or unorganized groups of individuals that are affected in one way or another by the artifact, affect technological design and development[76-78]. Langdon Winner, among many other scholars,

suggests that, although it is important to notice the existence and influence of relevant social groups in the developmental process of a technological artifact, it is also important to notice the *absence* of other social groups and, more importantly, to ask the question of *why* those groups are absent. He asks: "Who says what are relevant social groups and social interests? What about groups that have no voice but that, nevertheless, will be affected by the results of technological change? What of groups that have been suppressed or deliberately excluded? How does one account for potentially important choices that never surface as matters for debate and choice?" [86, p.369] Clearly, these are also the questions we need to consider if we intend to address the barriers that inhibit older people's involvement in technological innovation and development.

Following this direction, feminist studies of technology provide a promising approach that age studies can borrow. In particular, the notion of 'relevant but absent' social groups, as developed by Anne-Jorunn Berg[87], is of special importance for understanding older people's positions in the social shaping of new technologies. Berg analyzes the design and development of three smart house prototypes and finds that, although the home is traditionally considered to be the domain of women, none of the three prototypes have taken into account women's desires and needs. Indeed, housework – which is traditionally associated with women and includes tasks such as cooking, washing, cleaning, tidying, and mending – is almost completely ignored. The designers and producers of those projects – often male -- simply do not have any interest in housework, probably at least partly because they do not know too much about housework. And the primary target consumers of the smart home are those who share the same image as the designers and producers of those projects – namely, the technically interested male. Berg's work clearly shows that although women are a relevant social group, their interests have been ignored in the smart house projects. As Berg puts it, women as a social group are "relevant but absent" in the design and development of these housing technologies[87,p.310]. Similarly, older adults as a social group are currently also "relevant but absent" from technological design and choice. Looking at power asymmetries and social relations therefore can help to reveal structural barriers that inhibit older people's involvement in steering technological innovation and development.

The diversity of the older population

The older population is a diverse one, and includes individuals of different nationality, ethnicity, cultural background, gender, education, class, profession, health status, even age, etc. Therefore, it is important to study the independent and synergistic influences of these variables on older adults' learning and use of ICTs. A good example is the 'mediation model,' which considers the impact of four factors -- age, education, computer knowledge, and computer anxiety -- on older people's computer interest[88]. Based on previous literature, this model proposes that age and education would affect older adults' computer knowledge and computer anxiety, and the latter two would be the direct predictors of older adults' computer interest – in short, the impact of age and education on older adults' computer interest would be fully mediated by computer knowledge and computer anxiety. The results partly supported the hypothesized mediation model. In particular, the results suggested that age was negatively related to both computer knowledge and computer interest, and positively correlated with computer anxiety. Educational level was positively associated with computer knowledge and

computer interest, and negatively related to computer anxiety. Also, computer knowledge was negatively correlated with computer anxiety and positively related to computer interest, whereas computer anxiety was negatively related to computer interest. However, the data indicated that computer knowledge and computer anxiety could not fully explain age-related variance in older people's computer interest. This suggested that the oversimplified model ignored other potential predictors of older adults' computer interest, such as gender, class, and health status. Although this study has limitations, it signals an important starting point for building up useful theoretical frameworks that take into consideration the synergistic influence of various factors on older adults' learning and use of ICTs.

Gender-related issues

Among the diverse factors that affect older adults' experiences with technologies, gender deserves special attention for at least two reasons. First, the older population consists of more older women than older men, since women often outlive men. Second, older women experience aging differently from older men[89]. Currently, however, research on older adults either ignores gender and gender-related issues, or considers gender as a variable that could be simply added on to existing frameworks. In particular, in the area of aging and ICTs, few studies have explored and compared older women's and older men's experiences with ICTs. This literature review has found only a handful of studies that specifically consider gender-related issues. For instance, an empirical study addressed the impact of age- and gender-related changes in motor and musculo-skeletal systems on older adults' use of computers and associated input devices such as the mouse. The results of the experiment indicated that older adults, especially older men, experienced significant declines in joint range of motion of the wrist and grip strength. The results warned that use of computer input devices such as a mouse that requires fine motions of the wrist might cause physical damage to older adults, especially older men[15]. A qualitative study reported the experiences of six older Australian women with computers and the Internet. Those older women were willing and able to use new ICTs to communicate with their families and friends, and to maintain their independence and personhood[90].

CONCLUSION

Available research suggests that older adults' experiences with ICTs are different from those of younger adults in many ways. Are those differences generational or trans-generational phenomena? In other words, will those differences disappear or remain among future generations of older adults? It is well documented that the slow adoption of ICTs among the current generation of older adults is to a large extent due to lack of training and knowledge in the workplace and at schools. Therefore, it is not unreasonable to suspect that, since today's younger generations in general have more experiences with ICTs at school and work, as these generations age, they will be more familiar and comfortable with computers and the Internet than the current generation of older adults. However, as some scholars have suggested, we should be cautious in viewing the digital divide as a generational phenomenon[71]. After all, older adults' interactions with ICTs are embedded in and therefore influenced by complex social and cultural contexts. If the context remains the same, then the interactions between older adults and ICTs might as well remain the same. For instance, if future prices of computer equipment and Internet access are too high for future generations of older adults who have limited financial resources after retirement, then it is likely that those older

adults, even though they might have had prior experiences with and interests in ICTs, would have to reduce or even eliminate their use of computers and the Internet later in life. More importantly, due to the seemingly endless development of new ICTs, the differences between older and younger adults' use of new ICTs are especially likely to be trans-generational when considering the larger issue of the use of new technologies by older adults. Just as today's generation of older adults faces many barriers to their use of contemporary computers and the Internet, future generations of older adults are likely to face similar barriers in using future ICTs – unless steps are taken to address the structural obstacles that negatively affect older adults' participation in the design and use of new technologies.

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