The changing face of aging: Characteristics of older adult user groups

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S. J. Czaja, S. Z. Weingast. The changing face of aging: Characteristics of older adult user groups. Gerontechnology 2020;19(2):115-124; https://doi.org/10.4017/gt.2020.19.2.004.00 **Introduction** Technology is constantly evolving and changing with new systems and applications continually emerging. For example, there will be continual developments in artificial intelligence and virtual reality systems. The Internet of Things will promote the integration of technology applications and allow us to perform tasks more efficiently. Smart appliances are also being developed to make everyday living tasks easier. Technology is also becoming an integral part of healthcare and the workplace. In this regard, at the same time that technology is evolving, the characteristics of aging adults are changing. Understanding changes in how we define aging and the experience of aging is important when examining the interface between older adults and technology. **Research aim** In this paper, we aim to highlight changes in emerging and future technology systems and the concomitant implications of these changes for older adults. We also aim to present a new vision of the older adult. **Method** An overview of emerging technology systems is provided and the changing characteristics, needs, and preferences of older adults are reviewed. For example, today's older population is generally more educated and more diverse than previous generations. They are also more active and interested in participating in productive activities. Changes in social structures and manner which everyday tasks are performed are also discussed. **Results** Developments in technology provide opportunities to foster 'aging in place' and enhance the independence and quality of life of older people. They also present challenges to older people such as the continual need to engage in new learning and adapt to continual changes in technology systems. **Conclusions** Older adults represent an increasingly important user group of technology systems. To mitigate the challenges of an increasingly digital world and maximize the benefits of technology applications for older adults, their needs, preferences, and characteristics need to be considered in the design of these systems and applications.

Keywords: socio-demographics, attitudes, cohort differences

Introduction

Fozard, one of the founders of Gerontechnology, and colleagues (Fozard, Rietsema, Bouma & Graffmans, 2000) define Gerontechnology as both an interdisciplinary field of research that involves the scientific study of aging from multiple perspectives (e.g., gerontology, psychology) and technology, and as an application that involves the development and distribution of technologically-based products, environments, and services. One goal of gerontechnology is to use technology to prevent, delay, or compensate for the perceptual, cognitive, and physical declines of aging. A second is to use technology to support or enhance the opportunities associated with aging-related to communication, leisure, learning, service, and artistic expression. Achieving these goals requires knowledge of existing and emerging technologies, contexts where technology systems will be used, and characteristics of aging adult user groups.

Technology is constantly evolving and there are continual developments in artificial intelligence and extended reality (XR) systems. Autonomous vehicles are also on the horizon, which has significant implications for the mobility of aging people. The diffusion of technology into everyday life will also continue to accelerate. The Internet of Things will promote the integration of technology applications and allow us to perform tasks more efficiently. Smart appliances are also being developed to make everyday living tasks easier. Technology is also becoming an integral part of healthcare and the workplace. Essentially, technology is changing the way we work, learn, communicate, and recreate. Initially, television sets, which were not commonplace in American homes until the 1950s,

were stand-alone units, programs were in black and white, and there were no remote controls. Today, most homes have at least one flat screen high definition (HDTV), color TV that is controlled by remote controls (Statista, 2020). It is also common to 'stream' TV programs on mobile devices. The way people listen to music has also changed. Current cohorts of older adults listened to vinyl records on a turntable. This evolved to cassette tapes and CDs. Now people stream music through applications such as Apple music and speech recognition platforms such as 'Alexa'. The design and functionality of telephones have also changed dramatically. Many of today's older adults may have had experience with shared party lines in home telephone systems. Today, smartphones are common and are used to perform a variety of everyday tasks in addition to communicating.

Definitions of aging and the experience of aging are also changing. The life experiences of current and future generations of older adults are being shaped by developments in technology. Older adults today are different in many dimensions as compared to prior generations. Perceptions of aging also change with aging. One of the largest studies to date of age differences in aging perceptions (e.g., "how old do you feel") (Chopik, Bremner, Johnson & Giasson, 2018) found that older adults reported perceiving themselves as older than younger adults but perceived themselves as younger than their current age. Generally, the literature suggests that younger perceptions of aging, are associated with better psychological (Westerhof & Barrett, 2005) and physiological health, (Westerhof et al., 2014). There is no commonly accepted definition of an older person; in most developed countries the cut-off is age 65, but this is somewhat arbitrary. The United Nations uses 60 years to refer to older people. Generally, what it means to be old has different meanings in different societies. With increases in life expectancy, distinctions are now made between the young-old (65-74 yrs.), middle old (75-84 yrs.) and the oldest old (85+). At the Center for Research and Education on Aging and Technology Enhancement (CREATE) (a multi-site Center that focuses on older adults and their interactions with technology systems), we argue that perhaps more important than chronological age is a person's attitudes, functional abilities, and quality of life. We also argue that what it means to age successfully is multi-dimensional and extends beyond physical health. Gerontechnologists have the potential to make a myriad of contributions towards ensuring that older people in all cohorts experience 'successful aging'. In this article, the characteristics of older user groups are reviewed. The focus is on socio-demographic characteristics, lifestyle, technology experience, attitudes, and preferences. The implications for Gerontechnology are also discussed.

Demographics of the aging population

The world's population of older adults is significantly increasing. Today about 9% of the world's population is aged 65+ and by 2050 this percentage is projected to increase to nearly 17 percent of the world's population (1.6 billion people). Not only is the percent of older people in the population increasing, but the population of older adults is also aging. The global population of the 'oldest old' — people aged 80 and older — is expected to more than triple between 2015 and 2050, growing from 126.5 million to 446.6 million (He, Goodkind & Kowal, 2016) (*Figure 1*). The rate of people living to their 90s, nonagenarians, will continue to grow as will the number of centenarians. The number of centenarians is expected to reach 3.7 million worldwide by 2050. According to recent estimates, the United States currently has the largest number of centenarians followed by Japan, China, India, and Italy (Stepler, 2016).

The aging of the population will impact nearly all sectors of society, including the labor market; the demand for goods and services, such as housing, transportation, medical service; and social structures. People in the later older age cohorts (the 80s and 90s) are vastly different from those in the early older age cohorts (60s and 70s) and experience varying challenges. Those in the later cohorts are more likely to live alone, have a chronic condition or disability, experience problems with loneliness, and need help with everyday activities. Cognitive declines and memory impairments are also more common with increased age. The needs of cohorts of older adults are also likely to change in the future. For example, the current oldest-old cohort is likely to have children to help provide care and needed support. In the future, because of changes in family structures, such as people choosing to remain single or childless (Pew Research Center, 2015) the support system for future older adults will be weakened.

Thus, innovative ways to provide support for our aging population are needed. As gerontechnologists, we have the potential to consider how technology might play a role in providing social and healthcare support, and assistance with everyday living activities both within and outside of the home. For example, there is substantive literature regarding the negative consequences of social isolation and loneliness on health (e.g., Aylaz, Akturk, Erci, Ozturk &Aslan, 2012; Ellis & Hickie, 2001; Fratiglioni, Wang, Ericsson, Maytan &Winblad, 2000; Holt-Lunstad, Smith & Layton, 2010). There are a plethora of technologies that can help alleviate this problem. Social media platforms, videoconferencing applications, Virtual Reality applications, and social robots

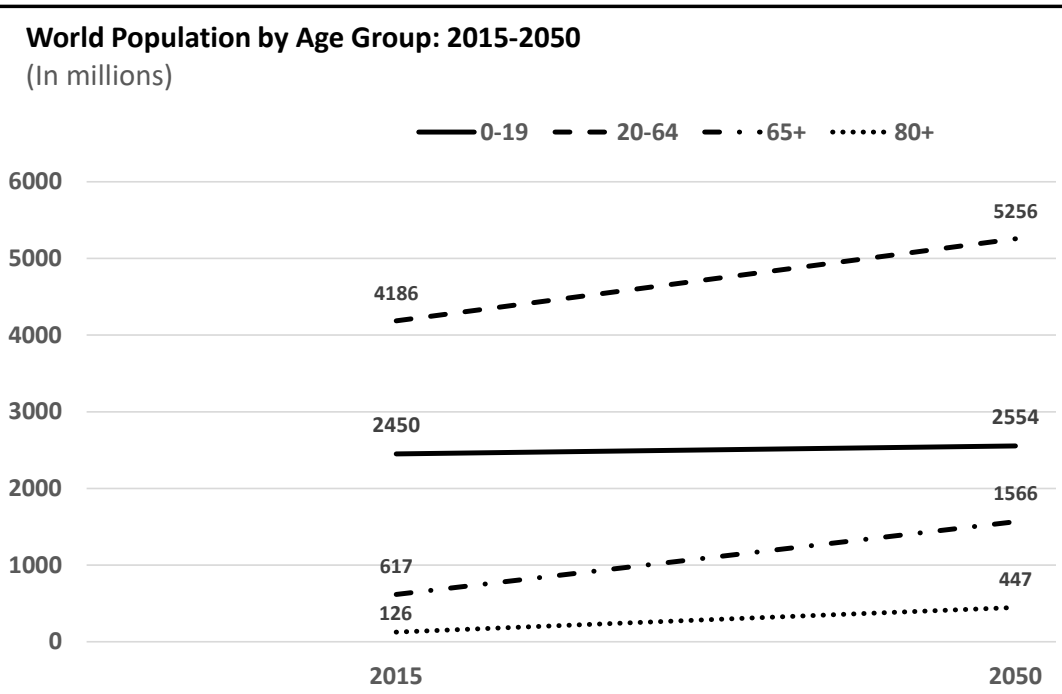

Figure 1. World population by age group: 2015 to 2050; Source: He, Goodkind & Kowal, 2016 and the US Census Bureau, 2013

hold great potential for enhancing social engagement opportunities for older adults. Telemedicine systems and e-health applications can help address healthcare needs, especially for those older adults with limited mobility. Technology applications can also be designed to support prospective memory tasks such as remembering appointments, important events, or medication schedules. However, the design of these systems must account for the differences in needs, preferences, and abilities among the aging cohorts. As noted by Fozard and Wahl (2012) it is important to simultaneously consider the impact of both cohort and age effects on the major domains of gerontechnology, such as housing, communication, mobility and transportation, health and functioning, work environments, and recreation.

In terms of demographic composition, currently, women tend to live longer than men so there are a greater number of females in the older age cohorts. One important distinction between older men and women that has a significant impact on well-being is living arrangements. Older men are more likely to be married and live with a spouse or partner, whereas older women are more likely to be widowed and live alone. Worldwide, about 17% of women aged 60+ live alone at compared to 9% of men. Women also have different health and morbidity patterns and typically have larger support networks. These trends are likely to continue in the future and have important implications for housing and social needs. Globally, women will comprise about 53% of those aged 60+ and 58% of those aged 80+ by 2050 (United Nations, Department of Economic and Social Affairs, Population Division 2017).

The majority of older adults wish to remain in their homes and communities for as long as possible. Assistive technologies can make housing more accessible to those with chronic conditions and disabilities. Smart home technologies and the Internet of Things can also improve safety and security, a particular concern for older women living at home. There is evidence to suggest that independently-living older people who live alone have higher health and social risks and are more likely to experience falls and have lower physical activity. House maintenance tasks can also become challenging, especially for someone with disabilities. Data from an interview study of older adults (N = 44) conducted by members of our Center for Research and Education on Aging and Technology Enhancement (CREATE) (Fausset, Kelly, Rogers & Fisk, 2011) indicate heavy household tasks or physically demanding tasks such as cleaning floors or changing bed linens were challenging, especially for women and persons who were single. Men found outdoor tasks challenging. These data suggest areas where interventions such as technology applications (e.g., robotics) can help enable aging in place.

Alternative housing arrangements, such as continuing care retirement communities, are availa-

ble in many communities (AARP, 2019). In these types of communities, individuals live in the type of housing that meets their needs and preferences (e.g., private apartment, assisted living). There are also co-housing communities where residents share things such as a garden and outdoor space. Another example of the current housing phenomenon is 'Naturally Occurring Retirement Communities' (NORCS), neighborhoods or buildings, characterized by a large percentage of older adult residents. In some NORCs, there are coordinated activities or support programs. There is also an increasing trend, across the globe, of 'Age-Friendly Cities', cities and communities that are committed to becoming age-friendly. Characteristics of age-friendly cities include transportation that is affordable and accessible, opportunities for employment, volunteerism, and social engagement, age-friendly communication and information about programs and services, outdoor spaces that are accessible and secure, and opportunities for older adults to participate in leisure, civic, and cultural activities (WHO, 2007). Technology can play an important role in supporting age-friendly cities. Baby boomers are also demanding different types of housing options including housing that offers more in terms of available services such as Wi-Fi connectivity, personal technologies (e.g., active-lifestyle technologies such as Peloton bicycles or golf simulators) and safety and security devices. We can anticipate that former housing options for seniors will no longer meet the needs of future generations of older adults.

In the United States and other developed countries, the older population is also becoming more ethnically and culturally diverse. Overall, racial and ethnic minority older adult populations in the United States have increased from 6.7 million in 2005 (18% of the older adult population) to 10.6 million in 2015 (22% of older adults) and are projected to increase to 21.1 million in 2030 (28% of older adults) (Administration for Community Living, 2018).

The increased cultural/ethnic diversity of the older adult population has implications for technology design. People from varied ethnic backgrounds have different life experiences, beliefs, attitudes, and differences in language. These are important considerations in systems design. For example, we were limited in our recruitment of Hispanic older adults in the CREATE PRISM project (Czaja et al., 2018) as the system was only available in English. They also have different expectations about aging and social and familial obligations. For example, in Africa, Asia, the Caribbean, and Latin America, older adults are much more likely to cohabitate with their children than older adults in Europe and North America (United Nations, Department of Economic and Social Affairs, Population Division 2017). However, overall the number of older people living alone is rising in most countries. Understanding ethnic and cultural differences and including diverse older adult samples in user testing is important when developing supportive interventions and programs.

Education, health, and income

Generally, the level of education of the current generation of older adults is higher than that of previous generations and this trend will increase in the future with more people becoming college-educated beyond high school. This is a very positive trend as higher levels of education are generally associated with better health and well-being. Higher levels of education are also related to participation in work activities and engagement in continuing education and training activities (e.g., Bjursell, Nystedt, Bjorklund & Sternang, 2017). These training activities can include upgrading skills, for example, to keep abreast of new technology developments.

Older people on some dimensions are healthier than prior generations of older people. For example, in high-income countries rates of severe disabilities among older adults have declined. However, advancing age is associated with a higher risk of chronic conditions such as diabetes, cancer, heart disease, and arthritis. The risk for the development of Alzheimer's Disease (AD) and other forms of cognitive impairment also increases with age. In 2017, there were about 50 million people worldwide with AD and this number is anticipated to increase to 75 million by 2030 (Alzheimer's Disease International, 2015) (*Figure 2*). Alzheimer's disease not only takes a toll on those afflicted but also on family members who provide the majority of care for individuals with AD. Other common conditions include hearing loss and visual problems such as macular degeneration (Whitson & Lin, 2014). Further, many older adults have more than one condition. The risk and incidence of the chronic disease vary by gender and ethnicity/culture and also by region and country.

To address the healthcare challenges associated with population aging, health and social structures are needed that meet the needs of older adults and their families. Clearly, technology can play a large role in addressing these issues. Technology applications can be used to: facilitate medication and disease management, monitor the functional and cognitive status of older people, enhance safety and access to care, and improve communications with healthcare providers. There is a wide variety of technologies available including telemedicine and e-health

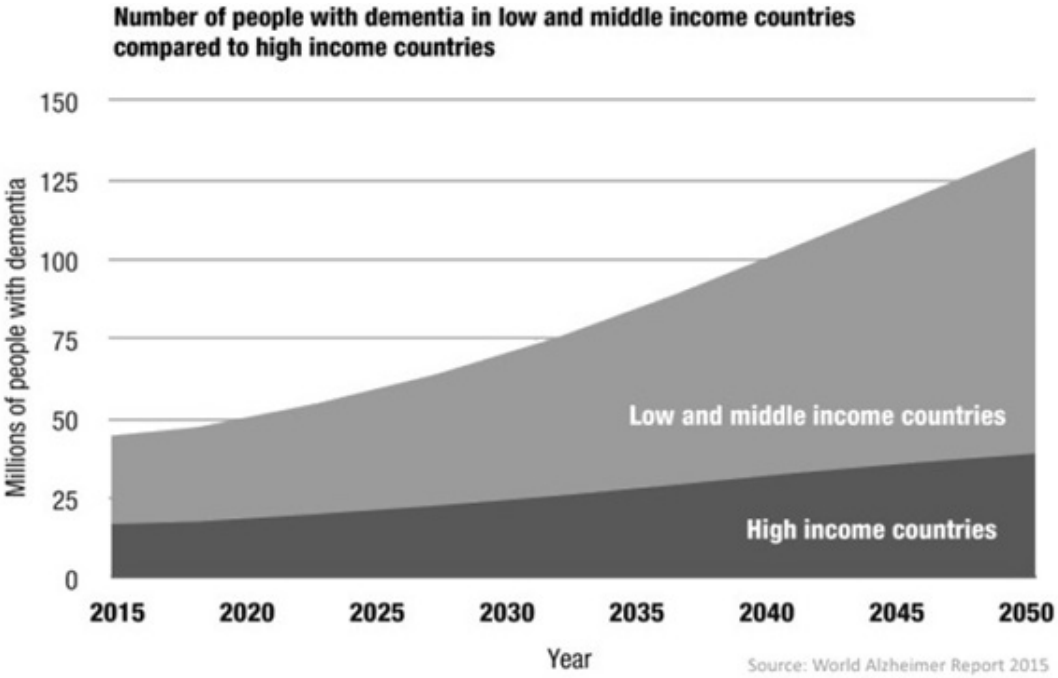

Figure 2. Number of people with dementia in low and middle income countries compared to high income countries; Source: Alzheimer's Disease International, 2015 World Alzheimer Report

applications, sensing and monitoring systems, wearables, and mobile devices (e.g., smartphones, tablets). Technology will continue to evolve and there will be continual innovations and advances such as developments in remote sensing, 3D display units, interactive TV, neuroprosthetics and robotics. Gerontechnologists must be involved in the design, implementation, and evaluation of these technology applications to insure uptake and efficacy.

For income, older adults vary greatly and many older adults worldwide are in the lower socioeconomic strata and have limited incomes. Additionally, opportunities for increasing income tend to diminish with age. Many older people may have to stop working because of health issues and may not have adequate resources to guarantee adequate income security to end of life. Poverty levels increase with advanced age. Although estimates are somewhat spotty, on average, the poverty level for persons among the over-75 years of age group across the 36 Organisation for Economic Cooperation and Development Countries (OECD) countries is 14.7 percent, which is 3.5 percent higher than the poverty level among 66 to 75 year-olds (OECD, 2015). Lower income status constrains the lives of many older people and impacts on housing options, access to technology, and other products and services. In many regions, it also impacts access to the Internet and broadband services, which is problematic in our increasingly digitized world.

Productive engagement

Today's older adults generally want to be productive and active in their later years. Many older people are choosing to remain in the labor force in some capacity. This includes full-time work, part-time work or pursuing a new career path. The picture of aging and work, as discussed by Sharit in this issue is complicated. There are differences in the participation of older adults in the workplace according to factors such as gender, type of job, industry or sector, and education level. For example, it is harder for older adults with low education or a lack of technology skills to find employment given the constant influx of new technology into the workplace. In a focus group study (Lee et al., 2009) we found that major barriers for older job seekers were the technical skills needed in today's workplace.

However, either because of desires among older adults to remain productive and engaged or financial insecurity, there is an increase of older adults in the workforce and we expect that these trends will continue in the future with more people working past normal retirement age. Toossi (2015) indicates in the United States the group of workers age 75+, is expected to reach 2.8 million people by 2024. Similarly, there have been strong efforts by governments in the EU to encourage people to remain in the labor force to ease fiscal pressures for governments providing pensions and medical care for their aging populations (Sinclair, Watson & Beach, 2013). Thus,

current trends to retire from full-time work by age 65 are unlikely to hold for the future. In the U.S. and many other countries, the workforce is also becoming more diverse as there are increased labor force participation rates among women and minorities (Toossi, 2015).

As noted, technology is ubiquitous in work environments. The influx of technology into the workplace can have both positive and negative impacts on older workers. For example, technology reduces the physical demands of tasks, which can be beneficial for older workers. Telework applications allow people to perform work activities from home, which offers several advantages for older adults such as more flexible work schedules and the reduced need to travel to a work location. These advantages may be beneficial for older adults who wish to remain employed but have more mobility restrictions or are involved in family caregiving. However, these benefits need to be weighed against potential challenges associated with telework such as work scheduling, training, and limited opportunities for social interaction (Sharit and Czaja, 2009). Assistive technologies may also make employment for older adults with disabilities a more viable option.

On the negative side, the influx of technology into the workplace creates a need for continual new learning and upgrading of skills. This can be challenging for older workers given age-related declines in ability such as processing speed. Charness (2019), in his seminal work on skill acquisition, has demonstrated that older adults generally take longer to acquire skills and need more feedback and environmental support. Our work, examining older adults and technology-based work tasks (Czaja & Sharit, 1998; Czaja, Sharit, Ownby, Roth, & Nair, 2001; Sharit, Czaja, Hernandez, Yang, Perdomo, Lewis, Lee, & Nair, 2004), has also shown that older adults are quite willing and able to learn technology-based work tasks. The need for new learning will continue with developments in workplace technologies such as emerging artificial intelligence and robotic applications.

There is also a strong push for workers to acquire new job skills on their own using 'E-learning', or computer-based instruction programs. This presents challenges for older adults who have limited technical skills. Also, the responsibility for continuing education is being shifted to the individual worker, and technology-mediated learning formats are being promoted as a way to help organizations and individuals meet training and lifelong learning challenges. There is a paucity of research examining the implications of these changes in the training and instructional process for older workers. Strategies are needed to ensure that the demands of technology-based jobs are commensurate with the skills and abilities of older people and that they are provided with ample opportunities to participate in job training programs. Further, these programs have to be designed to support older adult learners. There are guidelines available to guide the design of training programs (e.g., Czaja & Sharit, 2012); the key is to ensure that they are adhered to by organizations and designers of training software applications.

Technology applications also offer a venue for continued learning outside of the workplace. For example, there are numerous online learning applications, which provide a venue for learning something new or engaging in a new hobby. These applications also provide an opportunity for older people to acquire needed work skills. There are also numerous computer games and cognitive remediation programs available. While the benefits of these applications for enhancing cognitive skills are still under debate (National Academies of Sciences, Engineering, and Medicine, 2017, Simons, Boot, Charness, Gatercole, Chabris, Hambrick & Stine-Morrow, 2016), they do provide a means for cognitive engagement.

In addition to paid employment, there are other areas where older adults can remain productively engaged. For example, they can serve as mentors to younger people through intergenerational learning programs or as mentors to their peers. Dorgo and colleagues (2011) found that older adult peer mentors were as effective as student mentors in an older adult exercise program. Many older adults also engage in volunteer activities and make valuable contributions to the community or serve in important roles as caregivers either to a spouse, partner or friend or to a grandchild. Recent estimates suggest that about 32 percent of family caregivers in the United States who are providing care to an older adult are age 65 or older (National Academies of Sciences, Engineering and Medicine, 2016). We have found in our research (e.g., Czaja et al., 2013) that technology applications can be used to support family caregivers and that technology-based interventions can be efficacious in terms of improving caregiver outcomes. However, a stronger evidence base is needed regarding what type of technology applications best meet caregivers' needs, how this varies with caregiver characteristics and contexts, and how to best implement these applications in diverse caregiver situations.

Socialization and leisure activities

An important issue that is emerging with the increase of adults in the older cohorts is problems with social isolation and loneliness. The negative consequences of social isolation and loneliness, which are well documented in the literature, include physical and mental health, cognitive

declines, increased risk for mortality, and lower quality of life (e.g., Aylaz, Akturk, Erci, Ozturk &Aslan, 2012; Ellis & Hickie, 2001; Fratiglioni, Wang, Ericsson, Maytan &Winblad, 2000; Holt-Lunstad, Smith & Layton, 2010). Older adults who are more vulnerable to loneliness include those in the older cohorts, older women, those who live alone, those from lower SES strata, those with disabilities and LGBT older adults. Existing and emerging technology applications offer potential solutions to the problems of isolation and loneliness. The Internet and other technologies such as robotic applications and virtual reality can facilitate social connectivity. In today's world, the use of Information and Communication Technologies (ICTs) to form and maintain social relationships is quite common. A recent systematic review of the use of ICTs to address issues of social isolation (Chen & Schulz, 2016) concluded they can be effective tools to reduce isolation. We found in our CREATE PRISM project, which evaluated a software designed for older adults to enhance social engagement and provide access to resources and information, that the participants who used PRISM reported less loneliness and enhanced well-being. They also experienced an increase in computer proficiency and more positive attitudes towards technology (Czaja et al., 2018). Importantly, PRISM was designed using a user-centered design approach and involved older adults in the design of the software system. PRISM also represents one of the few large-scale randomized trials to examine the benefits of technology. As noted by Chen and Schulz (2016) more well-designed studies are needed to examine the benefits of technology to support engagement and socialization, especially for emerging technologies. We also need to examine the potential harmful effects. These are ripe areas of research for Gerontechnology.

On a more positive note, another emerging area of investigation is strategies to support leisure activities among aging adults. Engagement in leisure activities is important to the well-being and overall quality of life. Hobbies and participation in leisure activities provide opportunities for enriching our lives, socialization and cognitive engagement, and enhancement of physical and emotional health (e.g., exercise classes). Older adults, on average, have more time to engage in leisure activities and generally engage in a variety of activities. To foster engagement in leisure activities we need to understand the preferences of aging adults and the challenges they encounter when pursuing hobbies and other forms of leisure. In this regard, it is important to recognize that aging adults are a significant and increasing consumer group. They are not only consumers of goods and products but also of services and programs such as vacation and travel packages. Recently, travel programs have been recognizing the needs of the single traveler market, particularly older women. This is encouraging and suggests that the older consumer is being considered as an important part of the consumer market.

Older adults and technology

Given the increased reliance on technology within our society and the fact that well-being is increasingly dependent on technology, an important issue when thinking about the characteristics of older user groups is the degree of technology uptake among older adults. When comparing technology ownership and use across the decades, generally there is increase of computer and mobile device ownership and Internet use in the overall population and among older adults. However, older adults still lag behind. Currently, in the United States although 80% of persons aged 65+ own a cellphone only 53% own a smartphone and 32% own a computer tablet (Pew Internet Research, 2019). Further, about 67% of adults aged 65+ go online as compared to 96% of those aged 30-49 years and 87% of those aged 50-64 years. Patterns of technology uptake among aging adults are similar in other countries. Konig, Seifert, and Doh (2018) recently analyzed Internet use among people aged 50+ in 17 European Countries using data from the Survey of Health, Ageing and Retirement in Europe (SHARE) (N = 61,202). Findings indicated that 49% of all respondents use the Internet.

Yet, we cannot consider older adults as a single user group as degrees of technology experience, proficiency, and adoption vary greatly. In the U.S., adults in the older cohorts, those with disabilities, of lower socioeconomic status, and who live in rural locations tend to use Information and Communication Technologies (ICTS) less and have less broadband access. Similar trends exist in Europe where the degree of Internet use varies widely among European countries, and also as a function of age, gender, and socioeconomic status (Konig et al., 2018). Importantly, these data reflect uptake and use of computers, mobile devices, and the Internet; technology is much broader and includes other devices and products such as assistive devices and wearables.

A number of models such as the Technology Acceptance Model (TAM) (Davis, 1989), the Unified Theory of Acceptance Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003), and the Senior Technology Acceptance Model (STAM) (Chen & Chan 2014) have emerged in an effort to understand technology adoption and acceptance. These models indicate that perceived ease of use and perceived usefulness are important predictors of technology acceptance. Our CREATE model (Czaja et al., 2006) which examined the breath of tech-

nology use found that computer efficacy, cognitive abilities, and education predicted breadth of technology use. We also found that older adults used fewer technologies than younger adults. Recently, we (Berkowsky, Sharit & Czaja, 2018) examined factors that influence older adults' decisions about the adoption of new technology. Our findings indicated that the perceived value of the technology, confidence in the ability to learn the technology and perceived impact on the quality of life were the most significant predictors of willingness to adopt the technology. Understanding factors that predict technology uptake are important to the development of strategies to enhance technology uptake.

As noted, attitudes about technology such as confidence in the ability to use technology and technology self-efficacy are important predictors of technology acceptance and willingness to adopt the technology. In a recent study, we (Lee, Czaja, Moxely, Sharit, Boot, Charness & Rogers, 2019) examined changes in attitudes towards technology across a 19-year time span (1994 – 2013) using data from the Edward R. Roybal Center on Human Factors and Aging Research and CREATE. The sample included a large (N = 3908), a diverse sample of community-dwelling adults aged from 18 to 98 years. Generally, we found that although attitudes are more positive in more recent cohorts of older adults, there are still age disparities in attitudes. Older adults report less comfortable with and less efficacy about using computers than younger people. Those who have more education and experience with computers also have more positive attitudes. As noted, in our PRISM study (Czaja et al., 2018) we found that attitudes towards computers became more positive with the use of the PRISM system. Findings suggesting age differences in attitudinal variables such as technology efficacy have important implications for the design of technology training programs and technology systems.

Summary

A central goal of Gerontechnology is to design and deploy technology to prevent, delay, or compensate for the perceptual, cognitive, and physical declines of aging and to support or enhance the opportunities for older adults. Achieving these goals requires understanding older adult user groups. In general, today's older adults are involved in a myriad of activities, desire to remain independent and productively engaged, and are an increasingly important segment of the consumer market. They are also healthier in some dimensions and better educated than prior generations of older people. However, they still lag in use of technology. Older adults are also extremely heterogeneous and vary in skills, abilities, attitudes, preferences, and experiences. Future cohorts of aging adults will likely be different than current cohorts as they will be shaped by advances in health, technology, and social structures. Gerontechnology, which combines the study of aging and technology, has a great deal to offer in terms of ensuring that current and future generations of older people can remain productively engaged, live independently, and enjoy a good quality of life.

References

AARP (2019). How Continuing Care Retirement Communities Work. Retrieve from https://www.aarp.org/caregiving/basics/info-2017/continuing-care-retirement-communities.html

Administration for Community Living. (2018). 2018 Profile of Older Americans. Retrieve from https://acl.gov/aging-and-disability-in-america/data-and-research/profile-older-americans

Alzheimer's Disease International. (2015). The Global Impact of Dementia: An analysis of prevalence, incidence, cost and trends — World Alzheimer Report 2015. Retrieve from https://www.alz.co.uk/research/WorldAlzheimerReport2015.pdf

Alzheimer's Disease International. (2015). Dementia Statistics. Retrieve from https://www.alz.co.uk/research/statistics

Anderson, M. & Perrin, A. (2017) Technology Adoption Climbs Among Older Adults. Pew Research Center: Internet, Science & Technology. Retrieve from https://www. pewresearch.org/internet/2017/05/17/tech-adop¬tion-climbs-among-older-adults/

Aylaz, R., Aktürk, Ü., Erci, B., Öztürk, H., & Aslan, H. (2012). Relationship between depression and loneliness in elderly and examination of influential factors. Archives of gerontology and geriatrics, 55(3), 548–554. https://doi.org/10.1016/j.archger.2012.03.006

Berkowsky, R. W., Sharit, J., & Czaja, S. J. (2018). Factors Predicting Decisions About Technology Adoption Among Older Adults. Innovation in aging, 2(1), igy002. https://doi.org/10.1093/geroni/igy002

Bjursell, C., Nystedt, P., Bjorklund, A., & Sternang, O. (2017). Education level explains participation in work and education later in life. Educational Gerontology, 43(10), 511-521. https://doi.org/10.1080/03601277.2017.1357397

Charness, N. (2019). Can acquired skill and technology mitigate age-related declines in learning rate? In: S.J. Cza¬ja, J. Sharit, & J.B. James (Eds.). Current and emerging trends in aging and work. (pp. 243-257). Springer.

Chen, K., & Chan, A. H. (2014). Gerontechnology acceptance by elderly Hong Kong Chinese: a senior technology acceptance model (STAM). Ergonomics, 57(5), 635–652. https://doi.org/10.1080/00140139.2014.895855

Chen, Y. R., & Schulz, P. J. (2016). The Effect of Information Communication Technology Interventions on Reducing Social Isolation in the Elderly: A System-

atic Review. Journal of medical Internet research, 18(1), e18. https://doi.org/10.2196/jmir.4596

Chopik, W. J., Bremner, R. H., Johnson, D. J., & Giasson, H. L. (2018). Age Differences in Age Perceptions and Developmental Transitions. Frontiers in psychology, 9, 67. https://doi.org/10.3389/fpsyg.2018.00067

Czaja, S.J., & Sharit, J. (1998). Age differences in attitudes toward computers. The Journals of Geron¬tology: Series B, 53B(5), P329-340. https://doi.org/10.1093/geronb/53B.5.P329

Czaja, S. J., Sharit, J., Ownby, R., Roth, D. L., & Nair, S. (2001). Examining age differences in performance of a complex information search and retrieval task. Psychology and aging, 16(4), 564–579. https://doi.org/10.1037/0882-7974.16.4.564

Czaja, S. J., Charness, N., Fisk, A. D., Hertzog, C., Nair, S. N., Rogers, W. A., & Sharit, J. (2006). Factors predicting the use of technology: findings from the Center for Research and Education on Aging and Technology Enhancement (CREATE). Psychology and aging, 21(2), 333–352. https://doi.org/10.1037/0882-7974.21.2.333

Czaja S.J., & Sharit, J (2012). Designing training and instructional programs for older adults. CRC Press, Taylor & Francis Group.

Czaja, S. J., Loewenstein, D., Schulz, R., Nair, S. N., & Perdomo, D. (2013). A videophone psychosocial intervention for dementia caregivers. The American journal of geriatric psychiatry: official journal of the American Association for Geriatric Psychiatry, 21(11), 1071–1081. https://doi.org/10.1016/j.jagp.2013.02.019

Czaja, S. J., Boot, W. R., Charness, N., Rogers, W. A., & Sharit, J. (2018). Improving Social Support for Older Adults Through Technology: Findings From the PRISM Randomized Controlled Trial. The Gerontologist, 58(3), 467–477. https://doi.org/10.1093/geront/gnw249

Davis, F. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. MIS Quarterly,13(3), 319-340. https://doi.org/10.2307/249008

Dorgo, S., King, G. A., Bader, J. O., & Limon, J. S. (2011). Comparing the effectiveness of peer mentoring and student mentoring in a 35-week fitness program for older adults. Archives of gerontology and geriatrics, 52(3), 344–349. https://doi.org/10.1016/j.archger.2010.04.007

Ellis, P., & Hickie, I. (2001). What causes mental illness. In S. Bloch, & B. Singh(Eds.), Foundations of Clini¬cal Psychiatry (pp. 43-62). Melbourne University Press, 43-62.

Fausset, C. B., Kelly, A. J., Rogers, W. A., & Fisk, A. D. (2011). Challenges to Aging in Place: Understanding Home Maintenance Difficulties. Journal of housing for the elderly, 25(2), 125–141. https://doi.org/10.1080/02763893.2011.571105

Fozard, J.L., Rietsema, J., Bouma, H., & Graffmans, J.A.M. (2000). Gerontechnology: Creating enabling environments for the chal-lenges and opportunities of aging. Educa¬tional Gerontology, 26(4), 331-344. https://doi. org/10.1080/036012700407820

Fozard, J.L., & Wahl, H. (2012). Age and cohort effects in gerontechnology: A reconsid¬eration. Gerontechnology, 11(1), 10-21. https://doi. org/10.4017/gt.2012.11.01.003.00

Fratiglioni, L., Wang, H. X., Ericsson, K., Maytan, M., & Winblad, B. (2000). Influence of social network on occurrence of dementia: a community-based longitudinal study. Lancet (London, England), 355(9212), 1315–1319. https://doi.org/10.1016/S0140-6736(00)02113-9

He, W., Goodkind, D., & Kowal, P. (2016). An Aging World: 2015. US Census Bureau, US Government Publishing Office.

Holt-Lunstad, J., Smith, T. B., & Layton, J. B. (2010). Social relationships and mortality risk: a meta-analytic review. PLoS medicine, 7(7), e1000316. https://doi.org/10.1371/journal.pmed.1000316

Konig, R., Seifert, A., & Doh, M. (2018). Internet use among older Europeans: An analysis based on SHARE data. Universal Access in the Information Society, 17(3), 621-633.

Lee, C. C., Czaja, S. J., & Sharit, J. (2009). TRAINING OLDER WORKERS FOR TECHNOLOGY-BASED EMPLOYMENT. Educational gerontology, 35(1), 15–31. https://doi.org/10.1080/03601270802300091

Lee, C. C., Czaja, S. J., Moxley, J. H., Sharit, J., Boot, W. R., Charness, N., & Rogers, W. A. (2019). Attitudes Toward Computers Across Adulthood From 1994 to 2013. The Gerontologist, 59(1), 22–33. https://doi.org/10.1093/geront/gny081

National Academies of Sciences, Engineering and Med¬icine. (2016). Families caring for an aging America. https://doi.org/10.17226/23606.

National Academies of Sciences, Engineering and Medicine. (2017). Preventing Cognitive Decline and Dementia: A Way Forward. https://doi.org/10.17226/24782

OECD. (2015). Pensions at a Glance 2015: OECD and G20 indicators. https://doi.org/10.1787/pension_glance-2015-en

Pew Research Center. (2015). Parenting in America: Out¬look, worries, aspirations are strongly linked to fi¬nancial situation. Retrieve from https://www.pewsocialtrends.org/2015/12/17/1-the-american-family-today/

Pew Research Center. (2019). Mobile Fact Sheet. Retrieved from the Pew Research Center. Retrieve from https://www. pewresearch.org/internet/fact-sheet/mobile/

Sharit, J., Czaja, S. J., Hernandez, M., Yang, Y., Perdomo, D., Lewis, J. E., Lee, C. C., & Nair, S. (2004). An evaluation of performance by older persons on a simulated telecommuting task. The journals of gerontology. Series B, Psychological sciences and social sciences, 59(6), P305–P316. https://doi.org/10.1093/geronb/59.6.p305

Sharit Joseph, Czaja Sara J. (2009). Telework and the Older Worker. In S.J. Czaja & J. Sharit (Eds.), Aging and Work: Issues and Implications in a Changing Landscape. The Johns Hopkins University Press.

Simons, D. J., Boot, W. R., Charness, N., Gathercole, S. E., Chabris, C. F., Hambrick, D. Z., & Stine-Morrow, E. A. (2016). Do "Brain-Training" Programs Work?. Psychological science in the public interest: A journal of the American Psy-

chological Society, 17(3), 103–186. https://doi.org/10.1177/1529100616661983

Sinclair, D., Watson, J., & Beach, B. (2013). Working Longer: An EU Perspective. ILC-UK.

Statistica Survey. (2020). Share of households in the United States who owned a flat screen TV in 2018, by income. Retrieve from https://www.statista.com/statistics/663668/afflu¬ent-americans-who-owned-a-flat-lcd-led-oled-or-plasma-screen-tv/

Stepler, R. (2016). World's centenarian population projected to grow eightfold by 2050. FactTank: News in the Numbers. Pew Research Center. Retrieve from http://pewrsr.ch/22PVly7

Toosi, M. (2015). Labor force projections to 2024: The labor force is growing, but slowly. Monthly Labor Review. U.S. Bureau of Labor Statistics. https://doi.org/10.21916/ mlr.2015.48

United Nations, Department of Economic and Social Affairs, Population Division. (2017). World Popula¬tion Ageing 2017 – Highlights (ST/ESA/SER.A/397). Retrieve from https://www.un.org/en/development /desa/population/ publications/pdf/ageing/WPA2017_Highlights.pdf

Venkatesh, V., Morris, M., Davis, G., & Davis, F. (2003). User Acceptance of Information Technology: Toward a Unified View. MIS Quarterly, 27(3), 425-478. https://doi.org/10.2307/30036540

Westerhof, G. J., & Barrett, A. E. (2005). Age identity and subjective well-being: A comparison of the United States and Germany. The journals of gerontology. Series B, Psychological sciences and social sciences, 60(3), S129–S136. https://doi.org/10.1093/geronb/60.3.s129

Westerhof, G. J., Miche, M., Brothers, A. F., Barrett, A. E., Diehl, M., Montepare, J. M., Wahl, H. W., & Wurm, S. (2014). The influence of subjective aging on health and longevity: a meta-analysis of longitudinal data. Psychology and aging, 29(4), 793–802. https://doi.org/10.1037/a0038016

World Health Organization. (2007). Global age-friendly cities: A guide. World Health Organization.