Gerontechnology – Special Edition – Commentary

Dana Plude PhD[a,*]

[a]Division of Behavioral and Social Research, National Institute on Aging, National Institutes of Health, Bethesda, Maryland, USA; *Corresponding author: dana.plude@nih.gov

I am humbled to contribute to this special edition that honors the appointment of Dr. Neil Charness as Grandmaster by the International Society of Gerontechnology. As outlined in his autobiography, Neil has had a distinguished career not only in the discipline of Cognitive Aging but also in Aging and Technology. The papers included in this special edition provide a nice representation of the issues that have driven Neil's research from the outset and they reflect the multidimensionality of Neil's interests. The Center for Research and Education on Aging and Technology Enhancement (CREATE - https://create-center.ahs.illinois.edu/) has been supported continuously by the National Institute on Aging (NIA) since 1993, first as the Miami Center on Human Factors and Aging Research and subsequently (since 1999) as CREATE. Over that time, the project has been renewed four times, with each iteration offering important and groundbreaking initiatives in areas such as aging and interface design, videoconferencing, and health education. In his autobiography, Neil acknowledges important contributions by many of his colleagues, but one that bears special emphasis is the support and encouragement offered by Dr. Robin Barr, former Director of Extramural Activities at NIA, who had the vision and foresight to encourage Neil and his colleagues (Drs. Sara Czaja, Walter Boot, Wendy Rogers, Joe Sharit, Arthur [Dan] Fisk and Katinka Dijkstra) to pursue the CREATE concept and cultivate it into the unique resource it has become for supporting research on aging and technology. Another important historical antecedent of Neil's sabbatical in Boston and his evolving expertise in aging was the pioneering work of Jim Fozard, who established the Mental Performance and Aging Laboratory (MPAL) at the Veteran's Administration Outpatient Clinic during the 1970s and who has championed gerontechnology throughout his career, including his current role as an Associate Editor of the Journal of Gerontechnology and is providing the introduction to this Special Edition. I am compelled to single out these influences because I benefited from them directly as well during my own experience as an NIA Ruth Kirschstein National Research Service Award Postdoctoral Fellow at the MPAL (1980-1982).

In the sections that follow, I offer commentary on several themes that arise from the papers contributed to this special edition. The range of topics covered across the papers and the many important issues upon which they touch are testaments to the breadth and reach of Neil's prior work and set the stage for future research on aging and technology.

Cognition is one of the themes that cuts across these papers and the potential for technology to help older adults maintain effective cognitive function and, possibly, forestall normative decrements that are associated with aging. For instance, the paper by Boot and colleagues (Boot, Andringa, Harrell, Dieciuc and Roque, 2020) makes a case concerning the potential of video gaming as a testbed for examining the relationship(s) between aging and technology, and this seems both apt but also somewhat controversial. It is apt because older adults' engagement in meaningful video gaming as a leisure activity provides an opportunity to assess their use and adoption of new and emerging technologies. But it is also controversial because although the current paper frames video gaming in terms of leisure time for older adults, there has been much debate about the potential of cognitive training programs, whether gamified or otherwise, for maintaining and possibly enhancing cognitive skills in older adults (Simons et al., 2016; NASEM, 2017), and the current paper suggests that the answer depends upon the goal of such programs.

If the goal is to engage the user in enjoyable and engaging leisure time activity, then video gaming seems appropriate at least for the segment of the population that plays video games. An interesting question centers on whether young adult gamers (predominantly males) will continue

to play video games as they advance into later adulthood and what, if any, benefits cognitive or otherwise might accrue from such behavior. Demographic trends suggest that the proportion of older adults who play video games is likely to increase as younger 'gamers' age, but less clear is whether individuals who have never before played video games will decide to take them up in their later years. As noted in the paper by Boot et al. (2020), the answer to this question may hinge on the evolution of virtual reality-based programs that may appeal to a broader spectrum of users, regardless of age.

Communication/social connectedness is another theme that cuts across the contributions honoring Neil. While present throughout the lifespan, the interconnections and interdependencies between physical, mental, and social health, personal mobility, public safety, technology, community engagement, and well-being, or so-called 'connected living,' become more salient as people age. Social connectedness encompasses both the subjective experience of feeling close and connected to others as well as the objective structure and strength of connections to others in the social environment. The papers by Czaja and Weingast (2020) and Rogers and colleagues (Rogers, Mitzner & Bixter, 2020) in this special edition note that research has established links between social connectedness and a variety of health outcomes, including mortality, and there is evidence suggesting that social ties and social engagement can be protective against cognitive decline and dementia. For example, Steptoe and colleagues (O'Súilleabháin et al., 2019) conducted a 17-year follow-up on older adults in the Berlin Study of Aging and found that emotional loneliness is associated with an increased risk of all-cause mortality in older adults who live alone. Social isolation and feelings of loneliness are quite common among people with Alzheimer's disease (AD) and AD-related dementia (ADRD) but it is unclear whether these feelings occur prior to disease onset and whether loneliness is a risk factor for cognitive decline and AD/ADRD. The causal direction is not clear in part because cognitive decline also impairs interpersonal interactions and close relationships. Poey et al. (2017) analyzed data from the Aging Demographics and Memory study of aging, a nationally representative sample of adults over age 70, and found that the social environment moderates the relationship between the APOE4 allele, a purported risk factor for AD, and cognitive functioning. In a review of research involving animal models of AD, Hsaio et al. (2018) concluded that social isolation influences the progression of cognitive deficits and suggested a mechanistic scheme that explains how social isolation exacerbates cognitive impairment and

how social interaction with conspecifics rescues AD animals' memory deficit. The potential for technology to assist older adults' social connectedness (the experience of feeling close to others) is an important issue for future research.

An important topic that is briefly addressed in the paper by Czaja and Weingast (2020) centers on the loss of mobility or other forms of disability that can result in social isolation, restrict opportunities for social interaction, and further contribute to disruptions in important connections of living (i.e., feeling loved, cared for and valued in interpersonal interactions). Limited opportunities for engagement in essential or valued activities can have long-term consequences for physical health, emotional well-being, and cognitive function. At the same time, declines in visual, psychomotor, or cognitive functioning such as the progression to AD/ADRD, can compromise many aspects of connected living, including safe driving, the use of other forms of mobility to get around in the community, and broader aspects of social engagement. In many communities, the lack of transportation options can seriously impair older people's opportunities for connectedness with the community and social partners (see, for example, Dickerson et al., 2007; Molnar & Eby, 2008). Numerous studies have shown that loss of mobility is associated with loss of independence and freedom, increased depressive symptoms, increased risk of nursing home placement, and more general accelerated health declines. Given the aging of the population in the United States (US) and elsewhere around the world, these issues will only become more important, as will the continued need for a multidisciplinary and multifaceted approach to address them. Whereas the papers included here address the potential of technology for overcoming some of these outcomes, such as, for example, by reducing social isolation via video chat, they do not address how technology may enhance older adult mobility via increased access to ride-sharing services or other mobility support services for older adults.

The paper by Czaja and Weingast (2020) mentions autonomous vehicles as being 'on the horizon' but it is unclear how close that 'horizon' is and whether older adults will readily accept that kind of technology. Moreover, older adults who may be in the greatest need of mobility assistance, such as individuals with physical limitations and those who live in rural areas, may be unable to afford autonomous vehicles. Neil and his collaborators have done pioneering research on older adults' acceptance of automotive technology, such as advanced driver alert systems (see, for example, Charness, Yoon, Souders, Stothart & Yehnert, 2018; Souders, Charness, Roque

& Pham 2019), and clearly, more research is warranted to address this pressing area of need. More broadly, more research is needed to identify the causal pathways and the causal relationships that underlie associations between social and behavioral factors that contribute to successful aging and it is to that topic that I now turn.

In 2015 the National Academies of Sciences, Engineering and Medicine (NASEM) workshop entitled, 'Understanding Pathways to Successful Aging: How Social and Behavioral Factors Affect Health at Older Ages' (NASEM, 2015) emphasized the importance of defining a set of objective criteria for delineating causal pathways and causal relationships underlying associations between social/behavioral factors that contribute to successful aging. It also outlined approaches for investigating how these antecedents are linked to favorable outcomes and the most promising targets for interventions. These principles are critical for advancing a clearer understanding of the interrelationships between mobility, social connectedness, and health-related outcomes in aging. They are also important for suggesting targets for potential intervention as evidenced in a recent publication by Evans and colleagues (2018) based on the Cognitive Function and Ageing Study–Wales (CFAS-Wales) which suggested that maintaining a socially active lifestyle in later life may enhance cognitive reserve and benefit cognitive function. And, beyond whatever gains might accrue from social engagement and cognitive resilience and reserve, there is the equally important impact on enhanced activities of daily living – EADLs, as discussed in the paper by Rogers et al. (2020) – which undoubtedly contribute to an individual's quality of life regardless of age.

Demographic changes in the older adult population in the US (and the world) is yet another theme that cuts across the contributions in this special edition (e.g., Fozard, 2020; Czaja & Weingast, 2020). Adults are living longer, healthier lives and this has wide-ranging implications for society. One way to appreciate the changing demographic is to visualize it in terms of so-called population pyramids as a function of historical time. A population pyramid is a pair of histograms indicating the distribution of the population among the different age groups and sexes (males on the left and females on the right) and its shape conveys information about growth patterns and possible dependency issues or gender imbalances. For instance, a pyramid with a wide base and narrow top suggests high fertility and a growing population, whereas a pyramid with a narrow base suggests an aging population with low fertility rates. Focusing on the US, there have been dramatic changes in the population pyramid over the past half-century, with lower fertility rates and greater longevity giving rise to what looks more like a rectangle than a pyramid (with greatest increases at middle age and above), and the projection for the next half-century suggest that an inverted pyramid may be more apt! These kinds of changes in the population have important implications for work and the workplace as well as medicine and caregiving. As one example, it is projected that whereas a preponderance of older adults in the US today can rely on children for assisting with caregiving as the parents' age, future generations are less likely to do so both as a result of reductions in infertility as well as increasing numbers of adults opting to remain childless.

As noted in the paper on aging and work by Sharit (2020), this demographic change underscores the importance of technology in the workplace and its potential for accommodating older workers in order to remain productively engaged. In addition, increasing numbers of workers (of all ages) are employed as so-called 'contingent' workers, as contractors or employees in the 'gig' economy, which has important ramifications regarding work and retirement (Gale, Holmes & John, 2018). The recent trend toward decreasing personal investment in retirement funds coupled with decreasing or non-existent matching funds by employers (Gale, Gelfond & Fichtner, 2019) increases the likelihood of future cohorts of older workers needing to maintain employment simply to cover their living expenses, including rising healthcare costs.

As emphasized in the entire set of papers in this special edition, gerontechnology offers the potential for preventing, delaying or compensating for many of the declines associated with normative aging and enhancing opportunities for older adults. However, in the face of increasing multimorbidity with advanced aging, coupled with decreased financial savings over one's working career, it is not clear that older adults will have access to needed technology for meeting the manifold challenges of aging in modern society. Access to quality healthcare and its increasing cost is an important unmet challenge confronting our aging society and one that researchers must do more to address.

In closing, it is important to reiterate the positive messaging embodied in this collection of papers honoring Neil's election as Grandmaster by the members of the International Society of Gerontechnology, while also highlighting the challenges posed by technological innovations. Technology offers many opportunities to engage older adults in meaningful activity, whether work-related or leisure and benefiting their instrumental as well as enhanced activities of daily living. But

this potential cannot be truly realized unless two important challenges are addressed. First, is the challenge of ensuring personal security and safety in using any technology and especially online technology that may increase an older adult's vulnerability to scams. Research has shown that even in the absence of Alzheimer's disease or mild cognitive impairment, older adults suffer decrements in decision making that enhances their susceptibility to misinformation (see, for example, Boyle et al., 2012) but certain steps can be taken to effectively reduce this risk, such as forewarning users about the possibility of fraud (Scheibe et al., 2014).

The second major challenge confronting the promise of gerontechnology lies in differential access to technological resources, such as internet accessibility, and by extension, disparities in access to quality health care. Recent research is discouraging in showing that health disparities in the US have increased over the past several decades, particularly in rural areas and areas inhabited by non-white, uneducated, and under-resourced groups (see Hill et al., 2015). On this point, it is noteworthy that many investigators, including Neil and the CREATE team, have made it a priority to recruit rural and minority samples into their ongoing research, but these efforts have not been without challenges in terms of securing reliable access to technology by these individuals. For instance, Neil has described his experiences in trouble-shooting internet connectivity for remote, rural users living in North Florida where weather phenomena cause power outages that compromise internet-based connectivity (Charness, 2019). Even when power is restored, there is the challenge of bringing such systems back to functional status and these kinds of issues are of paramount importance for any technology-based solution. Clearly, Neil and his team are up to the challenge, but it is an undertaking that requires more than the ardent commitment of investigators like the CREATE team. A viable, realistic, long-term solution will require public-private partnerships and a global commitment by all stakeholders to realize the vision of gerontechnology as outlined in this collection of papers honoring Neil's well-deserved recognition as Grandmaster.

References

Berkman. L.F. (2000). Social Support, Social Networks, Social Cohesion and Health. Social Work in Health Care, 31:2, 3-14, https://doi.org/10.1300/J010v31n02_02

Boot, W.R., Andringa, R., Harrell, E.R., Dieciuc, M.A., & Roque, N.A. (2020). Older Adults and Video Gaming for Leisure: Lessons from the Center for Research and Education on Aging and Technology Enhancement (CREATE). Journal of Gerontechnology, Special Edition, (this volume).

Boyle, P. A., Yu, L., Wilson, R. S., Gamble, K., Buchman, A. S., & Bennett, D. A. (2012). Poor decision making is a consequence of cognitive decline among older persons without Alzheimer's disease or mild cognitive impairment. PloS one, 7(8), e43647. https://doi.org/10.1371/journal.pone.0043647

Charness, N. (2019). Technical Challenges for Technology-Based Intervention Studies with Older Adults. In W. R. Boot (Chair). Best Practices for the Design and Implementation of Technology Interventions for Older Adults. American Psychological Association Meetings, Aug 8-11: Chicago, IL.

Charness, N., Yoon, J-S., Souders, D., Stothart, C., & Yehnert, C. (2018). Predictors of Attitudes towards Autonomous Vehicles. Frontiers in Psychology, 18, 1-9. https://doi.org/10.3389/fpsyg.2018.02589.

Czaja, S.J. & Weingast, S.G. (2020). The changing face of aging: Characteristics of older adult user groups. Journal of Gerontechnology, Special Edition, (this volume).

Dickerson, A.E., Molnar, L.J., Eby, D.W., Adler, G., Bedard, M., Berg-Weger, M., Classen, S., Foley, D., Horowitz, A., Kerschner, H., Page, O., Silverstein, N. Staplin, L., & Truliool, L. (2007). Transportation and Aging: A Research Agenda for Advancing Safe Mobility. Gerontologist, 47, 578-590. https://doi.org/10.1093/geront/47.5.578

Evans, I., Llewellyn, D. J., Matthews, F. E., Woods, R. T., Brayne, C., Clare, L., & CFAS-Wales research team (2018). Social isolation, cognitive reserve, and cognition in healthy older people. PloS One, 13(8), e0201008. https://doi.org/10.1371/journal.pone.0201008. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6097646/

Fozard, J.L. (2020). Introduction to Special Issue of Gerontechnology in Recognition of Neil Charness, Ph.D., Sixth Grandmaster of the International Society for Gerontechnology. Journal of Gerontechnology, Special Edition, (this volume).

Gale, W.G., Gelfond, H., & Fichtner, J. (2019). How will retirement saving change by 2050? Prospect for the Millenial Generation. Brookings Economic Studies, Brookings Institute. Available online: https://www.brookings.edu/

Gale, W., Holmes, S., & John, D. (2018). Retirement plans for contingent workers: issues and options. Journal of Pension Economics and Finance. 1-13. https://doi.org/10.1017/S1474747218000288

Hill, C. V., Pérez-Stable, E. J., Anderson, N. A., & Bernard, M. A. (2015). The National Institute on Aging Health Disparities Research Framework. Ethnicity & Disease, 25(3), 245–254. https://doi.org/10.18865/ed.25.3.245

Hsaio, Y.H., Chang, C.H. & Gean, P.W. (2018). Impact of social relationships on Alzheimer's memory impairment: mechanistic studies. Journal of Biomedical Science, 25, 3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5764000/

Molnar, L.J. & Eby, D.W., (2008). The Relationship between Self-Regulation and Driving-Related Abili-

ties in Older Drivers: An Exploratory Study. Traffic Injury Prevention, Aug, pp. 314-319. https://doi.org/10.1080/15389580801895319.

National Academies of Sciences, Engineering, and Medicine. (2015). Understanding Pathways to Successful Aging: Behavioral and Social Factors Related to Alzheimer's Disease. Available online: https://www.nia.nih.gov/sites/default/files/2017-11/alzheimers-workshop-in-brief.pdf

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

O'Súilleabháin, P.S., Gallagher, S., & Steptoe, A. (2019). Loneliness, Living Alone, and All-Cause Mortality: The Role of Emotional and Social Loneliness in the Elderly During 19 Years of Follow-Up. Psychosomatic Medicine, 81, 521-526. https://doi.org/10.1097/PSY.0000000000000710

Poey, J.L., Burr, J.A., & Roberts, J.S. (2017). Social Connectedness, Perceived Isolation, and Dementia: Does the Social Environment Moderate the Relationship Between Genetic Risk and Cognitive Well-Being? Gerontologist, 57, 1031-1040. Available online: https://academic.oup.com/gerontologist/article/57/6/1031/29512362.

Rogers, W.A., Mitzner, T.L., & Bixter, M.T. (2020). Understanding the Potential of Technology to Support Enhanced Activities of Daily Living (EADLs). Journal of Gerontechnology, Special Edition, (this volume).

Scheibe, S., Notthoff, N., Menkin, J., Ross, L., Shadel, D., Deevy, M., & Carstensen, L. L. (2014). Forewarning reduces fraud susceptibility in vulnerable consumers. Basic and Applied Social Psychology, 36(3), 272–279. https://doi.org/10.1080/01973533.2014.903844

Sharit, J. (2020). The 'New' Older Worker. Journal of Gerontechnology, Special Edition, (this volume).

Simons, D.J., Boot, W.R., Charness, N., Gathercole, S.E., Chabris, C.F., Hambrick, D.Z., Stine-Morrow, E.A.L. (2016). Do 'brain training' programs work? Psychological Science in the Public Interest, 17(3), 103-186.

Souders, D. J., Charness, N., Roque, N. A., & Pham, H. (2020). Aging: Older Adults' Driving Behavior Using Longitudinal and Lateral Warning Systems. Human Factors, Vol. 62, No. 2, pp. 229-248. https://doi.org/10.1177/0018720819864510