Human–Computer Interaction Series

Sergio Sayago *Editor*

Perspectives on Human-Computer Interaction Research with Older People

Springer

Human–Computer Interaction Series

The Human-Computer Interaction Series, launched in 2004, publishes books that advance the science and technology of developing systems which are effective and satisfying for people in a wide variety of contexts. Titles focus on theoretical perspectives (such as formal approaches drawn from a variety of behavioural sciences), practical approaches (such as techniques for effectively integrating user needs in system development), and social issues (such as the determinants of utility, usability and acceptability).

HCI is a multidisciplinary field and focuses on the human aspects in the development of computer technology. As technology becomes increasingly more pervasive the need to take a human-centred approach in the design and development of computer-based systems becomes ever more important.

Titles published within the Human–Computer Interaction Series are included in Thomson Reuters' Book Citation Index, The DBLP Computer Science Bibliography and The HCI Bibliography.

More information about this series at http://www.springer.com/series/6033

Sergio Sayago
Editor

Perspectives on Human-Computer Interaction Research with Older People

Springer

Editor
Sergio Sayago
Departament de Matemàtiques i Informàtica
Universitat de Barcelona
Barcelona, Spain

ISSN 1571-5035 ISSN 2524-4477 (electronic)
Human–Computer Interaction Series
ISBN 978-3-030-06075-6 ISBN 978-3-030-06076-3 (eBook)
https://doi.org/10.1007/978-3-030-06076-3

Library of Congress Control Number: 2018967428

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Foreword

When I taught an undergraduate Human–Computer Interaction class at Dundee University, a key part of the curriculum focused on human diversity, including a section on ageing and how it impacts interaction design. I'd start the section by showing the class what might appear to have been a randomly selected picture of a neatly dressed older man, expecting they would assume it was someone with low digital literacy. I'd ask if they knew who it was, and I don't recall anyone ever giving the right answer. I'd then tell them that the person in the photo—Doug Engelbart—was responsible for the computer mouse and hypertext, two of their most familiar day-to-day technologies.

As part of their group project on user-centred design, students were encouraged to work with older adults as participants in exploratory research and evaluation. In this activity, they might also have the opportunity to meet Bill, who was a navigator with the British Royal Air Force during World War II. Using the analogue technology of the 1940s, he safely guided his crew to and from Japan in terrifying wartime conditions. But when it came to using software to create a slide presentation to share his passion for aviation, technology defeated him.

These are two examples of the many stories that illustrate the nuanced relationships we have with technology and the expectations we might have of older people's ability to use it. They are stories to remind us that successful use of technology by older people is a complex mix of design, psychological and physiological factors that are highly dynamic in nature. Lazy stereotypes and questionable assumptions of what older people can and can't do, what they want and what they should be given, can threaten a future where technology has the potential to enhance quality of later life.

In my work first in academia and latterly as a digital accessibility consultant, my experience is that awareness and interest in designing for diverse populations has never been higher. Yet, this is also a time where technology, inclusion and diversity have become politically charged topics at an unprecedented level of intensity. The gains we thought we'd made in recent years to establish the rights of diverse groups not to encounter discrimination are being threatened by movements capitalising on disenfranchisement—political and ideological shifts in and beyond the tech industry. The consequences of technology-mediated events such as the 2016 United States presidential elections, Brexit, the emergence of the alt-right, and stories questioning the ethics of Silicon Valley companies, create concerns of declining respect for people and diversity. We also have the seemingly constant economic pressure to create and ship technology that does more, and in new ways, making it harder to focus on providing a quality user experience for new and existing users.

These events put the progress we've made in universal design at risk. But we have an opportunity to embed knowledge of human diversity in a way that reduces ingrained bias in design decisions. When designing for diversity "just happens" because designers do it as a core professional skill, the argument—driven by expectations of expensive remediation and constrained functionality—that inclusive design is an unjustifiable economic burden is substantially weakened. Normalising diversity as far as possible helps ensure that digital content creators, policymakers, tool builders and the many other stakeholders who influence how technology shapes our lives do so in a way that is as innately inclusive as possible. And a design team that focuses on people with disabilities, people from ethnic minorities, people in stressful situations and older people is a team that is likely to find insights and innovations that benefit a wide audience.

That's why this collection of knowledge on ageing and technology is so welcome, not only to inform and encourage researchers working in this fascinating and important field to continue discovering and sharing, but to support technology design decisions that are informed and influenced by the characteristics and circumstances of a significant but under-represented demographic. I warmly applaud Sergio Sayago's dedication and commitment to assembling these perspectives on understanding and designing for the needs of older technology users in different situations. I hope this book can challenge assumptions, provide valuable evidence to guide design strategy and ultimately shine a light on opportunities to use technology to enhance the lives of older adults. And, I hope that we can look forward to a future where design teams are not surprised by Doug's technological expertise, and where Bill can share his passion and expertise through presentation software that works for him.

Fife, Scotland David Sloan, Ph.D.
User Experience Research Lead with The Paciello Group

Acknowledgements

This book would have been impossible to develop and complete without all the contributors. I am also enormously indebted to Josep Blat and Paula Forbes. Both played a key role in this book. I am also deeply grateful to Associació de Participants ÀGORA de l'Escola de Persones Adultes de La Verneda, Dundee User Centre and EspacioCaixa Madrid participants, who helped me to learn with and from them about the relationship between motivated older people and digital technologies, and who allowed me to share their experiences with the rest of the world. I thank my editor in Springer, Helen Desmond, for her support all along the way. My thanks also go to Ageing + Communication + Technologies (ACT), a research project (http://actproject.ca/) funded by the Social Sciences and Humanities Research Council of Canada, from providing me with research opportunities and stimulating, interdisciplinary conversations about ageing and digital technologies.

Contents

Editor and Contributors

About the Editor

Sergio Sayago (Ph.D., Human-Computer Interaction/Computer Science, Universitat Pompeu Fabra, Barcelona) has been conducting HCI research with older people since 2004. He has conducted long-term ethnographic, participant observation and co-design studies of real-life web accessibility (WCAG) and technology use, mostly communication and digital games, in different cultural settings. His current research focuses on long-term empowerment and democratisation, addressing making, programming and (embodied) conversational interfaces, with older and adult people with low levels of formal education.

Contributors

Javi Agenjo Universitat Pompeu Fabra, Barcelona, Spain

Chee Siang Ang University of Kent, Canterbury, UK

Arlene J. Astell Department of Occupational Sciences and Occupational Therapy, University of Toronto, Toronto, Canada;
Department of Psychiatry, University of Toronto, Toronto, Canada;
School of Psychology and Clinical Language Sciences, University of Reading, Reading, UK

Ronald Baecker University of Toronto, Toronto, ON, Canada

Angel Bergantiños Universitat de Barcelona, Barcelona, Spain

Josep Blat Universitat Pompeu Fabra, Barcelona, Spain

Clara Caldeira University of California, Irvine, CA, USA

Montserrat Celdrán Faculty of Psychology, University of Barcelona, Barcelona, Spain

Yunan Chen University of California, Irvine, CA, USA

Raymundo Cornejo Faculty of Engineering, Autonomous University of Chihuahua, Chihuahua, Mexico

Carrie Demmans Epp University of Alberta, Edmonton, AB, Canada

Yvonne Eriksson Mälardalen University, Eskilstuna/Västerås, Sweden

Mireia Fernández-Ardèvol IN3—Universitat Oberta de Catalunya, Barcelona, Spain

Susan M. Ferreira Télé-Université Du Québec, Québec, Canada

Michela Ferron Fondazione Bruno Kessler, Trento, Italy

Paula Forbes Abertay University, Scotland, UK

Rachel L. Franz University of Washington, Seattle, WA, USA

Vera Gallistl University of Vienna, Vienna, Austria

Francisco J. Gutierrez Department of Computer Science, University of Chile, Santiago, Chile

Noah Lenstra University of North Carolina at Greensboro, Greensboro, NC, USA

Gerard Llorach Hörzentrum Oldenburg GmbH & Medizinische Physik and Cluster of Excellence 'Hearing4all', Universität Oldenburg, Oldenburg, Germany

Nadia Mana Fondazione Bruno Kessler, Trento, Italy

Ornella Mich Fondazione Bruno Kessler, Trento, Italy

Barbara Barbosa Neves University of Melbourne, Melbourne, Australia

Galit Nimrod Ben-Gurion University of the Negev, Beer-Sheva, Israel

Sergio F. Ochoa Department of Computer Science, University of Chile, Santiago, Chile

Andrea Rosales IN3—Universitat Oberta de Catalunya, Barcelona, Spain

Sergio Sayago Universitat de Barcelona, Barcelona, Spain

Rodrigo Serrat Faculty of Psychology, University of Barcelona, Barcelona, Spain

Panote Siriaraya Kyoto Sangyo University, Kyoto, Japan

Marie Sjölinder RISE SICS, Kista, Sweden

Julita Vassileva Department of Computer Science, University of Saskatchewan, Saskatoon, SK, Canada

Feliciano Villar Faculty of Psychology, University of Barcelona, Barcelona, Spain

Jacob O. Wobbrock University of Washington, Seattle, WA, USA

Part I
Introduction

Chapter 1
Editorial Introduction—Perspectives on HCI Research with Older People

Sergio Sayago

1.1 Overview

A great deal of older-adult HCI research[1] conducted since its origins (1990–2000s) can be characterized by (i) understanding and compensating for the impact of age-related changes in functional abilities on older people's interactions with digital technologies, (ii) providing them with something they do not have or must improve, with either technologies specifically designed for them, or adapted, simplified versions of existing ones, and (iii) helping them to live as independently as possible and age-in-place with assistive technologies. This analysis has been discussed, with different levels of detail and approaches, in previous studies (Righi 2016; Ferreira 2015; Vines et al. 2015; Rogers and Marsden 2013; Parra et al. 2014).

While addressing these issues is important to make digital technologies more accessible, useful, and pleasant to use for the fastest growing segment of the population, there are reasons to claim that the current perspective on *decline* and *help* is not enough to better understand, design, and evaluate older people's interactions with digital technologies in the early 21st century. For instance, while seeing older people as a set of *human factors* might be, especially in Europe and the US, the most natural or obvious way of operationalizing this user group within HCI, there are alternative, more contemporary, less dehumanizing, and richer, ways of looking at them. Older people can also be seen as individuals with a wealth of life experience, with interests and aspirations in their later life, as well as limitations and losses. In addition to this, the predominant paternalistic—and, on some occasions, instrumental and medical—perspective on digital technologies and older people, while relevant, is limited,

[1] In this editorial introduction, I will use the expression 'older-adult HCI research' and 'HCI research with older people' interchangeably.

S. Sayago (✉)
Universitat de Barcelona, Barcelona, Spain
e-mail: ssayago81@gmail.com

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_1

as it fails to explore the extent to which digital technologies fit into older people's lives and enable them to be and feel empowered in their older adulthood. Is helping them all digital technologies can do for older adults?

This current perspective indicates that older-adult HCI still has not kept up with changes in paradigms of HCI (Harrison et al. 2011; Hassenzahl 2010; Bannon 1991)—from Human Factors to Human Actors, and to User eXperience. These changes have been prompted by, and aligned with, the evolution of digital technologies (e.g., from computers being a work-placed tool that were used for specific tasks to a much more ubiquitous presence in our everyday lives), their users (e.g., from experts to non-experts), and technology use (e.g., from productivity and efficiency as ICT goals to flourish and well-being). Older-adult HCI research might not have progressed at the same rate as HCI because of its youth. HCI research with older people has skimmed the surface of the complexity, diversity and richness of old age and ageing,[2] as the field focuses almost completely on the individual, social and negative side of ageing, which does not help us understand, appreciate, and design the relationship between older people and digital technologies at its full.

Against this background, which I discuss further in Sect. 1.2, I set out to publish a book to take older-adult HCI research forward by providing a new (or different) perspective on it. I released a call for expressions of interests in a blog post[3] and disseminated it as widely as possible. Sixteen expressions of interests were submitted and peer-reviewed by two reviewers, with different levels of academic seniority, and myself. We encouraged the authors to discuss the new perspective introduced in their chapters. Fourteen chapter proposals were accepted.[4]

Contributions come from researchers working at universities and/or technological centers in Europe (Sweden, the Netherlands, Germany, Austria, the UK, Spain, Italy), Canada (Toronto, Alberta), the US (California, Washington), South America (Chile, Mexico), Australia (Melbourne), and the Middle East (Israel). This international dimension is in accord with the widespread interest in ageing and digital technologies.

The contributors come from many different fields, such as Psychology, Informatics, Sociology, Information Design, Computer Science, Communication, Library and Information Studies. This variety of areas provides an interdisciplinary character to the perspective introduced in this book, and is aligned with the multidisciplinary nature of both HCI and research on older people/ageing and digital technologies.

The interdisciplinary perspective that emanates from the chapters, which I outline in Sect. 1.4, does not ignore the current or most predominant perspective, as doing so would be a mistake. We cannot ignore that age-related changes in functional abilities do have an impact on older people's interactions with digital technologies. Instead, the perspective is an invitation to

---

[2]See, for example, the series of three handbooks of ageing: *Handbook of the Biology of Aging*, *Handbook of the Psychology of Aging*, and *Handbook of the Aging and the Social Sciences*. At the time of writing this book, the current edition is the seventh.

[3]http://hciolderpopulation.wordpress.com/.

[4]Two expressions of interest were not aligned with the mission and vision of the book.

- address topics that include decline, health, help and isolation, but *go beyond* them, such as leisure, fun and culture, to delve into the role of digital technologies in multiple facets of older people's lives,
- focus more on doing research and designing technologies *with* and *for* older adults, and their local communities, to avoid and fight against social conceptions of ageing, such as ageism,
- examine their *life course (and transitions)*, *strengths*, *interests*, and *values*, as well as their limitations and needs, to design technologies that not only help older adults do something but also empower them in their older adulthood.

This perspective deepens and widens older-adult HCI research. Within this perspective, older people are not only individuals in need of help but also Social Actors (Sayago 2009). This perspective is also more aligned with the current wave (UX) of HCI and the diversity of ageing than the current one, and suggests a number of future research opportunities, which I discuss in the final chapter of the book.

1.2 Background

At the outset of the 21st century, we are faced with a number of global issues. According to the United Nations,[5] these issues are, amongst others, Big Data for Sustainable Development, Climate Change, Gender Equity, Peace and Security, Water, Refugees and Ageing. The subject matter of this book deals with the latter. As stated in (United Nations 2017), population ageing—the increasing share of older persons in the population—is poised to become one of the most significant social transformations of the 21st century, with implications for nearly all sectors of society. Population ageing is occurring in a context in which digital technologies, code and software are having a profound influence on the world. Thus, it is timely and important to study the relationship between older people and digital technologies. This book addresses it from the viewpoint of HCI.

HCI research with older people is, at the time of writing this book, still in its infancy. To the best of my knowledge, two of the first studies were the seminal *Human Factors Research Needs for an Aging Population* (Czaja 1990) and the *Handbook of Human Factors and the Older Adults* (Fisk and Rogers 1997), both published in the 1990s. Since then, ageing has become a significant research area in HCI (Vines et al. 2015). A growing number of books addressing the topic of older people and digital technologies have been published over the last decade (Barbosa and Vetere in print; Johnson and Finn 2017; Friberg and Wright 2014; Harness 2011; Pay and McLaughlin 2011; Fisk et al. 2009). Special sessions/workshops in major HCI conferences, and conferences devoted to older people and digital technologies, are also regularly held.[6]

---

[5] http://www.un.org/en/sections/issues-depth/global-issues-overview/.

[6] ITAP: International Conference on Human Aspects of IT for the Aged Population (http://2018.hci.international/itap).

This growing importance of ageing within HCI can be taken as an example of the overall and ever-increasing interest in research on ageing, which has become a major focus in science and in the many professions that serve ageing populations, as the *Handbook of Aging* series—see footnote 3—illustrate. How has HCI research with older people evolved over the years? From time to time, it is a useful intellectual exercise to take stock of the research conducted in a field. This exercise allows us to better understand the research conducted, identify gaps and missing areas, and ways of filling/addressing them. Although older-adult HCI is a relatively young research area, I argue that this exercise is timely and necessary. The body of knowledge amassed over almost 30 years enables us to lay out the set of concepts and practices that characterize much of it, and to discuss research direction(s) that could be taken in the early 21st century.

I will carry out this exercise by taking as a reference point the evolution or waves of HCI research, which I outline in the next section, since these waves provide a useful analytical framework. Please note that the references cited in the following Sects. 1.2.1 and 1.2.2 aim to be exemplary of the issues discussed. The reader is invited to refer to them to develop a more comprehensive view.

1.2.1 Waves of HCI Research in a Nutshell

Within the first HCI wave (1980–1990s), users were regarded as a passive element in the human-machine equation. They were reduced to a set of (mostly cognitive) characteristics—Human Factors (Bannon 1991). The Human Information Processing Model (Card et al. 1983) and the GOMS model are exemplary works of this first wave of HCI. Much research was conducted under laboratory conditions, where experts (e.g., technicians, scientists, and engineers) used computers.

The second HCI wave (1990–2000s), which was largely motivated by the fact that computers moved out of laboratories in the 1990s, looked at users not simply as objects of study, but as active and autonomous agents (especially, in work settings). Within this wave, users are regarded as Human Actors (Bannon 1991). Usability, social relationships, communication, collaboration and cooperation are important topics of this wave. Thus, studies conducted in laboratories were important but not enough. Research should be conducted in real-life settings too. It was also generally accepted that the user should take part in the design of technologies so that they better met their needs. Ethnography—and its variants for an engineering context, such as Contextual Design (Holtzblatt and Beyer 1998)—and Participatory Design (Schuler and Namioka 1993), became key research and design approaches. Important theoretical frameworks in this wave were, amongst others, Activity Theory (Kaptelinin and Nardi 2006), Distributed Cognition (Hutchins 1995) and Situated Action (Suchman 1987).

Mobile Interface Design with older people: a series of international events on mobile HCI for older adults (https://olderadultsmobileinterfaces.wordpress.com/).

The focus of the third (or current) wave is to understand (and do) HCI research by addressing the user as a whole—their motivations, needs, interests, practices, emotions, culture, values, and so on. This change in perspective is often referred to as a 'turn to experience', which attempts to go beyond usability and the instrumental (e.g., 'get things done') focus of previous HCI (Harrison et al. 2011; Hassenzahl 2010; Bødker 2006; Hassenzahl and Tractinsky 2006). This third wave has primarily been motivated by the varied and rich use that people with different profiles and age ranges make of digital technologies in their everyday lives. A turn to embodiment (Dourish 2004) and values (Shilton 2018), are, amongst others, contemporary HCI theories (Rogers 2012). A plethora of research and design methods and approaches, quantitative, qualitative and mixed, online and offline, are conducted (Lazar et al. 2017).

The reader is referred to (Grudin 2017) to know more about the evolution of HCI research, and to (Rogers 2012) for HCI theories.

1.2.2 Evolution of Older-Adult HCI Research: A Guided Discussion

During the 1990s, the seminal Czaja (1990) and Fisk and Rogers (1997) both argued that age-related declines in functional abilities affected performance in a wide range of contexts, and that new interfaces, which made up for these declines, were needed. Despite running the (unavoidable) risk of oversimplifying previous research, the claims made by these seminal works 20 years ago, which share important traits with the first wave of HCI, inasmuch as older people are narrowed down to a set of factors, still predominate in much of today's HCI research with older people. Common to most studies is to (a) examine the extent to which age-related changes in functional abilities impact on their interactions with digital technologies (e.g. Guo 2018; Haesner et al. 2018; Ahn et al. 2014), and (b) to propose the design of new or alternative versions of existing technologies that compensate for these changes (e.g. Fröhlich et al. 2016; Muskens et al. 2014; Dalgaard et al. 2013; Graf et al. 2012).

The predominance of this approach might be due to the fact that age-related changes in functional abilities stand out in older people's interactions—be they gestural, voice-driven or point-and-click—with digital technologies. The way we conceptualize users in technology design (Oudshoorn et al. 2016; Neven 2010) provides another explanation. Stereotypes run deep in humans, because of cultural and cognitive reasons, and in the case of older people and technologies, these tend to be overwhelmingly negative (e.g. Durick et al. 2013). To briefly illustrate this fact, imagine an older person using a computer before answering the following questions. Have you pictured a man or a woman? Is he or she struggling or using it smoothly? At present, the most likely answers are: (a), man, because technology = men, and (b) struggling, because age enters into and shapes everyday social interaction, affecting the expectations (and evaluations) of the individuals involved. We associate digital technologies with the young and older people with frailty.

Another considerable research strand is concerned with communication (e.g., Coelho et al. 2017; Barbosa et al. 2017; Rogers and Mitzner 2017), and supporting and fostering independent living, healthy and active ageing (e.g. Yuan et al. 2018; Parra et al. 2014). These studies pay attention to, and design technologies that make up for, age-related changes in functional abilities. Yet, they also go beyond these human factors by addressing other topics, such as technology use, social relationships, attitudes and motivations, which are more related to the second and current HCI wave. Within this research strand, we find different types of technologies, ranging from games to robots, designed to enrich and facilitate intra- and intergenerational communication, and to help older people do daily activities on their own (e.g. McNeill et al. 2017; Coelho et al. 2017; Frennert and Östlund 2014). Much older-adult HCI research concentrates on this strand. This might be—perhaps—motivated by calls for public funding (e.g. AAL, H2020), which, more often than not, view technology solely as a solution to the problems of older people, and a way to provide more cost-effective support to our growing aging population.

HCI research with older people is a very rich field. Other studies, which I found difficult to fit into the previous two strands, include those which, for instance, (i) explore the usability, accessibility and usefulness of emerging styles of human-computer interaction, such as virtual and conversational agents (Carrasco 2017), robots (McGlynn et al. 2017), interactive glasses (Haesner et al. 2018) and ubiquitous technologies (Cozza et al. 2017), (ii) examine important aspects in technology uptake by older people, such as first-level (access), second-level (skills), and third-level (outcome/benefit) digital divide (Scheerder et al. 2017; Khosravi et al. 2016; Wu and Munteanu 2018), (iii) explore human-animal interaction with older adults (Gee et al. 2017), (iv) look at factors relating to responsibility, values and cultural expectations contributing to older people's resistance to digital technologies (Knowles and Hanson 2018), and (v) explore the emerging topic of smart *ageing* cities (Righi et al. 2015).

By interpreting the waves of HCI research within the context of older-adult HCI, there are reasons to argue that this field has yet to embrace more fully the third wave. I will provide three relevant examples to support this claim:

(1) In much of the research reviewed above, older people tend to be portrayed by using the 'rhetoric of compassion' (Rogers and Marsden 2013), i.e., to provide them with something they lack. A noteworthy example is the way in which a large number of studies that focus on communication and independent (ambient assisted) living to justify their objectives: older people are socially isolated and homebound. Some older people fit this profile but (many) others do not (Cornwall et al. 2008). Current research does not represent well enough the relationship between digital technologies and those older people who, for instance, lead active and socially rich lives, attend courses in community centres on a broad array of topics, travel and do exercise on a regular basis.

(2) Much of today's HCI research with older people is so focused on the—perhaps—most noticeable traits of ageing (decline in functional abilities) that it forgets that a person who is 65 (or older) is a product of what he or she has been before (Settersten 2003). This life experience aspect is, in a way, related to one

of the most important tenets of ethnography, which can be summarized with the Native American Proverb "never criticize a man until you've walked a mile in his moccasins",[7] and just as important, if not more, than cognitive-related declines, in adult education (Knowles et al. 2005).

(3) The strong focus on communication and health, albeit important, reduces considerably the role that digital technologies could (and should play) in older people's lives. How can digital technologies empower them in their older adulthood (e.g., extend their abilities, understand further issues that matter to them)? Empowering people through technology is of increasing concern in the HCI community (Schneider et al. 2018). This is happening in tandem with a growing interest in HCI in "doing good with technology" or in Positive Computing (Calvo and Peters 2014), and with Positive Psychology, which attempts to "remind (our field) that psychology is not just the study of pathology, weakness, and damage; it is also the study of strength and virtue" (Csikszentmihalyi 2014, p. 284). Interdisciplinary research on ageing has also shown that ageing is a complex process of both losses and gains.

These three examples illustrate that the predominant perspective is not enough to address a number of issues, which are not only important in HCI but also in other related areas. Older people have mostly been overlooked in HCI until relatively recently, and this might be why these topics have not attracted much research attention yet. However, the time is ripe for addressing them, without turning a blind eye to those aspects on which we have focused thus far. If we look at the current wave of HCI, it draws upon, deepens and widens, the previous two waves; it does not ignore them altogether.

A growing number of recent studies have started to provide alternative perspectives on HCI with older people by, for example, reflecting on the fundamental question of 'when we talk about older people in HCI, who are we talking about?' (Righi et al. 2017), and looking into the transition from older people as passive consumers of digital content to active creators of both digital contents and technologies (Guo 2018; Ferreira et al. 2017; Rogers et al. 2014). This book contributes to keep pushing the boundaries.

1.3 Overview of the Contents of the Book and Chapters

The first two chapters of the book (Part II) address an important topic—technology design—from different perspectives: dementia and the role of designers.

Arlene J. Astell in Chap. 2 argues that there is a need for practical, affordable and scalable solutions to empower people to live as well as possible with dementia. To achieve this, Arlene argues that we need to shift from the medical approach focused on the symptoms of dementia to an approach based on empowerment through the

[7] Some argue that the *Walk a Mile in His Moccasins* actually comes from a poem written by Mary T. Lathrap in 1895—https://www.aaanativearts.com/walk-mile-in-his-moccasins.

sensitive and appropriate use of technology. This chapter also reports on design activities to create technologies with and for people who have dementia, and not only with and for their caregivers and relatives.

Yvonne Erikson and Marie Sjölinder in Chap. 3 discuss the role of design in supporting an interest in and use of technologies among older people. Yvonne and Marie argue that the design of new services targeted at older people needs a new approach, because stereotypes and assumptions affect (older) people's self-image and attitudes towards technology. Ageing is not an illness. Central to the new approach put forward in this chapter is to make designers and technology developers more aware of the impact of stereotyped and taken-for-granted views on all of us.

The third chapter opens a series of chapters (Part III) that focus more on exploring, understanding and building the relationship between older people and widespread or emerging digital technologies.

Andrea Rosales and Mireia Fernández-Ardèvol in Chap. 4 investigate the intergenerational use of smartphones over time by triangulating the results of a comparative analysis of the generational use of smartphones based on logs, with an online survey and focus groups. With some exceptions, this approach is uncommon in older-adult HCI. The results show that older people are a minority and a heterogeneous group regarding smartphone use in Spain. The results also show that values, habits and long-term perspectives influence their decision to use smartphones. To avoid structural ageism in the design of intelligent systems based on smartphone logs, Andrea and Mireia invite us to take digital minorities and heterogeneity into account in our research.

Clara Caldeira and Yuna Chen in Chap. 5 provide a review of older people's use of self-tracking and self-tracking technology. The review shows that while older people are engaged in self-tracking activities, the functionalities, assumptions, visual design and advertising of activity trackers, which are among the main self-tracking tools currently available, are focused on young and middle-aged adults. Most of the studies are conducted with older adults with special needs (or their caregivers), and aim to improve/monitor their health. While important, Clara and Yuna claim that there is potential for leveraging both self-tracking and monitoring to offer adequate support for older people who are still independent.

Michela Ferron, Nadia Mana and Ornella Mich in Chap. 6 show that mid-air gesture interaction cannot only overcome some accessibility issues that come with age, but also make the interaction more pleasant, fun and engaging for older users. This chapter presents the main characteristics of mid-air gesture interaction, discusses the most prominent design challenges for older adults, describes how the authors approached the design of this kind of interaction in an H2020 project through a user-centred and value-based design approach, and proposes a set of design recommendations. These include designing for fun and designing gestures following a participatory and user-centred design approach, which challenges the most common one: designing gestures that are easy for an algorithm to recognize!

Panote Siriaraya and Chee Sian Ang in Chap. 7 report on a mixed-based study aimed to investigate how various aspects of 3D virtual worlds influence the social interaction experience—the sense of being together with others—of older users.

Delving into older people's interactions with virtual worlds, Panote and Jim show that, in addition to the commonly assumed cognitive ability barriers, concerns about deception and false identity of avatars, and prior expectations of 3D computer generated environments as being non-serious fictional spaces, determined their (in this case, negative) social experience.

Gerard Llorach and colleagues in Chap. 8 discuss their ongoing research on building the interactive 3D web graphics aspects of Embodied Conversational Agents. They present an innovative technological pipeline, which allows us to carry out rapid (and mostly inexpensive, with free tools) online experiments to address key issues, such as anthropomorphic aspects, in the design of ECAs with, and for, older people and their local communities. Gerard and colleagues also report on initial results of activities aimed to explore the physical appearance of ECAs for older people. The results indicate that a group of older people preferred ECAs to be female, and that designing them was easy and great fun.

In Part IV, the chapters explore issues which have received scant attention thus far in older-adult HCI, such as online leisure, adopting a community perspective, and others that are gaining traction, such as the transition from passive to active creators of digital content.

Vera Gallistl and Galit Nimrod in Chap. 9 suggest three pathways towards a better understanding of the roles online leisure plays in older adults' subjective wellbeing (SWB): (i) simultaneous exploration of various online leisure activities, (ii) concurrent examination of both online and offline leisure activities; and (iii) differentiation among discrete sub segments of older Internet users. Vera and Galit point out that the impact of media-based leisure activities on SWB does not depend on the type of medium used (offline or online) but rather on the purpose they serve.

Noah Lenstra in Chap. 10 puts forward a new concept, the informatics life course, grounded in ethnographic research in senior centres and public libraries in the US. This concept refers to how a person learns technology throughout the stages of his or her life as he or she ages in place. Retired individuals have rich, multifaceted lives, of which age-related changes in functional abilities are just one facet. Key dimensions of this concept are experiences of ageing in communities, technology support, ageism, and the transition from work to retirement. Noah argues that the informatics life course can contribute to correct ageist stereotypes, which leads some older adults to stop using technology when they retire, out of a belief that technology is inherently the domain of hunger individuals.

Montserrat Celdrán, Rodrigo Serrat and Feliciano Villar in Chap. 11 focus on the motivations, which are a key topic in UX, for older people to write a blog. The results of a number of interviews with older adults, who are likely to exhibit the profile of the next generation of older people, indicate that transition to retirement plays a key role (a more important one than declines in functional abilities and social relationships) in explaining their adoption of blogging, as well as most common ones, such as a desire to write and express ideas.

Chapter 11 touches upon older people's heterogeneity, which is a recurrent topic in the discussion on technology and older people…but how heterogeneous is the use they make of digital technologies? The next two chapters address this question.

Susan M. Ferreira, Sergio Sayago and Josep Blat in Chap. 12 argue that digital technology use by older people is not so heterogeneous as one might think. Their chapter draws on a 5-year ethnographic study of technology use by approximately 220 older people in Barcelona, and two rapid ethnographic studies in Denmark and Brazil, with 90 older people taking part in each country. Susan and colleagues show that a perceived need of taking control over ‘who sees what’ when they share digital media online, sharing this content with those they care for, and feeling more useful, socially and digitally included were striking similarities among the three groups.

Francisco J. Gutierrez and colleagues in Chap. 13 present a different picture, reporting on more differences than similarities between older people in Latino American and in the West as far as digitally-mediated intergenerational social interaction is concerned. For instance, while some exceptions occur, Latin American families follow an interaction routine—grounded in tradition—that in most cases involves a weekly family reunion, which tends to be more difficult to happen in the West. This stresses the need to consider more deeply cultural aspects in older-adult HCI research.

The last two chapters (Part V) address methodological aspects—namely, the need to adapt usability methods to older people—and a future research topic, computer programming and older people.

Rachael L. Franz and colleagues in Chap. 14 stress the importance of understanding how to conduct effective usability testing methods with older people. By comparing three common usability testing methods (concurrent thinking-aloud, retrospective thinking-aloud, and co-discovery) and conducting interviews with HCI experts, the results support an approach that includes the need to understand users and empower them in usability studies through adjusted and user-sensitive multi-methods.

Sergio Sayago, Ángel Bergantiños and Paula Forbes, in Chap. 15, draw upon three in-person courses conducted in an adult educational centre, and discuss the relative relevance of technology acceptance constructs, showing that Perception of Usefulness is more than Perceived Ease-Of-Use, as the participants had to perceive the fit of programming in their lives. Sergio and colleagues also introduce new elements to understand technology acceptance in this context, such as Perceived Exclusion.

1.4 Perspective on HCI Research with Older People

The perspective on HCI research with older people introduced in this book is interdisciplinary, draws heavily on the contents of fourteen chapters, and has three key elements:

> To examine topics related to technology use that include, but also *go beyond*, age-related decline in functional abilities, health, help and isolation/communication, to delve into the role of digital technologies in multiple facets of older people’s lives.

Chapters in Part II, III, IV and V are related to this element. In Part III, Chap. 5 invites us to realize that self-tracking technologies, which are mostly related to monitoring, can be used for other purposes than health, such as learning more about ourselves. Chapter 6 argues that fun and engagement are achievable objectives when designing mid-air gesture interaction for older people, and can have the added benefit of encouraging older adults to exercise. Chapter 8 presents an innovative, low-cost technological pipeline for looking into anthropomorphic aspects of an emerging type of human-computer interaction style: Embodied Conversational Agents. Chapter 4 suggests that designing intelligent system based on smartphone logs can lead to digital ageism and overlook digital minorities. Ageism is also addressed in Part II (Chap. 3) and Part IV (Chap. 10). In Part IV, Chap. 9 focuses on subjective wellbeing, and argues that older adults now live in increasingly mediated environments, which are shaped by offline and online content. Thus, their subjective wellbeing is not determined by involvement in one specific activity or the other, but rather by simultaneous involvement in several offline and online activities. Chapters 12 and 13 show the need to focus more on cultural aspects. In Part V, Chap. 15 shows that we know little—if anything—about the factors that can foster programming acceptance among older people.

To focus more on doing research and designing technologies *with* and *for* older people, and their local communities, to avoid and fight against negative social conceptions of ageing, such as ageism and stereotypes.

Chapters in Part II, III, IV and V are related to this element. In Part II, Chap. 2 argues for a shift in approach as far as technology design and people with dementia is concerned, where there is a need to move away from the current medical approach focused on the symptoms of dementia to an approach based on empowerment through the sensitive and appropriate use of technology. Chapter 3 indicates that there is a need for making designers more aware of the impact of stereotypes and the most widespread design approach on older people's self-image and attitudes towards technology. In Part III, Chap. 6 argues for putting older people first in the design of gestures. Rather than giving priority to gestures that are easy to recognize by algorithms, the focus should be on meaningful and natural gestures for users. Chapter 8 presents older people as competent designers of avatars with free online tools. In Part IV, Chap. 10 argues for doing more HCI research with older people in communities, where they usually receive the support they need to appropriate technologies. Chapter 13 invites us to reflect on whether and how we can reuse the design knowledge gained thus far to devise the next wave of interaction systems for older people living in non-European and non-Western countries. In Part V, Chap. 14 shows that there is a need to adapt usability methods so important as the thinking-aloud protocol to older people's characteristics to keep them motivated in usability studies. Chapter 15 reinforces this need to adapt methods by discussing the difficulties in conducting questionnaires with technology acceptance constructs with older people.

Chapter 15 also highlights the importance of social aspects in fostering programming acceptance among this user group.

> To examine more older people's *life course* (and transitions), *motivations*, *strengths*, *interests*, and *values*, as well as their limitations, weaknesses and needs, to design technologies that not only help them do something but also empower older adults.

Chapters in Part III, IV and V are related to this element. In Part III, Chap. 4 argues that their values, habits and long-term perspectives considerably influence older people's decision to use smartphones with more or less frequency. Chapter 7 shows that, in addition to the commonly assumed cognitive ability barriers, concerns about deception and false identity of avatars, and prior expectations of 3D computer generated environments as being non-serious fictional spaces, determined their social interaction experience. In Part IV, Chap. 10 puts forward the informatics life course, which refers to how a person learns technology throughout the stages of his or her life as he or she ages in communities. Chapter 11 shows that, in addition to overcoming age-related changes in functional abilities, the transition to retirement takes on a key role in explaining the adoption of blogging by (some) older people. In Part V, Chap. 14 argues that usability tests can have a lasting impact on older people's self-efficacy if they perceive the test as too difficult. The chapter also proposes the best method of testing as being co-discovery in order to alleviate this issue. Chapter 15 stresses the need to understand the fit of programming in older people's lives in order to foster the acceptance of this technology.

References

Ahn HS, Santos MPG, Wadhwa C et al (2014) Development of brain training games for a healthcare service robot for older people. Lect Notes Comput Sci 8755:1–10

Bannon LJ (1991) From human factors to human actors the role of psychology and human-computer interaction studies in systems design. In: Greenbaum J, Kyng M (eds) Design at work: cooperative design of computer systems. Lawrence Erlbaum Associates, Hillsdale, NJ, pp 25–44

Barbosa B, Vetere F (in print) Ageing and digital technology: designing and evaluating emerging technologies for older adults. Springer

Barbosa B, Franz R, Judges R et al (2017) Can digital technology enhance social connectedness among older adults? A feasibility study. J Appl Gerontol 38(1):49–72

Bødker S (2006) When second wave HCI meets third wave challenges. In: NordiCHI, Oslo, Norway, pp 14–18

Calvo R, Peters D (2014) Positive computing: technology for wellbeing and human potential. The MIT Press, Cambridge

Card S, Moran T, Newell A (1983) The psychology of human-computer interaction. Lawrence Erlbaum Associates, Mahwah

Carrasco R (2017) Designing virtual avatars to empower social participation among older adults. In: Proceedings of the 2017 CHI conference extended abstracts on human factors in computing systems—CHI EA 2017, pp 259–262

Coelho J, Rito F, Duarte C (2017) You, me & TV—fighting social isolation of older adults with Facebook, TV and multimodality. Int J Hum-Comput Stud 98:38–50

Cornwall B, Naumann E, Schumm L (2008) The social connectedness of older adults: a national profile. Am Sociol Rev 73(2):185–203

Cozza M, De Angeli A, Tonolli L (2017) Ubiquitous technologies for older people. Pers Ubiquit Comput 21(3):607–619

Csikszentmihalyi M (2014) Flow and the foundations of positive psychology. Springer

Czaja SJ (1990) Human factors research needs for an aging population. National Academies Press, USA

Dalgaard LG, Gronvall E, Verdezoto N (2013) MediFrame: a tablet application to plan, inform, remind and sustain older adults' medication intake. In: 2013 IEEE international conference on healthcare informatics, Philadelphia, pp 36–45

Dourish P (2004) Where the action is: the foundations of embodied interaction. The MIT Press, London

Durick J, Brereton M, Vetere F et al (2013) Dispelling ageing myths in technology design. In: OzCHI, Adelaide, Australia, pp 467–476

Ferreira SM (2015) An alternative view of ICT's use by older people in human-computer interaction: similarities, digital content creation and perceived well-being. PhD dissertation. Universitat Pompeu Fabra, Spain

Ferreira SM, Sayago S, Blat J (2017) Older people's production and appropriation of digital videos: an ethnographic study. Behav Inf Technol 36(6):557–574

Fisk AD, Rogers WA (eds) (1997) Handbook of human factors and the older adult. Academic Press, San Diego, USA

Fisk A, Rogers W, Charness N et al (2009) Designing for older adults: principles and creative human approaches. CRC Press, Boca Raton

Frennert S, Östlund B (2014) Review: seven matters of concern of social robots and older people. Int J Soc Robot 6:299–310

Friberg K, Wright S (2014) Toward post ageing: technology in an ageing society. Springer, New York

Fröhlich D, Lim C, Ahmed A (2016) Co-designing a diversity of social media products with and for older people. In: Proceedings of the 7th international conference on software development and technologies for enhancing accessibility and fighting info-exclusion, pp 323–330

Gee NR, Mueller MK, Curl AL (2017) Human–animal interaction and older adults: an overview. Front Psychol 8:1–7

Graf C, Hochleitner C, Tscheligi M (2012) How to design accessible TVMs for older adults. In: NordiCHI, Copenhagen, Denmark, pp 1–3

Grudin J (2017) From tool to partner: the evolution of human-computer interaction. Synthesis lectures on human-centered informatics. Morgan and Claypool, USA

Guo P (2018) Older adults learning computer programming: motivations, frustrations, and design opportunities. In: CHI 2017, Denver, Colorado, p 7070

Haesner M, Wolf S, Steinert A et al (2018) Touch interaction with Google glass—is it suitable for older adults? Int J Hum Comput Stud 110:12–20

Harness N (2011) Designing telehealth for an aging population: a human factors perspective. CRC Press, Boca Raton

Harrison S, Sengers P, Tatar D (2011) Making epistemological trouble: third-paradigm HCI as successor science. Interact Comput 23(5):385–392

Hassenzahl M (2010) Experience design: technology for all the right reasons. Synthesis lectures on human-centered informatics. Morgan & Claypool Publishers, USA

Hassenzahl M, Tractinsky N (2006) User experience—a research agenda. Behav Inf Technol 25(2):91–97

Holtzblatt K, Beyer H (1998) Contextual design: defining customer-centered systems. Morgan Kaufmann Publishers—a more recent version was published in 2017 (Contextual design: design for life)
Hutchins E (1995) Cognition in the wild. The MIT Press, Cambridge
Johnson J, Finn K (2017) Designing user interfaces for an aging population: towards universal design. Elsevier/Morgan Kauffman, USA
Kaptelinin V, Nardi B (2006) Acting with technology: activity theory and interaction design. The MIT Press, Cambridge
Khosravi P, Rezvani A, Wiewiora A (2016) The impact of technology on older adults' social isolation. Comput Hum Behav 63:594–603
Knowles B, Hanson VL (2018) The wisdom of older technology (non)users. Commun ACM 61(3):72–77
Knowles M, Holton E, Swanson R (2005) The adult learner: the definitive classic in adult education and human resource development. Elsevier, Burlington, MA
Lazar J, Heidi J, Hochheiser H (2017) Research methods in human-computer interaction. Morgan Kaufmann Publishers, USA
McGlynn SA, Kemple S, Mitzner TL et al (2017) Understanding the potential of PARO for healthy older adults. Int J Hum-Comput Stud 100:33–47
McNeill A, Coventry L, Pywell J et al (2017) Privacy considerations when designing social network systems to support successful ageing. In: ACM-CHI 2017
Muskens L, van Lent R, Vijfvinkel A et al (2014). Never too old to use a tablet: designing tablet applications for the cognitively and physically impaired. In: ICCHP, pp 391–398
Neven L (2010) "But obviously not for me": robots, laboratories and the defiant identity of elder test users. Sociol Health Illn 32(2):335–347
Oudshoorn N, Stienstra M, Neven L (2016) How diversity gets lost: age and gender in design practices of information and communication technologies. J Woman Aging 2841:1–30
Parra C, Silveira P, Far IK et al (2014) Information technology for active ageing: a review of theory and practice. Found Trends Hum-Comput Interact 7(4):351–448
Pay R, Mclaughlin A (2011) Designing displays for older adults. CRC Press, Boca Raton
Righi V (2016) Re-thinking human-computer interaction research and design with a growing ageing population. Widening contexts of technology use, changing the subject and object of design. PhD dissertation, Universitat Pompeu Fabra, Spain
Righi V, Sayago S, Blat J (2015) Urban ageing: technology, agency and community in smarter cities for older people. ACM Communities & Technologies, Limerick, Ireland, pp 119–128
Righi V, Sayago S, Blat J (2017) When we talk about older people in HCI, who are we talking about? Towards a 'turn to community' in the design of technologies for a growing ageing population. Int J Hum Comput Stud 108:15–31
Rogers Y (2012) HCI theory: classical, modern, and contemporary. Synthesis lectures on human-centered informatics. Morgan & Claypool, USA
Rogers Y, Marsden G (2013) Does he take sugar? Moving beyond the rhetoric of compassion. Interactions 20(4):48–57
Rogers WA, Mitzner TL (2017) Envisioning the future for older adults: autonomy, health, well-being, and social connectedness with technology support. Futures 87:133–139
Rogers Y, Paay J, Brereton M et al (2014) Never too old: engaging retired people inventing the future with MaKey MaKey. In: CHI, Toronto, ON, Canada, pp 3913–3922
Sayago S (2009) Human-computer interaction with older people: from human factors to social actors. PhD dissertation, Universitat Pompeu Fabra, Spain
Scheerder A, van Deursen A, van Dijk J (2017) Determinants of Internet skills, uses and outcomes: a systematic review of the second- and third-level digital divide. Telemat Inform 34(8):1607–1624
Schneider H, Eiband M, Ullrich D et al (2018) Empowerment in HCI—a survey and framework. In: Proceedings of the 2018 CHI conference on human factors in computing systems—CHI 2018, pp 1–14

Schuler D, Namioka A (1993) Participatory design: principles and practices. Lawrence Erlbaum Associated, Hillsdale, NJ
Settersten RA (2003) Invitation to the life course: toward new understandings of later life. Baywood Publishing Company, Amityville, NY
Shilton K (2018) Values and ethics in human-computer interaction. Found Trends Hum-Comput Interact 12(2):107–171
Suchman LA (1987) Plans and situated actions. Cambridge University Press, Cambridge, UK
United Nations, Department of Economic and Social Affairs, Population Division (2017) World Population Ageing 2017
Vines J, Pritchard G, Wright P et al (2015) An age-old problem: examining the discourses of ageing in HCI and strategies for future research. ACM Trans Comput-Hum Interact 22(1):1–27
Wu AY, Munteanu C (2018) Understanding older users' acceptance of wearable interfaces for sensor-based fall risk assessment. In: Proceedings of the 2018 CHI conference on human factors in computing systems, p 119:13
Yuan CW, Hanrahan BV, Rosson MB et al (2018) Coming of old age: understanding older adults' engagement and needs in coproduction activities for healthy ageing. Behav Inf Technol 37(3):232–246

Sergio Sayago (Ph.D., Human-Computer Interaction/Computer Science, Universitat Pompeu Fabra, Barcelona) has been conducting HCI research with older people since 2004. He has conducted long-term ethnographic, participant observation and co-design studies of real-life web accessibility (WCAG) and technology use, mostly communication and digital games, in different cultural settings. His current research focuses on long-term empowerment and democratization, addressing making, programming, and (embodied) conversational interfaces, with older and adult people with low levels of formal education.

Part II
Design

Chapter 2
Creating Technologies with People Who have Dementia

Arlene J. Astell

2.1 Introduction

Dementia is a syndrome that has multiple causes, each of which produces different challenges for the individual but all of which are characterised by irreversible brain damage and progressive worsening over time. As age is the greatest risk factor for developing dementia (Prince et al. 2015) increasing life expectancy means the number of people with dementia is rising rapidly. Worldwide in 2015, 46 million people were estimated to have dementia, predicted to rise to 74.7 million by 2030 and 131.5 million by 2050, with the fastest rate of growth in low- and middle-income countries (Prince et al. 2015). There are currently no disease-modifying therapies for dementia, i.e., no medication that can stop or reverse the disease process (Mehta et al. 2017). In the past 15 years alone, over 400 drug trials have failed to deliver (Bennet 2018).

Over the course of dementia, people experience progressive decline in their cognitive abilities such as memory, attention, executive functions and aspects of language. These cognitive abilities support all aspects of our behaviour and as such their gradual erosion undermines the skills that allow people to look after themselves. For example, impaired executive functions can interfere with an individual's ability to plan, initiate and monitor activities such as shopping, cooking, route planning and driving. In some types of dementia, it is the behavioural changes that are most

A. J. Astell (✉)
Department of Occupational Sciences and Occupational Therapy, University of Toronto, Toronto, Canada
e-mail: arlene.astell@utoronto.ca

A. J. Astell
Department of Psychiatry,
University of Toronto, Toronto, Canada

A. J. Astell
School of Psychology and Clinical Language Sciences, University of Reading, Reading, UK

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_2

noticeable. These cognitive and behavioural changes unsurprisingly interfere with an individual's independence and autonomy, and they increasingly turn to other people for support, primarily family members (Prince et al. 2016). In the UK, recent estimates value the unpaid support provided by families at approximately £17.4bn per annum, accounting for two-thirds of the total estimated cost of dementia of £26.3bn, which includes loss of productivity from family members giving up work to look after a relative, (Prince et al. 2015). In the US in 2016, 18.2 billion hours of unpaid support were provided to people with dementia, valued at $230.1 billion (Alzheimer's Association 2017). Worldwide, the total global estimated cost of dementia in 2015 was US$818 billion, predicted to rise to one trillion US dollars by 2018, equivalent to the 18th largest economy in the world (Prince et al. 2015).

The growing numbers of people living with dementia puts the current model under the spotlight as more countries around the world look for ways to respond. The rising costs, mounting pressures on healthcare systems and lack of medications suggest we need new approaches to dementia.

2.2 Current Context

At present dementia is primarily viewed through a clinical-lens, i.e., that dementia is a clinical issue and thus requires clinically-based responses. This has pros and cons for individuals who have dementia. The major benefit is a diagnosis, a label which provides an explanation for the changes in cognition and behaviour that a person is experiencing. Knowing that these changes have a cause (neurological disorder) and a name (dementia or Alzheimer's disease for example) brings relief to individuals and their families (Dubois et al. 2016). In addition, a diagnosis can help people to access services and clarify their wishes for the future. However, the majority of people with dementia across the world do not have a diagnosis as recent estimates suggest that only 20–50% of cases are documented in high-income countries, with a much lower percentage in low-to middle-income countries, which have far fewer resources and specialized services (Prince et al. 2015). Other barriers to receiving a diagnosis include "stigma, suicide risk, lack of training, diagnostic uncertainty…and the reluctance of healthcare providers to make a diagnosis when no effective disease-modifying options are available" (Dubois et al. 2016, p. 617).

This latter point is especially telling as many countries are currently focusing their public health efforts on increasing diagnostic (memory clinic) services. For most people, a medical diagnosis is usually accompanied by some form of medical treatment. In dementia there are very few options available for healthcare providers, especially for the less common types of dementia. As stated above, there are no drugs to reverse or cure any type of dementia. The only available medications—acetylcholinesterase (AcHe) inhibitors—target Alzheimer's disease, aim to bring symptomatic relief, benefit approximately 50% of people, have only modest impacts (small gains in cognition or activities of daily life or no change), which last for a short (up to 12 months) period of time (Wattmo et al. 2012). There are no medications specifically for the other causes of dementia although people with vascular dementia may be offered drugs that target cardiovascular risk factors, such as high blood, pressure, high cholesterol and blood clotting.

In the absence of medication there is also a lack of nonpharmacological interventions. In the UK, the National Institute of Health and Clinical Excellence (NICE) recommends that people be offered group cognitive stimulation therapy (CST) and additionally, group reminiscence and cognitive rehabilitation “be considered” (https://www.nice.org.uk/guidance/ng97/chapter/Recommendations#interventions-to-promote-cognition-independence-and-wellbeing). The most common version of CST lasts for 14 sessions and is offered shortly after diagnosis. This leaves people with dementia to manage as best they can, often over many years, with little or no input from health services, except for dealing with comorbid health conditions or when crises occur.

What is missing are practical solutions to enable people to live day to day with dementia. This means being able to continue with their daily activities for as long as possible and to minimise or delay placing demands on their families or formal services. To achieve these aims, we need to work with people who are living with dementia to identify the things they wish to keep doing and co-create solutions that work for them, in a similar way to efforts for empowering people with developmental conditions such as autism spectrum disorders (Huijnen et al. 2017) or Down’s syndrome (Augusto et al. 2016). A recent scoping review (Lindqvist et al. 2016) identified several factors important to people living with dementia in relation to activities they want to keep doing. These include activities that convey social values and wellbeing through staying connected to friends or social activities such as dancing or other hobbies; activities that support significant roles such as being a good host or a sociable person; activities that reduce demands on others to avoid being a burden; and activities that increase health and safety, such as getting around safely in the local environs (Lindqvist et al. 2016). However, another recent study found that 99% of people living at home with dementia had at least one or more unmet needs, including managing other health conditions, safety at home and outdoors, opportunities for meaningful activities, and assistance with day to day activities (Black et al. 2013). As such there is huge potential for developing new approaches to empower people to live well with dementia.

2.3 Technology for Dementia

Technology has the potential to bring about the required step-change in how we think about and approach dementia. This means expanding our view beyond dementia as a clinical condition limited to what medical services can offer. People who are living with dementia must be valued as fellow citizens, whose needs, wishes and desires are as important as everyone else’s, not dehumanized as a list of symptoms or problems that have to be solved. For too long the bulk of technology developments have been doing things ‘to’ or ‘for’ people who have dementia (Astell 2006). Most technology solutions have focused on the issues prioritised by caregivers, particularly safety and security. For example, the use of wearable sensors to track people with dementia in and out of the home (Landau and Werner 2012) or installation of sensors in their homes to monitor their behaviour (Karakosta et al. 2015). While outdoor navigation and safe use of appliances are a concern for many people who have dementia, these specific issues have been the focus of much technology development as they are frequently the aspects of supporting a relative with dementia that families find most challenging. As such, much technology development to date has focused more on meeting the needs and wishes of family caregivers, or organisations, and working with them, than with the individuals who have dementia.

Whilst these efforts are usually well-intentioned, they often present ethical issues relating to decision-making, privacy, data sharing, etc., (see for example discussion of the use Robotic carers with people with dementia: Felzmann et al. 2015; and GPS tagging of people with dementia: Landau and Werner 2012). Working primarily with caregivers also reflects a paternalistic approach to people living with dementia. This stems from the prevalent ‘deficit’ model of dementia whereby people with dementia are considered less able to participate than other members of society due to the changes they experience in their cognitive and behavioural abilities. Caregivers on the other hand are able to articulate their needs and concerns. This results in many projects focusing on caregiver needs, in part because they are perceived as ‘easier’ to work with. In addition, there has been a long-tradition of treating family members as proxies for people with dementia. However, the extensive literature on family caregivers clearly demonstrates they have their own, separate needs, wishes and desires. Whilst these may overlap with those of their relatives with dementia, these must be approached as two separate sets of user requirements. Additionally, formal caregivers have a third set of needs in relation to dementia.

The negative perception and low expectations of people with dementia are very powerful and can be found everywhere in the copious descriptions of what people are unable to do, their limitations and inabilities relative to people who do not have dementia. The consequence is that people with dementia are continuously excessively disabled by the attitudes and reactions of other people and the environment in which they operate (Astell 2013). This means that they are frequently not included in decisions, have interventions secreted (e.g. sewing sensors into their clothing) or imposed (e.g. disabling the cooker) on them and are treated as objects to be ‘managed’.

Unsurprisingly, it is still very unusual for people with dementia to be included in research projects or development of technologies in their own right. This situation is not unique to dementia, as other commentators have pointed out similar attitudes in development of technologies to ‘disadvantaged’ populations in general (Rogers and Marsden 2013). Rogers and Marsden (2013) named this the “rhetoric of compassion”, which they argue has dominated the HCI field in respect of groups deemed to “need help”, including people living with dementia, and those with vision loss, mobility challenges, and developmental delays. To address this rhetoric, Rogers and Marsden propose a “hand-over” (p. 54) model that extends user-centred and participatory design methods to ones that empower people to be fully engaged at all stages of the process.

To achieve this demands that we stop thinking in terms of "deficit and compensation", especially in respect of ageing and people with age-related changes, which has traditionally been framed as "a problem that can be managed by technology" (Vines et al. 2015, p. 39:1). As indicated above, the 'managing a problem' focus tends to reflect the views of people—service providers or family caregivers—who are actually articulating their own problems or priorities. Moving away from this dominance creates some very interesting design challenges for people living with dementia as they undoubtedly experience decline in abilities compared to previous levels of functioning. However, people with dementia cannot only participate as partners in research (Astell et al. 2009, 2014), they are developing their own solutions to enable them to live as well as possible with dementia. For example, at a recent public event I hosted looking at the functionality of current smart devices, one of the attendees with dementia spontaneously demonstrated the apps he uses on his smartphone and how the utilises the calendar function to carry out all activities and appointments he has planned.

As this example indicates there are existing devices and functionality that could benefit people with dementia right now. To be successfully applied and adopted, we need to recognise and address the cognitive-behavioural aspects of everyday life where people with dementia could benefit. That is, we need responses that not only recognise the cognitive-behavioural components of each of the dementia subtypes—which are differentiated by their cognitive and/or behavioural features—but can compensate for or mitigate the impairments associated with them to provide a way for people to keep carrying out desired and meaningful activities. This means understanding the cognitive and behavioural elements of activities people wish to continue and providing interventions to enable people to keep carrying them out (Astell 2015). As indicated above, current mainstream technology can support cognitive functions such as memory and activity planning, as well as communication, entertainment and enjoyable pastimes. Some of these devices, such as touchscreens (Joddrell and Astell 2016) and motion-detection systems (Dove and Astell 2017a) have already been shown to have applications for people with dementia. These benefits could be massively extended to reach more people with dementia and more aspects of their lives, if we look at their wants, needs and desires as collections of cognitive and behavioural challenges in need of creative solutions.

2.4 Reconceptualising Dementia

The first key point to changing our understanding of dementia is to comprehend that dementia is not a single entity. There are multiple causes of dementia and each of these are characterised by different effects on cognitive and behavioural function. As such people with different types of dementia can be expected to face different difficulties and require different solutions to empower them. In addition, each type of dementia leaves different aspects of cognition and behaviour relatively unaffected, and these can be leveraged to develop targeted support.

The most recent edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-V; American Psychiatric Association 2013), uses the term 'Neurocognitive Disorders' (NCD) rather than dementia, to refer to a range of conditions including delirium, Mild Cognitive Impairment (MCI) and what was previously called dementia. The DSM-5 identifies six domains of cognitive function: executive function, learning and memory, complex attention, language, perceptual-motor, and social cognition, with different profiles of impairment corresponding to the different aetiologies of the condition (Sachdev et al. 2014). In the DSM-5 a distinction is made between mild or major levels of severity where major NCD is characterised by the cognitive impairment interfering with a person's daily functioning. DSM-V includes 10 different specific causes: Alzheimer's disease, Frontotemporal lobar degeneration, Lewy body disease, Vascular disease, Traumatic brain injury, Substance/medication use, HIV infection, Prion disease, Parkinson's disease, Huntington's disease, another medical condition, Multiple aetiologies, or Unspecified where there is no obvious cause (see Table 2.1 for main types with the major cognitive and other changes).

Estimating global prevalence of different dementia subtypes is challenging due to lack of consistency in diagnostic criteria, differences in mean population ageing and global variations in education and vascular risk factors (Rizzi et al. 2014). However, it is accepted that the most common cause of dementia is Alzheimer's disease (AD) which is thought to account for approximately 60% of cases (Rizz et al. 2014), although estimates vary considerably. Vascular dementia is associated with stroke or another acute event and accounts for about one-fifth of cases of dementia (Rizzi et al. 2014). However, these numbers are estimates as a considerable number of people experience cognitive challenges associated with both AD and VaD, so-called mixed dementia.

Among the less common dementia types are Dementia with Lewy Bodies (DLB) and Fronto-temporal Dementia (FTD), which commonly occur in people under 65 years of age. There are three subtypes of Frontotemporal dementia that all affect language—non-fluent aphasia, semantic dementia and logopenic aphasia, known as Primary Progressive Aphasias (Onyike and Diehl-Schmid 2013). Difficulty with speech severely limits social interactions in all sorts of situations from the workplace (PPA primarily affects people between 45 and 65 years), public transport, shopping, socialising and personal relationships. Unsurprisingly, individuals with Primary Progressive Aphasia commonly report depression, including loss of interest and social withdrawal (Medina and Weintraub 2007) as well as other behavioural changes such as irritability and apathy (Moddirousta et al. 2013). Posterior Cortical Atrophy (PCA) or Benson's syndrome (Benson et al. 1988) is another uncommon type of dementia that occurs most often in people between 50 and 65 years of age. PCA is thought to be a variant of Alzheimer's disease, although other underlying causes have been found in some people (Crutch et al. 2012). PCA has a distinct cognitive profile of impaired visual processing that includes difficulties judging distances, distinguishing between moving objects and stationary objects, reading a line of text, disorientation, and difficulty identifying and using common tools or objects. People with PCA have relatively well-preserved long-term memory and insight into their condition at least at the early stages (Crutch et al. 2012).

Table 2.1 DSM-V (2013) Main causes of neurocognitive disorders

DSM neurocognitive disorder		Cognitive features	May also occur
Alzheimer's		Progressive decline in learning and memory and at least one other cognitive domain, often executive function	Depression, apathy
Vascular		Decline in complex attention, executive function	Personality and mood changes, lack of initiative, depression, and emotional lability
Frontotemporal—frontal type		Disinhibition	Major behavioural changes—apathy, inertia, loss of empathy, stereotyped or ritualistic behaviour, dietary changes
Frontotemporal—primary progressive aphasia	Nonfluent /agrammatic	Effortful, dysfluent, agrammatical speech	Depression, anxiety, agitation, apathy, irritability
	Semantic	Impaired single word comprehension	
	Logopenic	Impaired word finding and production	
Lewy body		Fluctuating cognition, attention and alertness	Visual hallucinations, REM sleep disorder, Parkinsonian movement disorder (later)
Parkinson's disease		Changes in memory, concentration and judgment Trouble interpreting visual information Muffled speech	Apathy, mood disturbances, psychotic symptoms, personality changes and sleep problems

The patterns of cognitive impairment do not just differ across dementia subtypes, they also change over time, with some aspects of function affected early and others preserved far into the disease process. Understanding the likely patterns of change over time and the ways different cognitive domains are affected is another critical element for thinking about ways in which technology can be helpful for people with dementia. Understanding the cognitive challenges and how these change over time is also crucial for developing efficient and appropriate strategies for approaching and working alongside people with dementia as experts in their condition.

2.5 Creating Digital Solutions

Given the lack of current interventions and the growing numbers of people with dementia, both the opportunity and need for new approaches are huge. For those people new to this area or with technologies developed for other populations, Table 2.1 should provide inspiration for 'things' that could be beneficial. The need for new things (devices, services, apps) spans all dementia types, with each making a compelling case for innovative solutions. Alzheimer's disease because of the sheer numbers but also PPA or PCA, for example, which affect fewer people, but those people are younger, usually working and often with children or other responsibilities.

In addition to creative thinking, developing effective technologies needs to take the cognitive and behavioural aspects of dementia into account, both in terms of thinking about what a digital solution could look like as well as for establishing a co-creation model with people with dementia. A number of recommendations for working collaboratively with people who have dementia (and their caregivers) can be found in a reflective article myself and colleagues wrote based on our experience over two projects using touchscreen devices (Astell et al. 2009). For people new to the field I would also add the MAREP PARTNERs guidelines[1] for engaging people with dementia in technology creation.

Additionally, in 2009 I also proposed the REAFF framework (see Table 2.2) to highlight key issues to consider in approaching development of technologies for people with dementia. The four REAFF—Responding, Enabling, Augmenting and Failure-Free—principles are intended to encourage thinking about the intended technology user and what they need. To these, based on further experience, I now add priorities, context and accessibility.

Priorities. As indicated above, much technology development to date has reflected the priorities of caregivers who tend to focus on the challenges they experience. Less is known about the priorities, needs and wishes of people with dementia, particularly when their dementia is past the early stages. Identifying their priorities aligns with the current or third wave of HCI, which embraces experience and meaning-making of the technology user(s) (Bødker 2015). User Experience (UX) has emerged as central to the design process, which requires an understanding of the individual's motivation

[1] https://uwaterloo.ca/murray-alzheimer-research-and-education-program/sites/ca.murray-alzheimer-research-and-education-program/files/uploads/files/partners_guide_1.pdf.

Table 2.2 REAFF framework

Principle	Definition
Responding	Technological solution must be responsive to the needs of people with dementia
Enabling	Technological solutions must enhance the life of the person with dementia and not disable them in any way
Augmenting	Technological solutions must build on and extend the retained abilities and skills of people with dementia
Failure-free	Technological solutions must be intuitive and accessible and not undermine the confidence of a person with dementia

to use a product (Hassenzahl 2011). For too long, there has been a strong belief that people with dementia are unable to convey their priorities and motivations, hence the reliance on caregiver's views. To examine this issue, we recruited eight couples comprising one person with dementia and their partner who lived at home together. Each couple was asked to keep a two-week log of their daily activities. From these logs we asked the individuals with dementia to select one activity that was important to them to be able to keep doing. Six couples completed the log and from these variously prioritised: independently using the television and digital programming remote controls (2 individuals), using a digital camera, taking medication, preparing a meal and hanging out laundry.

All of these activities are fairly commonplace and the sorts of activities one takes for granted in daily life. They illustrate the proposal that people with dementia prioritise activities that maintain their identity and previous roles in the family or home (Lindqvist et al. 2016). However, because they are fairly routine activities, little attention has been paid to understanding their component parts and why they might become challenging for people with dementia. One exception is Wherton and Monk's (2010) very elegant analysis of the difficulties people with dementia face carrying out activities in the kitchen. They developed a framework based on the Action Coding System (Schwartz et al. 1991, 1995) to break down the individual steps of the tasks. This approach produced insightful and illuminating descriptions of the exact difficulties people with dementia face. Whilst this approach produced very useful information, it is labour intensive and highly individualised, limiting its scalability, but definitely recommended reading for people interested in supporting home-based activities.

At this time, innovative solutions that reflect the priorities of people with dementia are starting to emerge. One example is Read Clear—http://www.readclear.co.uk—a free-to-download app developed by the Cortical Posterior Atrophy Group at University College London, with people with PCA, to enable them to read books and news items. This was created specifically to address the challenges reported by people with PCA and their desire to keep reading, another routine activity that we take for granted from an early age. Understanding what is important to people with dementia and their priorities for their everyday lives are crucial for developing technologies that they will want to use. This can be seen through work within the ‘maker movement’ in HCI (Bardzell et al. 2017), which emphasises empowerment through making. Elegant illustrations include of people with dementia creating and sharing art work (Lazar et al. 2016) and making music (Müller-Rakow and Flechtner 2017).

2.5.1 Context

In addition to their priorities, another crucial aspect for developing successful interventions with people who have dementia is to understand the context in which people operate. Context includes their home, the physical environment they interact with, including shops, banks, transport, etc., and their social environment, including family, friends and other important relationships. A common response to questions about implementing and maintaining technology with people who have dementia, for example, “how will they remember the login?” “will they keep it charged?” “will they remember to take it with them?” is that “the caregiver will do it!” This not only presumes the presence of at least one or more people in a caregiving role, it reveals that the technology is not really for people with dementia.

Context is central to UX but can be difficult to operationalize, particularly since the rise of mobile devices which has transformed how we operate in the world (Holtzblatt and Beyer 2017). Designing technologies that both support human activities and fulfil their motives requires techniques that can delineate a structured way of gathering (and analyzing) contextual data for interaction purposes and conveying contextual information in a useful way for interaction designers (Holtzblatt and Beyer 2017). When working with people who have dementia, this requires a focus on the way they interact within their environment and the people and objects within it. For example, we started developing CIRCA (Computer Interactive Reminiscence and Conversation Aid: Alm et al. 2004) at the suggestion of a care home manager who was concerned that families reduced the number and duration of visits to her residents as they “could not have a conversation”. The problem was initially characterised by caregivers as an inability of people with dementia to communicate efficiently. However, when the team examined the conversation context it was clear that one specific aspect of cognition—working memory—was causing the communication breakdown. Essentially working memory allows you to keep in mind what is being said long enough to process it. People with Alzheimer’s disease have a working memory difficulty and so they struggle to answer direct questions, such as “what did you have for your lunch today?” “did you see the doctor?” To support conversations CIRCA circumvented the working memory problem through a multimedia database presented on a touchscreen, with whatever was on the screen as the current topic. Working with people who have dementia using paper prototypes, wireframe mock-ups and physical objects, we iteratively developed a touchscreen interface for them to access photographs, videos and music. CIRCA was designed so that there is no need for people to remember what was previously discussed or keep track of conversational turns and this positively improved relationships and caregiver's perceptions of people with dementia (Astell et al. 2010).

2.5.2 *Accessibility*

As already demonstrated currently available technology can be useful to people with dementia if they know about it and how to access it—no small barrier for many people. Over the past five years my research group has hosted a number of public interactive technology workshops which includes Technology Interaction—an activity where people get to try existing technologies in their original packaging. At these workshops across the UK and Canada with different populations (i.e. not just people living with dementia), similar issues come up time and again in relation to accessing existing technology. These encompass specialised assistive devices as well as off-the-shelf items that could be beneficial. Key feedback includes lack of knowledge about available technologies (including apps, devices and web-based services) and where and how to access them (i.e., through doctor, pharmacy, electronics store, on-line, etc.); lack of opportunity to try out technologies before making purchase decisions; and lack of personal experience or skills or lack of available/accessible support to set things up and learn how to use them. These findings cut across all groups of technology users including older adults with and without age-related challenges, people of any age with vision, hearing or mobility loss and many frontline staff in services supporting these user groups.

Accessibility also includes the features of any device or application either existing or being created. Since 2010 we have been working with people with dementia in the Netherlands, UK and Canada to identify accessibility features of apps and tablets (Groenewoud et al. 2017; Joddrell and Astell 2017). This includes features of tablets that help or hinder users with dementia, such as passcodes, system updates, need to have an online account to download apps, and keeping the device charged. We have also created an app accessibility framework to test existing apps for their suitability for people with dementia (Joddrell et al. 2016). So far this has focused on gaming apps that people with dementia would like to play, including digital versions of familiar games (Astell et al. 2016). The framework addresses issues including modes of interaction of the game, app settings, design, customisation and age-appropriateness. Working with people with dementia we developed a website for people to search for games they would like to play based on our recommendations using the app evaluation framework (https://www.actodementia.com).

We also worked with two game studios to modify their existing apps to make them more accessible for people with dementia (Joddrell and Astell 2017). Based on our observations of people with dementia playing a familiar game (Solitaire; Mobilityware) and an unfamiliar game (Bubble XplodeTM; Spooky House studio) we identified where certain features of the app were hindering people with dementia or where additional features could be added to aid them. One of the studios, Mobility Ware, launched version 4.10 of their Solitaire app on 9th November 2016 with the notice “After working with a University in England we have added accessibility features for people with dementia” (Joddrell 2017).

As already mentioned, another aspect of accessibility relates to learning how to use technology. This applies to projects where new technologies are being created as much as when adopting existing ones. Out of the box most devices require some practice and time to be able to use them efficiently, irrespective of whether the user has dementia. To advance knowledge about this aspect of accessibility we have been working with people with dementia to look at how to empower them to use motion-based technology (MBT; Dove and Astell 2017b). From a review of the literature we identified multiple examples of motion-based technologies being used with people who have dementia. The review confirmed that people with dementia are able to learn to use MBT and these have been used for cognitive, physical and leisure activities (Dove and Astell 2017a). However, we also identified a major lack of information about how to introduce train, and support people with dementia to use MBT.

To address this, we conducted a participant observation at a local specialised day program that used an Xbox 360 Kinect once a week as part of their weekly group activities (Dove and Astell 2017b). The participants included 23 older adults with complex needs including 16 with dementia. Through 20 weekly observations of approximately one hour each we identified the strategies the day program staff and volunteers used to introduce games to the clients, train them to play and support them to take their turns (Fig. 2.1). These included breaking the movements down into steps, verbal prompts and encouragement (Dove and Astell 2017b). Based on our observations and literature review, we then developed a 24-session group Kinect bowling activity and tested this in another adult day program for people with dementia. Eleven people played together as a group for one hour twice a week for 12 weeks (Dove and Astell 2018). We found that task breakdown, verbal prompts and encouragement enabled the participants to learn to play and the activity became so popular that the day program purchased an Xbox at the end of the project and continue to bowl twice a week.

2.6 Conclusions

There is a need for practical, affordable and scalable solutions to empower people to live as well as possible with dementia. To achieve this requires that we embrace dementia as a set of complex and challenging puzzles that require out of the box thinking. For example, working with people who have dementia to create their own technologies. We also need to apply creative techniques to ensure their motivations and contexts are fully appreciated, such as those employed by Rodgers (2018). Given that the different types of dementia can disrupt functioning in different ways, one approach is to focus not on the dementia as the starting point but instead to consider the activities people carry out and de-construct them into their component parts (Astell 2015). Linking these components to the specific cognitive processes and behaviours needed to carry them out should facilitate the development of interventions appropriate to different types of dementia that maximize spared abilities

Fig. 2.1 Accessing motion-based technology

while minimizing impaired ones, i.e., creating ‘cognitive prostheses’. This is particularly important for ensuring that engineering and ICT solutions take full account of cognitive and behavioural needs of all people with dementia. This approach should also facilitate more rapid development of interventions for less common dementia subtypes. In terms of the five temporal lenses of participatory design (Saad-Sulonen et al. 2018), working with people who have dementia is invariably phasic, retrospective, prospective and long-term but most importantly it is emergent, “an in the moment, continuously unfolding phenomenon entangled with other ongoing activities” (Saad-Sulonen et al. 2018, p. 2).

References

Alm N, Astell A, Ellis M, Dye et al (2004) A cognitive prosthesis and communication support for people with dementia. Neuropsychol Rehabil 14(1–2):117–134

Alzheimer’s Association (2017) 2017 Alzheimer’s disease facts and figures. Alzheimer’s Association, Chicago, USA

American Psychiatric Association (2013) Diagnostic and statistical manual of mental disorders, 5th edn

Astell AJ (2006) Technology and personhood in dementia. Qual Ageing Older Adults 7(1):15–25

Astell AJ (2009) REAFF—a framework for developing technology to address the needs of people with dementia. In: Proceedings of first international workshop RSW-2009, Cambridge, UK, 5 September 2009. CEUR Workshop Proceedings, pp 5–10. ISSN 1613-0073

Astell AJ (2013) Technology and fun for a happy old age. In: Sixsmith A, Gutman G (eds) Technology for active aging. Springer Science, 169–187

Astell AJ (2015) Supporting a good life with dementia. In Prendergast D, Garattini C (eds) Ageing and the digital life course. Berghahn Books, New York, pp X–Y

Astell AJ, Alm N, Gowans G et al (2009) Involving older people with dementia and their carers in designing computer-based support systems: some methodological considerations. Univ Access Inf Soc 8(1):49–59
Astell AJ, Ellis MP, Bernardi L et al (2010) Using a touch screen computer to support relationships between people with dementia and caregivers. Interact Comput 22(4):267–275
Astell AJ, Malone B, Williams G et al (2014) Leveraging everyday technology for people living with dementia: a case study. J Assist Technol 8(4):164–176
Astell AJ, Joddrell P, Groenewoud H et al (2016) Does familiarity affect the enjoyment of touchscreen games for people with dementia? Int J Med Informatics 91:e1–e8
Augusto JC, Kramer D, Alegre U et al (2016) Co-creation of smart technology with (and for) people with special needs. In Conference: 7th internal conference on software development and technologies for enhancing accessibility and fighting info-exclusion, Vila Real, Portugal, December 2016, p X
Bardzell J, Bardzell S, Lin C et al (2017) HCI's making agendas. Found Trends® Hum–Comput Interact 11(3):126– 200. https://doi.org/10.1561/1100000066
Bennet DM (2018) Lack of benefit with idalopirdine for Alzheimer disease. JAMA 319(2):123–125
Benson DF, Davis J, Snyder BD (1988) Posterior cortical atrophy. Arch Neurol 45(7):789–793. https://doi.org/10.1001/archneur.1988.00520310107024
Black BS, Johnston D, Rabins PV et al (2013). Unmet needs of community-residing persons with dementia and their informal caregivers: findings from the maximizing independence at home study. J Am Geriatr Soc 61(12):2087–2095
Bødker S (2015) Third-wave HCI, 10 years later—participation and sharing. Interactions 22(5):24–31
Crutch SJ, Lehmann M, Schott JM et al (2012) Posterior cortical atrophy. Lancet Neurol 11(2):170–178. https://doi.org/10.1016/S1474-4422(11)70289-7
Dove E, Astell AJ (2017a) The use of motion-based technology for people living with dementia or mild cognitive impairment: literature review. J Med Internet Res 19(1):e3
Dove E, Astell AJ (2017b) The Kinect project: group motion-based gaming for people living with dementia. Dementia, published online 1st December 2017
Dove E, Astell AJ (2018) Kinecting through group digital games. J Dement Care 26(1):18–19
Dubois B, Padovani A, Scheltens (2015) Timely diagnosis for Alzheimer's disease: a literature review on benefits and challenges. J Alzheimer's Dis 49(3):617–631. https://doi.org/10.3233/JAD-150692
Felzmann H, Beyan O, Murphy K, Casey D et al (2015) Robot-assisted care for elderly with dementia: is there a potential for genuine end-user empowerment? The Emerging Policy and Ethics of Human-Robot Interaction, Portland OR. March 2nd
Groenewoud H, de Lange J, Schikhof Y et al (2017) Experiences of people with dementia playing casual games on a tablet. Gerontechnology 16(1):37–47
Hassenzahl M (2011) User experience and experience design. Experience Design: Technology for all the right reasons. http://www.interactiondesign.org/printerfriendly/encyclopedia/user_experience_and_experience_design.html
Holtzblatt K, Beyer H (2017) Contextual design. Design for life, 2nd edn. Morgan Kaufmann, Cambridge, MA
Huijnens CAGJ, Lexis MAS, Jansens R et al (2017) How to implement robots in interventions for children with autism? A co-creation study involving people with autism, parents and professionals. J Autism Dev Disord 47(10):3079–3096
Joddrell P (2017) Investigating the potential of touchscreen technology to create opportunities for independent activity with people living with dementia. Unpublished thesis
Joddrell P, Astell AJ (2016) The use of touchscreen technology with people living with dementia: a review of the literature. JMIR Rehabil Assist Technol (JRAT) 3(6):e10
Joddrell P, Astell A (2017) ActoDementia: implementing accessibility options for dementia in existing touchscreen apps. Alzheimer's Dement: J Alzheimer's Assoc 13(7):162–163

Joddrell P, Astell AJ, Hernandez A (2016) Identifying existing, accessible touchscreen games for people living with dementia. In: Meisenberger K, Buhler C, Penaz, P (eds) Computers helping people with special needs. Lecture notes in computer science, vol 9758. Springer, Heidelberg, pp 509–514

Karakostas A, Lazarou I, Meditskos G et al (2015) Sensor-based in-home monitoring of people with dementia using remote web technologies. In 2015 International conference on interactive communication technologies and learning (IMCL). https://doi.org/10.1109/imctl.2015.7359618

Landau R, Werner S (2012) Ethical aspects of using GPS for tracking people with dementia: recommendations for practice. Int Psychogeriatr 24(3):358–366

Lazar A, Cornejo R, Edasis C et al (2016) Designing for the third hand: empowering older adults with cognitive impairments through creating and sharing. DIS 2016, Proceedings of the 2016 ACM Conference on Designing Interactive Systems, 1047–1058

Lindqvist E, Persson Vasiliou A, Astell A et al (2016) Activities people with mild cognitive impairments want to master—a scoping review. Br J Occup Ther 79(7):399–408

Medina J, Weintraub S (2007) Depression in primary progressive aphasia. J Geriatr Psychiatry Neurol 20(3):153–160

Mehta D, Jackson R, Paul G et al (2017) Why do trials for Alzheimer's disease drugs keep failing? A discontinued drug perspective for 2010–2015. Expert Opin Investig Drugs 26(2):735–739

Moddirousta M, Price BH, Dickerson BC (2013) Neuropsychiatric symptoms in primary progressive aphasia: phenomenology, pathophysiology, and approach to assessment and treatment. Neurodegener Dis Manag 3(2):133–146

Müller-Rakow A, Flechtner R (2017) Designing interactive music systems with and for people with dementia. Des J 20(Suppl 1):S2207–S2214. https://doi.org/10.1080/14606925.2017.1352736

Onyike CU, Diehl-Schmid J (2013) The epidemiology of frontotemporal dementia. Int Rev Psychiatry (Abingdon, Engl) 25(2):130–137

Prince M, Wimo A, Guerchet M et al (2015) World Alzheimer's report 2015: the global impact of dementia. Alzheimer's Disease International (ADI), London, UK

Prince M, Comas-Herrera A, Knapp M et al (2016) World Alzheimer report 2016: improving healthcare for people living with dementia. Alzheimer's

Rizzi L, Rosset I, Roriz-Cruz M (2014). Global epidemiology of dementia: Alzheimer's and vascular types. BioMed Res Int 2014, Article ID 908915, 8 p

Rodgers PA (2018) Co-designing with people living with dementia. Codesign 14(3):188–202

Rogers Y, Marsden G (2013) Does he take sugar? Moving beyond the rhetoric of compassion. Interactions 1–48. https://doi.org/10.1145/2486227.2486238

Saad-Sulonen J, Eriksson E, Halskov K et al (2018) Unfolding participation over time in the design of IT. CoDesign 14(1):1–3. https://doi.org/10.1080/15710882.2018.1426981

Sachdev PS, Blacker D, Blazer DG et al (2014) Classifying cognitive disorders: the DSM-5 approach. Nat Rev Neurol 10:634–642

Schwartz MF, Reed ES, Montgomery M (1991) The quantitative description of action disorganisation after brain damage: a case study. Cogn Neuropsychol 8(5):381–414

Schwartz MF, Montgomery MW, Fitzpatrick-DeSalme EJ et al (1995) Analysis of a disorder of everyday action. Cogn Neuropsychol 12(8):863–892

Vines J, Pritchard G, Wright P et al (2015) An age old problem: examining the discourses of ageing in HCI and strategies for future research. ACM Trans Comput Hum Interact (TOCHI) 22(1):2

Wattmo CM, Wallin AK, Minthon L (2012) Functional response to cholinesterase inhibitor therapy in a naturalistic disease cohort. BMC Neurol 12:134

Wherton JP, Monk AF (2010) Problems people with dementia have with kitchen tasks: the challenge for pervasive computing. Interact Comput 22(4):253–266

Arlene Astell has almost 20 years of experience partnering with people who have dementia to create technologies they can and want to use. Following her doctoral work at the University of

Warwick examined the impact of dementia on speech and communication, she qualified as a Chartered Clinical Psychologist and her career to date has centred on empowering people to live and age as well as possible through research and innovation.

Chapter 3
The Role of Designers in the Development and Communication of New Technology

Yvonne Eriksson and Marie Sjölinder

3.1 Introduction

A woman around 80 years old is busily exploring an iPad in a crowded Apple Store in Brussels. A group of young men looks on intensely, observing as she navigates in and out of different apps. In another part of the store, people wait their turn to connect their iPhones to a huge screen on the wall, which blows up their games and pictures to extra-large proportions. The group of people occupied by this activity is between 20 and 80 years old. What we witness here is that age does not govern interest in technology. After all, the majority of people connecting their iPhones to the screen were women in their seventies.

This example elucidates the fact that we are now facing the first generation of people, who are defined as old, accustomed to this technology. Therefore, a discussion about the *design* of technology that takes into consideration different aspects of ageing without reducing the capacity of the technology itself is needed. The design of new services targeted at older adults needs to take a new approach. It is no longer about reducing content and increasing font size. The design needs to be focused on the service and communication between different stakeholders.

Society often defines a person as old as soon as they have retired, but not all people retire at the same age. It is often one's profession or socioeconomic background that influences their age of retirement. Older adults are not a homogenous group, and the diversity among people increases alongside an increase of age (Östlund 1999). It should also be noted that it is important to adopt a perspective based on the "ageing

Y. Eriksson (✉)
Mälardalen University, Eskilstuna/Västerås, Sweden
e-mail: yvonne.eriksson@mdh.se

M. Sjölinder
RISE SICS, Kista, Sweden
e-mail: marie.sjolinder@ri.se

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_3

body"—which we will all encounter at some point in time—rather than general stereotypes related to the word "old" or "ageing."

There are many assumptions regarding ageing that are deeply rooted in our culture (DeFalco 2009). Stereotypes of older people are prevalent as we continuously seek to define and assign attributes to the people we meet (Cuddy et al. 2005). Stereotypes can vary and are present to different extents. However, a person's relationship with new technology is not an unusual aspect when creating or using stereotypes (Durick et al. 2013). For example, one assumption about older adults is that they are negative about new technology. But this is not supported by research findings. Studies have shown, already in the 1990s, that older adults possess the same attitudes towards new technology as younger adults (Dyck and Smither 1994; Kelly and Charness 1995).

Stereotypes and assumptions about certain groups also affect people's self-image and how they act in different situations. Pre-existing expectations around ageing might affect interest in or ability to use everyday technology. The way we experience technology is related to attitudes and how we are treated and approached by the people around us. It is not unusual for older adults to be treated in a degrading manner; for example, when visiting a store to purchase a technological device. Such prejudice has also been identified in design studies, where design suggestions from young girls and older adults are not taken as seriously as those contributed by other groups of people. As a consequence, these groups' opinions are not taken into consideration during the design process and, instead, the design is based on stereotypes and what the designers deem suitable for them (Oudshoorn et al. 2016). Such treatment may also affect how a group perceives themselves and lead to a self-degrading image in relation to their ability to contribute to a design process or use technology.

In this chapter, we will investigate the role design can play in enhancing the interest in and use of various kinds of technology, such as digital technology. We will discuss how design can hinder people from participating in and using new technology, as well as other contributing aspects, such as socioeconomic conditions, that exclude older people (and even younger people) from being a user of technology. From this perspective, it is also the designer's responsibility to conduct their work in a manner that does not exclude people from certain groups. A larger focus needs to be placed on communication within the design team and with society at large when conveying a message alongside a product or a service. The most important part of the conversation, however, is the one with the users. The designer needs to ensure that users from different socioeconomic backgrounds, and those affected by presuppositions, are involved in the design process, and that their opinions and suggestions are taken into consideration and have an impact on the final product or service.

3.2 Digitalization and the Use of Technology

There is no question that society is affected by digitalization. The following statement was made by the Swedish Digitalization Commission:

"Our current societal development is powered, in addition to digitalisation, by a number of profound social trends such as increasing globalisation, accelerating urbanisation, a growing knowledge society, stronger individualisation and greater diversity and pluralism. This means that we now face a digital transformation that will change nearly everything; what we do, how we do it and what we can done" (SOU 2016:89, 32).

EU institutions recognize digital literacy and Internet access as important factors when it comes to the enjoyment of citizenship rights. This is reflected by the influence that Information and Communication Technologies (ICT) and Internet are already having on many people's private, public, and day-to-day lives. In parallel, with a focus on digitalization, interest is growing around the topic of ageing, and what it may mean for society to have an increased number of older people in Europe. This has influenced research related to older people and technology (Longhurst et al. 2017; Nikou 2015; Turkle 2011; Eriksson 2016). It has also generated a lot of worry related to how older people will manage in future society, since a high degree of digital literacy will be required. But, when it comes to digital literacy and Internet usage, is age the only limiting factor?

It becomes obvious that age does not explain itself the limited use of Internet or ICT, when demographic statistics are compared to statistics showing the proportion of the population that uses the Internet. In European countries, the percentage of the population aged 65–79 is about 14%, and the percentage of those aged 80 and older is about 5% (ec.europa.se). According to European Union Internet User Statistics, 73% of the population in Europe uses the Internet, with the lowest number of users found in Romania where only 44.1% use the Internet, followed by Bulgaria (51%), Greece (53%), Portugal (55.2%), and Cyprus (57.7%). Most European populations have more than 70% Internet usage, while in countries such as Luxembourg, Denmark, and Sweden, over 90% of the population uses the Internet (statisticpbrain.com, 2017). Evidently, age is not the only factor contributing to a lower level of qualifications for technology usage; other factors, such as gender and financial circumstances, may also contribute.

Smartphones provide easy access to the Internet and an array of Internet services. Statistics on smartphone ownership, related to the number of residents in a country, indicate that the devices reach more than 100% of individuals. Many people own more than one smartphone in countries such as Sweden, Netherlands, and the UK, while only about 30% of those living in Ukraine or Poland own a smartphone. This could be compared to the low level of Internet access among people living in countries with a low average economic standard and large socioeconomic disparity. Access to and use of the Internet and smartphones is, above all, a matter of socioeconomic standards. Therefore, to focus on age as a limiting factor is, in many ways, irrelevant. Research indicates that, among students, it has to do with the relationship between socioeconomic status and ICT competence (Aesaert and Braak 2015). These kinds of results are inconsistent, however, because the studies are often based on students' self-reported competencies regarding digital literacy (Ibid.). However, when it comes to investigating how older people assess themselves as being digitally literate or not, this has to be considered—in addition to the economic resources that allow a person to afford the Internet, computer, and/or smartphone. Future society will probably meet the challenges regarding the use of ICT that are, foremost, related to socioeconomic status rather than age, as research indicates.

Currently, much of the discussion regarding digitalization and the development of technology is focused on the technology itself rather than individual and societal needs. In the future, however, the digitalization of society will affect much of our daily lives. Therefore, designers (including product designers, service designers, and information designers) need to take the challenge of including a broader group of users more seriously. It is not enough to present a prototype intended for a group of future interested users of different ages. To really create user-friendly ICT tools, designers need to find new ways of working, where they can familiarize themselves with the various cognitive and physical limitations that come with age. In addition, designers need to find new ways of getting access to users and interacting with them during the design process.

3.3 Perspectives on Design

The word design means a lot of things. It can be a general concept, a plan, intention, or a product. Design is about doing things consciously and comparing alternatives in order to select the best possible solution. It is about exploring and experimenting, which is the core of innovation (Blessing and Chakrabarti 2009). Here, we are focusing on the activity of design itself, and how the plan and condition of this activity will affect the product. Planning a design product should preferably involve planning the design activities that include the user. To better learn about the intended user and what to take into consideration for a future product, it is necessary to involve users from the very beginning. This provides a broader understanding of who the users are, what requirements they have, and to which cultural context they belong. Cultural aspects involve both the self-image, and the self-image influencing performance.

In the context of digitalization and the influence of everyday tasks, however, it is necessary to problematize and discuss digitalization in terms of digital inclusion and exclusion (Weerakkody et al. 2012). Having access to ICT does not necessarily go hand in hand with the ability to use the tools fully or partially. ICT requires the formation of new habits and some degree of digital literacy. Digital literacy is something that is gained over time, which means that many older adults have it. Research shows that older people are motivated to use ICT because it keeps them in touch with relatives, and they will often follow the Facebook page of local associations as a way of staying updated on upcoming events (Righi et al. 2012). Research also indicates that older people use technology in many different ways and social situations, as well as for different purposes (Sayago et al. 2016).

Learning new things is demanding, and using age as an excuse for not being interested in or learning things like ICT tools is often accepted by society. This is not to blame those people using age as an excuse, but rather to add to our perception and understanding of ageing. The common perception of an older adult is that they do not accept or understand the latest thing—be it fashion, music, or technology. Since we are shaped through the interactions we have with our environment (Oyserman 2015), the process of ageing is also affected and, in turn, older adult's own perceptions of users of new technology. For example, it is not uncommon for older adults to avoid new technology in the belief that it is too difficult for them to use (Durick et al. 2013).

It is often claimed that it is more difficult for older adults to learn how to use technology. Studies have shown that the learning process is, in fact, longer (Kelly and Charness 1995), and that more time is needed to solve different tasks (Kubeck et al. 1999; Mead et al. 2000; Sjölinder et al. 2003). However, the effect of these age-related differences might be overestimated. Studies reporting difficulties for older adults who are learning and using technology have often failed to provide the appropriate context for introduction and learning (Broady et al. 2010). This again reiterates the importance of not contributing to a degrading self-image but, instead, providing a supportive environment for all learners (Broady et al. 2010). This could be overcome through the design of products and services, and the instructions that belong to the devices or services. For example, the instructions for how to use an ICT tool could be divided into different categories: beginner, intermediate, and experienced. In addition, sound feedback or synthetic voice could be used to guide the user when explaining a product or service. However, this would require the text to be written for speech, making it not entirely suited for reading.

The complexity of digital devices varies, and different situations require different levels of knowledge when it comes to using the capacity the technology offers. Depending on their needs, users are expected to find out what is required. This leads to individual adoption or appropriation of technology, and people not using it to its fullest capacity or in a very efficient way. Design that takes this into consideration will support individual adaption of the technology.

When it comes to user-friendliness, the user has to be defined or, at least, framed. "How Users and Non-Users Matter" (Oudshoorn and Pinch 2005) emphasizes that users and technology are inseparable. We suggest that the *design of technology* and the user's needs are inseparable. Furthermore, in a discussion on the theory of Social Construction of Technology (SCOT), it is argued that users are agents of technology change (Oudshoorn and Pinch 2005). In line with the SCOT view, it is possible to take a less rigid position in relation to ICT and older adults, and instead consider older users as agents for the development of useful and innovative technology based on specific needs caused by an ageing body.

The usability of digital systems and equipment is not often prioritized by purchasers, due to a lack of competence and insight into the consequences. Furthermore, the brief the designer receives from a company does not often include user involvement. But this might be costly for the users and the efficiency of company operations and, for private use, it is less prioritized. In the ISO-standard DIS 9241-11, usability is defined as "the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in particular environments." This includes (1) to what extent a task is fulfilled or a goal is reached, (2) the effort needed to perform the actual task and reach the goal, and (3) to what extent the user feels comfortable using a product and to what extent it supports them in performing a task or reaching a goal.

The three steps for achieving usability start with a specified goal. However, for a user that is not associated with a specific workplace or organization, it could be difficult to define the goal. Therefore, an individual user's needs must be specified, along with what their goals are for those needs.

On an abstract level, one might consider that it is obvious that the user will access the Internet, read the news, watch TV, log into their bank account, etc. But if we go into detail, a more explicit description of the single task goals is required. The first step is to let a user know what is achievable through using ICT, with emphasis on what might be relevant for them. That has to be related to the user's interests, habits, and behaviour. The second step is to compare the interests, habits, and behaviour to what is already partly or entirely digitalized and what is expected for the future. From there, it is possible to discuss the user's needs. Once the user's needs are defined, it is possible to define various goals. Depending on the interface, it is conceivable to evaluate the amount of effort needed to perform the actual task and reach the goal. The third step has to do with feelings involved while the task is being performed, and that is something that can change over time. For skilled ICT users who have reached a high level of digital literacy, performing a task could require a lot of effort because of reduced sensory control due to age. If the designer does not develop the product together with the user or focus groups, they are not able to evaluate the product from the user's perspective.

3.4 Design as Communication—Communication as Design

As previously mentioned, design is also about communication—within a design team, between stakeholders, with a customer, with the product, and about the product. Like lifestyle brands, producers of technology design package their products with values the consumer can identify with. Consumption fulfils various social and personal aims and is, in many ways, part of the presentation of self (Goffman 1959). Producers of technology not only offer devices that satisfy practical needs but frequently release new versions of their products, enticing purchases by those who wish to belong to the latest wave of development. When we think of technology consumption, the consumer we often bear in mind is a young person. Over the last decades, however, that picture has slowly started to change. How a product is marketed will influence the user's interest level and understanding of it and its aim. The design of the information or advertisement could therefore be crucial to how it is perceived, and how the user will relate to the actual product or service.

However, different life phases are also often described in a narrow-minded way, ignoring diversity and lifestyles. Such stereotypes are, in turn, emphasized and used in many contexts; for example, in marketing or in the promotion of certain behaviour. The concept of "active ageing" has been discussed in terms of broadening perspectives and taking into consideration the many aspects of a user's life (Durick et al. 2013). However, it is also based on a stereotype that conveys an image of a newly retired person, with good health and financial status, living a healthy and active life.

One of the most pronounced tools we use for elevating or belittling the people we meet is language. Depending on how we address someone, we can either make him or her feel good and satisfied with herself or diminished and unconfident. It is not uncommon that, when addressing a person with an ageing body, we modify our language and begin to speak more slowly and with a simplified vocabulary; which, as a consequence, leads to feelings of dependence and lowered self-esteem (Brown and Draper 2003).

Skills and experience related to the use of digital technology varies between different groups. According to Olsson, Samuelsson and Visco (2017), older people's access to and use of ICT tends to be more limited compared to other social groups. However, from our point of view, it is not possible to define the older people as a social group since age is not something that links people together as a homogeneous group. In more critical situations, such as health care, it is no longer up to a single individual. Instead, there is often a chain of people with different functions involved in the communication with the older adult. Designers of devices that are used in healthcare are dealing with primary users and secondary users, which are the caregivers and relatives. In these situations, the various users also have different roles, and therefore different requirements—and sometimes even different goals. In this context, stereotypes affect the interactions between healthcare personnel, older adults, and their relatives. A focus on illness and frailty reinforces the stereotype of older adults' dependency and inability to take care of themselves (Eliassen 2016). A conscious design that reflects on this aspect could avoid presumptions about specific target groups. If digital literacy is related to social and economic status, the relationship between the caregiver and the care recipient's social groups is crucial. Here, the designer can play a key role by including a wider group of users in the design of ICT. This way, they can encourage people with less experience and less privileged social positions to not only use ICT tools, but to participate in UX-situations.

A large number of older adults are actually physically active and lead their lives without support from society. Therefore, it would be misleading to claim the need for services that encourage older adults to be more physically active. Instead, focus should be placed on maintaining physical activity (Durick et al. 2013). Regardless of the words we choose, the image we provide will, to some extent, be affected by stereotypes of older adults—either in terms of what is desirable or what is a less favourable scenario. Most perspectives on older adults and the design of new technology—both positive and negative—do, to some extent, contribute to a self-fulfilling prophecy.

3.5 Design and Communication—A Smartphone Example

The various smartphone models currently on the market do not differ dramatically in terms of function or interface. There are some variations in the appearance of the design, and in size and weight. When it comes to symbolic value, however, the difference between smartphone brands is huge. This could be explained by the design of the branding. Brands like Apple and Samsung do not have an explicitly specific age group target, while others do. The Swedish company Doro is mostly known for the production of different kinds of telephones designed with a special focus on the older people. Doro smartphones include, for example, a safety alarm, large buttons, and a supposedly user-friendly interface. The company was founded in 1990 in Kalix, in northern Sweden, but the founder Jan-Erik Larsson got started already in 1970 developing telephones that send alarms to central stations. The technology was used for mountain rescue and reporting burglary, and in 1990 it was further developed for use at home for people with special needs. In 2004, a digital security alarm was added.

Doro has introduced a smartphone in two versions, Doro 8040 and Doro 8035. On the company webpage (doro.se) the two smartphones and a cell phone are presented, with focus on the smartphones. In the upper part of the webpage, the smartphones are presented from a user perspective, with one man and one woman portrayed in alternating images. They represent active, good-looking people past the age of seventy. One image portrays the man sitting by a keyboard. He is wearing jeans and a leather jacket. An associated text lets us know that we are meeting Lasse Holm, 74 years old, and his experience of the smartphone is this: "Doro 8040 is simple, it is fantastic if you want to learn how to use a smartphone." Further down on the webpage, we are told that he is a musician. The other image portrays a woman standing by a mixer table in a glittering black dress. She is wearing big DJ headphones around her neck. The accompanying text invites us to learn more about her by clicking on a button. We learn her name is Cecilia Nebel, a journalist who has recently launched a talk show for people over 60. Interestingly, her own age is not specified. From a marketing perspective, Doro uses the concept of active ageing (Durick et al. 2013), which is based on a stereotype that conveys the image of an older person living a healthy and active life.

So, how is the Doro smartphone supposed to be easier to use than other smartphones? When using the phone for the first time there is an option to choose between a traditional Android interface and Doro's own simplified interface. However, the simplified interface consists of unfamiliar icons and childish language which, rather than strengthening the user, could lead to feelings of dependence and lowered self-esteem (Brown and Draper 2003). Many of the functionalities send out a mixed message. For example, if you follow the instructions, you can start the smartphone very easily. But once you have activated all the functions, there are no further instructions and the step-by-step introduction is not possible to access again without restarting your phone with factory settings. Even though the designer of the Doro smartphone has taken details such as large typography into account, well-designed instructions are lacking. Designed information needs to be repeated in order for users to learn how to use the product, and this is especially the case for older adults (Brown and Draper 2003). Furthermore, the navigation on the Doro smartphone is not intuitive and lacks similarity with other phones. Finally, help functions are difficult to find and confusing to use. And so the question remains: What makes this smartphone easier to use than other smartphones? And what kind of communication does Doro intend to have with their customers?

The Doro webpage conveys an image of older adults in line with the concept of "active ageing," with able users embracing different, exotic challenges. Mean-while, the content of Doro 8040 sends out a completely different message. For one thing, the manner in which the phone's introduction plays out, with overly simplified instructions, is patronizing. Other important aspects, such as privacy settings, are not explained in a clear way. Altogether, this conveys the impression that the company has made assumptions about what kind of information is too difficult for this target group, even when simplified.

3.6 Designing with the User

As mentioned above, one assumption about older adults is that they face difficulties describing their own needs with respect to new technology. Thus, care personnel and/or relatives often become involved and speak on their behalf. In these situations, it is likely that the view of the older adult as a technology user affects how needs are perceived or for whom the intended technology may be relevant. It is important to be aware of how and if the people surrounding the intended user incorporate their own needs into the design suggestions. This presents a challenge for designers and researchers, especially when developing for end users with whom it is difficult to relate and whose world of experience is different from their own (Crilly et al. 2008). Therefore, it is important to strive to gain as much insight as possible about the user—about their past, present, goals, and wishes. Another important aspect in the design process is to understand in what contexts the technology would be most useful or beneficial to the end-user.

Taking a user-driven perspective entails involving the user from the very start of the design process in order to gain a deeper understanding of their needs. Merely asking about their needs or evaluating a pre-existing product is not enough. There is no easy solution to the problem. However, a broader-minded approach could be to place the largest focus on the individual and the new possibilities each phase of life can offer and, when needed, take the ageing body into consideration by making sure this aspect places as little limitation as possible upon what that person would like to achieve.

In the future, user-driven technology might focus on complex interfaces and devices that are simple to use for people with physical limitations. Limitations that imply slower reactions and movements do not, per se, lead to restriction regarding interest in and use of advanced technology. However, this requires user involvement in the design process. Bringing users into the design process at an early stage instead of testing almost finished prototypes on users is an important practice to incorporate into the design practice, which will cause a number of changes to occur. It will change how we design, what we design, and who designs. It will also affect the tools and methods that the new teams of co-designers will use. At the front end, design will become synonymous with design research, creating new landscapes of opportunity for designers and researchers. It will be necessary to work in close collaboration with all the stakeholders during the design development process, and together with a variety of professionals with hybrid design and research skills. As a result, what is being designed will change.

3.7 Conclusion

A considerable amount has already changed, and contemporary society now expects inhabitants to be familiar with technology and able to use it. This also includes older people and, more than ever, older people are involved in a societal change that partly belongs to the future. In the very near future, it will probably be impossible to pay bills without having an Internet bank account. If someone wants to use a grocery store's home delivery service, they will have to place their order from a webpage. To gain deeper insight on political events or news, inhabitants need to have access to Internet, since on television and radio programs or news broadcasts, we are increasingly told to visit a webpage in order to access additional information.

We have discussed the meaning of the ageing body, active ageing, and their relation to ICT, with smartphones as an example. Ageing is not an illness, but a natural process of life, and many people keep up their interests and lifestyles as they age with only some limitations. However, there exists a fixation on age when it comes to the information and advertisements targeted at people who are older. The concept of active ageing is present in advertisements for clothes, travel destinations, and sports, and the target group is very often addressed as mature people. The language in such information and advertisements is often formulated in opposition to the active ageing concept, since the language used is patronizing. This not only influences our collective image of what it means to get older, but also an individual's self-image. When it comes to ICT of various kinds, we find the same attitude. By analyzing the Doro 8040 product description and comparing it with the user interface, we found it to be somewhat more complicated than other smartphones. The reason could be that Doro was trying to make the interface less complex and, in the process, left out necessary information. Older people are the target group for Doro's products, and they implicitly play with active ageing. At the same time, they adopt a patronizing attitude, which can be found on both their webpage and in the smartphone user instructions.

Good-looking and active ageing people have become the ideal, in parallel with good-looking and active young people. How will this affect older people's self-image in relation to life-long learning and the use of ICT products in general? People who experience the negative effects of an ageing body are still capable of using, learning, and interacting with information and communications technology and being part of the digitalization of society.

References

Aesaert K, van Braak J (2015) Gender and socio-economic related differences in performance based ICT competences. Comput Educ 84:8–25

Blessing L, Chakrabarti A (2009) DRM, a Design Research Methodology. Springer Verlag

Broady T, Chan A, Caputi P (2010) Comparison of older and younger adults' attitudes towards and abilities with computers: implications for training and learning. Br J Edu Technol 41(3):473–485. https://doi.org/10.1111/j.1467-8535.2008.00914.x

Brown A, Draper P (2003) Accommodative speech and terms of endearment: elements of a language mode often experienced by older adults. J Adv Nurs 41(1):15–21. https://doi.org/10.1046/j.1365-2648.2003.02500.x
Crilly N, Maier A, Clarkson PJ (2008) Representing artefacts as media: modelling the relationship between designer intent and consumer experience. Int J Des 2(3):15–27
Cuddy AJC, Norton MI, Fiske ST (2005) This old stereotype: the pervasiveness and persistence of the elderly stereotype. J Soc Issues 61(2):265–283
DeFalco A (2009) Uncanny subjects. Columbus: The Ohio Univeristy Press
Durick J, Robertson T, Brereton M et al (2013) Dispelling ageing myths in technology design. In: Proceedings of the 25th Australian computer-human interaction conference: augmentation, application, innovation, collaboration, pp 467–476
Dyck JL, Smither JA (1994) Age differences in computer anxiety: the role of computer experience, gender and education. J Educ Comput Res 10(3):239–248
Eliassen AH (2016) Power relations and health care communication in older adulthood: educating recipients and providers. Gerontologist 56(6):990–996. https://doi.org/10.1093/geront/gnv095
För digitalisering i tiden. SOU 2016:89—Regeringen.se (with a summary in English).
Goffman E (1959) The presentation of self in everyday life. OpenLibrary.org
Kelly CL, Charness N (1995) Issues in training older adults to use computers. Behav Inf Technol 14(2):107–120
Kubeck JE, Miller-Albrecht SA, Murphy MD (1999) Finding information on the World Wide Web: exploring older adult's exploration. Educ Gerontechnology 25:167–183
Longhurst B, Smithe G, Bagnall G et al (2017) Introducing cultural studies. Routledge, London
Mead SE, Sit RA, Rogers WA et al (2000) Influences of general computer experience and age on library database search performance. Behav Inf Technol 19(2):107–123
Nikou S (2015) Mobile technology and forgotten consumers: the young-elderly. Int J Consum Stud 39(14):294–304
Östlund B (1999) Images, users, practices—senior citizens entering the IT-society. KFB-Rapport 1999:9
Oudshoorn N, Neven L, Stienstra M (2016) How diversity gets lost: age and gender in design practices of information and communication technologies. J Women Aging 28(2):170–185
Oyserman D (2015) Culture as situated cognition. In: Scott RA, Kosslyn SM (eds) Emerging trends in the social and behavioral science. https://doi.org/10.1002/9781118900772.etrds0067
Righi V, Sayago S, Blat J (2012) Older people's use of social network sites while participating in local online communities from an ethnographical perspective. In: CIRN 2012 Community informatics conference: ideals meet reality
Sayago S, Rosales A, Righi V, Ferreira SM, Coleman GW, Blat J (2016) On the conceptualization, design, and evaluation of appealing, meaningful, and playable digital games for older people. Games Cult 11(1–2):53–80
Sjölinder M, Höök K, Nilsson L-G (2003) The effect of age-related cognitive differences, task complexity and prior internet experience in the use of an on-line grocery shop. Spat Cogn Comput 3(1):61–84
Turkle S (2011) Life on screen. Identity in the age of internet. Simon & Shuster Paperbacks, New York
Weerakkody V, Dwivedi Y, El-Haddadeh R et al (2012) Conceptualizing e-inclusion in Europe: an explanatory study. Inf Syst Manag 29:205–320

Yvonne Eriksson Ph.D. and Professor of Information Design at Mälardalen University, Sweden. She has initiated and been involved in research projects that take place in an industrial context and focus on visual communication for a global market. These involve communication strategies; assembly instructions and pictures. She has conducted research in tactile reading for more than twenty years and has an interest in how ICT can be used for special needs. She is a member of

the Advisory Board of Design Society and co-chair of the Special Interest Group (SIG) Human Behavior in Design. She is the chair of MDH Living Lab.

Marie Sjölinder Ph.D. within Psychology with a focus on older adults and the use of technology. She is working at RISE (Research Institute of Sweden) SICS with managing national and international projects within the areas of eHealth and welfare technology. Marie Sjölinder is a member of the international board of ITAP/HCII (International conference on human aspects of it for the aged population) and active in several international collaborations within the area of older adults and the use of technology.

Part III
Technologies

Chapter 4
Smartphone Usage Diversity among Older People

Andrea Rosales and Mireia Fernández-Ardèvol

4.1 Introduction

Intelligent systems allow smartphones to be adapted to user behaviour. However, older people are a minority in digital systems (e.g. Eurostat 2017; Pew Research Center 2017) and minorities are poorly represented in intelligent systems (Bonchi et al. 2017). To make the human computer interaction community aware of the importance of taking older people into account in the design of intelligent systems, there is a need to break down the stereotypes about older people and ICTs, particularly with regard to smartphones. Firstly, because older people are the fastest growing Internet group (Pew Research Center 2017) and although they use smartphones less intensively than other generations, this use is important to them (Rosales and Fernández-Ardèvol 2016b). Secondly, because older people are a diverse user group (Sawchuk and Crow 2011; Loos et al. 2012), although little is known about the diverse ways in which they perceive and use their smartphones.

To compensate for the lack of empirical evidence, in this chapter we have triangulated the data from three separate studies. The three studies focus on smartphone use and were conducted in Spain between 2014 and 2017. Firstly, we analysed the tracked activity. Smartphone logs were used to make a comparative analysis of the generational use of smartphones between 2014 and 2016 (tracked use study). This study allowed us to see how older people use smartphones differently from other generations and how this has increased over time. Secondly, we explored the reported use. Through a survey of a representative sample of the older online Spanish population we identified three different types of older smartphone users (reported use study). Finally,

A. Rosales (✉) · M. Fernández-Ardèvol
IN3—Universitat Oberta de Catalunya, Barcelona, Spain
e-mail: arosalescl@uoc.edu

M. Fernández-Ardèvol
e-mail: mfernandez@uoc.edu

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_4

we looked at reflections on use. Using focus groups, we explored the perceptions, experience and skills of a group of older grandmothers regarding their smartphones, in order to understand why they use their devices (reflection on use study).

The tracked use study confirmed that older people use their smartphones less often and for less varied purposes than other generations. This difference increased between 2014 and 2016. Yet, comparatively older people might consider the camera, gallery and settings features (among others) more relevant than younger generations do. The survey allowed us to show the diversity of older smartphone users. We identified three clusters of smartphone users among older people who can be described as basic, proficient and advanced users. Basic users mainly use smartphones for making calls and taking pictures, while proficient users utilise most of the preinstalled functions on their devices, and advanced users download new apps. Finally, the reflection on use by means of focus groups showed that basic and advanced users could have positive and negative perceptions of smartphone use, and all of the participants were willing to learn more about the use of smartphones. However, basic users often have less experience with digital technologies and are less autonomous in their use of smartphones.

The paper is structured as follows: Related work, Methods, Results, Discussion and Conclusion.

4.2 Related Work

Algorithms, which use digital logs to learn from user behaviour and adapt services to their needs, are now pervasive (Schäfer and Van Es 2017). So-called intelligent systems rule our lives and it is assumed they will dominate them even more in the future. Smartphones also use logs as part of their intelligent systems, e.g., for fast app launching (Yan et al. 2012; Huangfu et al. 2015), to improve battery life (Ferreira et al. 2011), to suggest proactive tasks (Banovic et al. 2014) or to offer contextual information (Maggiore et al. 2014). Logs are also used to predict stress (Ferdous et al. 2015), bipolar disorder (Alvarez-Lozano et al. 2014), spending behaviour (Singh et al. 2013) and friendship (Ikebe et al. 2012), among others (De Montjoye et al. 2013).

However, while digital adoption is growing faster among individuals aged over 65 (Fundación Telefónica 2017; Pew Research Center 2017; Eurostat 2018). Such growth has not been enough to close the digital divide, especially for the oldest part of the population (Friemel 2016). Older people are therefore still a minority in digital systems and minorities are poorly represented in intelligent systems (Hajian et al. 2016). Specifically, most of the studies that make use of smartphone logs do not include older people and do not consider intergenerational differences in smartphone usage (Rosales and Fernández-Ardèvol 2016b). They do not therefore make decisions taking into account the habits of older people, which leads to structural ageism (Coupland and Coupland 1993).

The smartphone has opened the door to technology adoption for people with no prior Internet experience (Taipale 2016). New smartphone users today are mostly older people. Despite having access to the smartphones, most new users are part of the second digital divide, the divide in skills and uses (Van Dijk 2006). Where available, data confirms that older individuals tend to rely more on mobile Internet access than a landline connection (e.g. Eurostat 2017; Pew Research Center 2017). However, when smartphones are the only device available to access the Internet, there is limited use of the web and/or less autonomy in its usage, which reinforces social exclusion (Pearce and Rice 2013; Park 2015; Mascheroni and Ólafsson 2016).

In Spain, the smartphone is the most popular digital device, used by 61% of the population aged 15 and over (ONTSI 2017), and is the most pervasive channel for online access (Fundación Telefónica 2017). However, older people use their smartphones less often than other age groups (Rosales and Fernández-Ardèvol 2016b). Teenagers and young people are the benchmark generations for ICT studies, as they can help to identify trends (Castells et al. 2006). More specifically, personal communication patterns and the use of media evolve as we grow older (Charness et al. 2001; Ling et al. 2012), mainly because our interests and life circumstances change, and older people are also affected by these dynamics (Gilleard et al. 2015; Fernández-Ardèvol et al. 2017; Naab and Schwarzenegger 2017).

There is therefore a need to consider heterogeneity in studies on later life, illustrating the diversity hidden under the label of 'older people' (Sawchuk and Crow 2011; Loos et al. 2012). Higgs and Gilleard (2015) argue for a distinction to be made between the third and fourth age in order to capture diversity in old age. Specifically, Leme et al. (2014) suggested three types of older mobile phone users: firstly, experienced users for whom the smartphone is essential; secondly, new users eager to learn; and thirdly, new users who have adopted the mobile phone because of social pressure and find it difficult to manage. However, this classification mixes skills and attitudes towards the smartphone. An earlier study classified older mobile phone users as assisted users, basic users, intermediate users and expert users (Fernández-Ardèvol and Arroyo 2012). Skill assessment, however, is not static and varies according to the technology and the context (Litt 2013). In this paper we therefore propose a particular classification of smartphone users.

This chapter focuses on the smartphone usage divide. We characterise different older smartphone users, according to the tools that they use and what they report using. Finally, we reflect on their reasons for remaining basic users.

4.3 Methods

We used three separate studies to analyse how older people use smartphones and the nuances of this usage. Each study involved different participants. In this section, we present the details of three studies on smartphone usage conducted in Spain between 2014 and 2017.

4.3.1 Tracked Use: Smartphone Logs

We collected data on the smartphone activities of a sample of adult individuals in two waves. The first wave collected data over one month in November 2014 (Rosales and Fernández-Ardèvol 2016a, b) and the second over one month in September 2016. Since most of the sample included Android smartphones, we focused on these devices for this study. The first wave involved 207 valid panellists and the second 321. In 2014, the panellists were 39.08 years old on average, with a standard deviation (SD) of 12.76. We classified both samples into six age groups: 20–24, 25–34, 35–44, 45–54, 55–64 and 65+. The participants were recruited and data collected through an online commercial panel. The tracking system counts each time a feature is displayed in the screen, while the screen is on, as a new access. Background activities are not therefore considered. It also registers how long each feature is displayed on the screen. Beyond demographic variables, the system thus provided us with the number and duration of every app used and each website visited. We analysed the number of smartphone activities by taking into account the features. Some specific features are provided by well-known commercial apps (e.g. WhatsApp); in such cases we analysed the commercial app as a unique feature. Other features, such as email or the gallery, are provided by similar apps from different developers; in such cases we analysed similar apps together under the name of the feature. We made no distinction between whether the same feature is used through apps or web access. E.g. Facebook is counted whether an app or the Internet browser is used for accessing it. For analytical purposes, we selected the most popular features, considering the number of users by age category and frequency of access. E.g. messaging represents only 0.2% of the app accesses, but is used by almost all participants.

Independence analysis between variables was supported by the appropriate statistical test. For the analysis of continuous variables we used the Pearson correlation. For comparisons of continuous variables among groups we used ANOVA (analysis of variance) tests, and a Chi-squared test for categorical variables. We also used the Bonferroni test when appropriate. We highlighted statistically significant differences (SSD) for probability levels below the usual 5%. Unfortunately, due to technical limitations it was not possible to analyse data from 2014 for the 65+ age group (the subsample was too small, $n < 30$). Informed consent was provided by panellists to the commercial panel that conducted the study as part of their relationship.

4.3.2 Reported Use: Survey

We conducted an online survey targeted at Internet users aged 60 years and older living in Spain. The fieldwork was conducted in November 2016, with a final valid sample size of 2,232 responses from people aged 60 to 87,66.45 years old on average and an SD of 5.62. Representativeness was ensured through quota sampling, which followed the same age and sex distribution as the population under study (Jacobetty and Fernández-Ardèvol 2017). The survey analysed the use of (non-) digital media and our interest focused on the functions respondents reported using on their mobile phones. As the data was categorical, we used a two-step cluster analysis to identify the types of users according to the functions they use on their smartphones. We then analysed whether there were differences between clusters in terms of socio-demographic characteristics by using the above-mentioned tests of independence. We conducted the online survey through a commercial panel, ethical consent was provided by panellist to the panel as part of their relationship.

4.3.3 Reflection on Use: Focus Groups

We conducted five focus groups with 25 participants in Barcelona (Catalonia), Spain, between April and May 2017. The participants were all grandmothers aged 65+ who had used some sort of digital communication technology in the past. The average age was 71.8, with a standard deviation of 6.03. We will refer to them by the number of the focus group, their age and a letter if there is more than one participant of the same age, e.g. FG2-65A, FG2-65B. Conversations revolved around the ecology of media used to communicate with family and friends. We conducted a thematic analysis of the features the participants used in order to classify them as basic or proficient smartphone users. We also analysed their perceptions, skills and digital experience. Ethical consent was provided by participants prior to the beginning of the focus groups.

4.4 Results

4.4.1 Tracked Use

For both years, it was noted that the younger the panellist, the more they used smartphones. In 2014, age and smartphone activities were negatively correlated ($r = -0.216$, $p < 0.05$). In 2016, there were statistically significant differences (SSD) in the number of logs by panellists according to their age group ($F(5, 315) = 30.089$, $p < 0.001$). All discussed SSD refer to a 5% level of error.

Three dimensions are relevant. Firstly, the number of smartphone activities by user increased significantly from 2014 to 2016 ($F(1, 526) = 45.492$, $p < 0.005$). However, this increase was recorded in younger age groups and is not significant for the 55–64 age group.[1] Secondly, the duration of logs increased significantly between 2014 and 2016 ($F(1, 523) = 17.570$, $p < 0.001$). Thirdly, the number of apps used increased significantly between 2014 and 2016 ($F(1, 525) = 13.973$, $p < 0.005$),

[1] 20–24 ($F(1, 64) = 19.827$, $p < 0.005$), 25–34 ($F(1, 104) = 49.332$, $p < 0.005$), 35–44 ($F(1, 127) = 23.261$, $p < 0.005$), 45–54($F(1, 114) = 5.964$, $p < 0.05$), 55–64 ($F(1, 72) = 3.299$, $p > 0.05$).

although the significant growth was only seen in the younger age groups (those up to 44).[2]

For data collected in 2016, we analysed the use of the most popular features. In accordance with previous results, there were SSD in the use of the most popular features by age, revealing that the younger generations use features including the clock, Facebook, Facebook Messenger, Google Maps, Instagram, Market, messaging, Twitter, WhatsApp and YouTube more often than older generations (see Table 4.1).[3] However, contrary to the general trend, the camera, contacts, email, gallery, Google, messaging, phone and settings are more relevant for older people than for younger age groups (see Table 4.1). Indeed, there were no SSD between age groups in the use of the camera, contacts, phone and settings. Older people therefore use such features proportionally more than other age groups. Specifically, there were SSD in the use of email, the gallery, Google and messaging, with younger generations using these less often than older generations (see Table 4.1).[4] Beyond WhatsApp, the weight of other apps in everyday use provide no significant differences by age group (see Fig. 4.1).[5]

4.4.2 Reported Use

As an exploratory analysis, we used an appropriate multivariate technique for reducing the dimensions in the case of nominal data and a large dataset. We used a two-step cluster analysis to analyse the data on the use of 19 mobile phone functions (see Table 4.2). The optimum number of clusters, log-likelihood distance measure and Schwarz's Bayesian criterion supported the decision. The silhouette measure of cohesion and separation equalled 0.2, which confirms a fair overall goodness of fit (Mooi and Sarstedt 2011). The three clusters obtained have a clear interpretation as they reflect different levels of use of the smartphone features: basic, proficient and advanced users. According to the results of the two-step cluster analysis, the most important predictors for cluster membership are downloading apps (1.0), visiting websites via browser (0.86), and using GPS and maps (0.82), as their use was quite different among the three clusters. In contrast, listening to the radio, gaming, MMS, ordinary voice calls, podcasts and SMS have no importance as input predictors (0), all of them were quite uncommon among panellists to influence the clusters.

[2]20–24 ($F(1, 64) = 6.402$, $p < 0.05$), 25–34 ($F(1, 104) = 11.150$, $p < 0.005$), 35–44 ($F(1, 126) = 19.864$, $p < 0.005$), 45–54 ($F(1, 114) = .544$, $p > 0.05$), 55–64 ($F(1, 72) = .008$, $p > 0.05$).

[3]Clock ($F(5, 314) = 5.571$, $p < 0.005$), Facebook ($F(5, 308) = 13.341$, $p < 0.005$), Facebook Messenger ($F(5, 310) = 3.175$, $p > 0.05$), Google Maps ($F(5, 307) = 6.195$, $p > 0.005$), Instagram ($F(5, 308) = 25.031$, $p < 0.005$), Market ($F(5, 312) = 6.588$, $p < 0.005$), Twitter ($F(5, 307) = 7.735$, $p < 0.005$), WhatsApp ($F(5, 310) = 31.867$, $p < 0.005$), YouTube ($F(5, 307) = 14.972$, $p < 0.005$).

[4]Email ($F(5, 311) = 2.519$, $p < 0.05$), Gallery ($F(5, 310) = 2.447$, $p < 0 .05$), Google ($F(5, 308) = 3.845$, $p < 0.005$), Messaging ($F(5, 310) = 2.953$, $p < 0.05$).

[5]Camera ($F(5, 307) = 1.504$, $p > 0.05$), Contacts ($F(5, 314) = 2.139$, $p > 0.05$), Phone ($F(5, 309) = 1.199$, $p > 0.05$), Settings ($F(5, 309) = 1.492$, $p > 0.05$).

Table 4.1 Percentage of smartphone access to selected features from total smartphone access by age group. Black background shows features more relevant for 65+ than other age groups

	20–24	25–34	35–44	45–54	55–64	65+	Total
WhatsApp*	**20.2***	**16.9***	**16.6*[a]**	**16.1*[a]**	**18.9*[a]**	**19.3*[a]**	17.6
Facebook*	**6.1***	**6.3***	**5.0*[a]**	**5.2*[a]**	**3.8*[a]**	**3.2*[a]**	5.4
Google*	**4.0*[a]**	**4.9*[a]**	4.3	6.0	6.4	**6.0***	5.0
Email*	1.6	**2.6*[a]**	2.3	3.6	3.9	**4.5***	2.7
Instagram*	**3.4***	**2.1***	**0.8*[a]**	**0.5*[a]**	**0.3*[a]**	**0.1*[a]**	1.4
Twitter*	**2.2***	1.4	**0.8*[a]**	**0.8*[a]**	**1.0*[a]**	**0.4*[a]**	1.2
Gallery*	**0.9*[a]**	0.8	1.1	1.4	1.7	**1.7***	1.1
Contacts	0.3	0.3	0.9	1.1	1.4	2.2	0.8
Clock*	**0.7***	0.6	0.6	0.6	0.8	**0.4*[a]**	0.7
Market*	**0.5***	**0.5***	**0.7***	**0.7***	0.8	**0.6*[a]**	0.6
YouTube*	**0.8***	0.7	**0.7*[a]**	**0.4*[a]**	**0.4*[a]**	**0.2*[a]**	0.6
Settings	0.4	0.3	0.5	0.8	0.7	1.1	0.5
Camera	0.2	0.3	0.4	0.5	0.5	0.5	0.4
Phone	0.3	0.2	0.6	0.3	0.6	1.6	0.4
Facebook Messenger*	**0.3***	0.2	0.2	0.3	**0.2*[a]**	**0.1*[a]**	0.3
Google Maps*	**0.2***	**0.2***	0.2	0.2	0.2	**0.1*[a]**	0.2
Messaging*	0.1	0.2	0.2	**0.4***	0.5	**0.4*[a]**	0.2

*Shows SSD
*[a]Shows SSD among groups who use the feature less

Otherwise, instant messaging and photos were pretty common among the three groups, so they have no major influence in clusters. Indeed, the clusters showed statistically significant differences in all the considered functions except for two: taking photographs common among the three clusters, and listening to podcasts rather uncommon among all of them.

The basic cluster included 524 panellists, accounting for 26% of the sample. It represents those who use smartphones mainly for taking pictures, making voice calls and instant messaging. Some of them also use the SMS, alarm, clock and reminder features, but barely use other functions (Fig. 4.2, Table 4.2).

The proficient cluster included 962 panellists, accounting for 47.7% of the sample. It represents those who are very proficient in the use of smartphones. Most of them use all the functions mentioned in the basic cluster, and most of the functions that often come preinstalled on their smartphones, although not all of them (Fig. 4.2, Table 4.2).

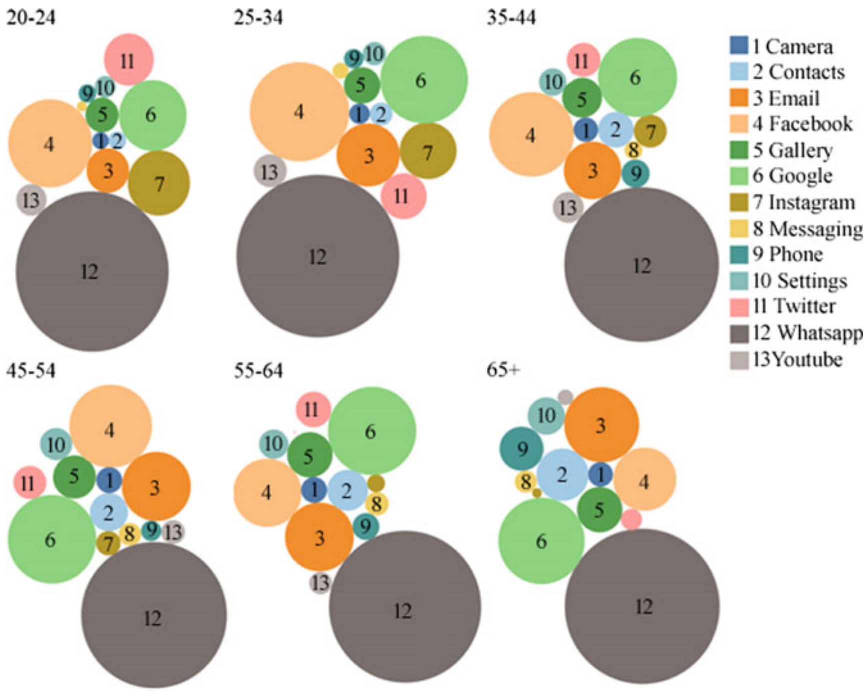

Fig. 4.1 Percentage of selected features from all smartphone activities by age group

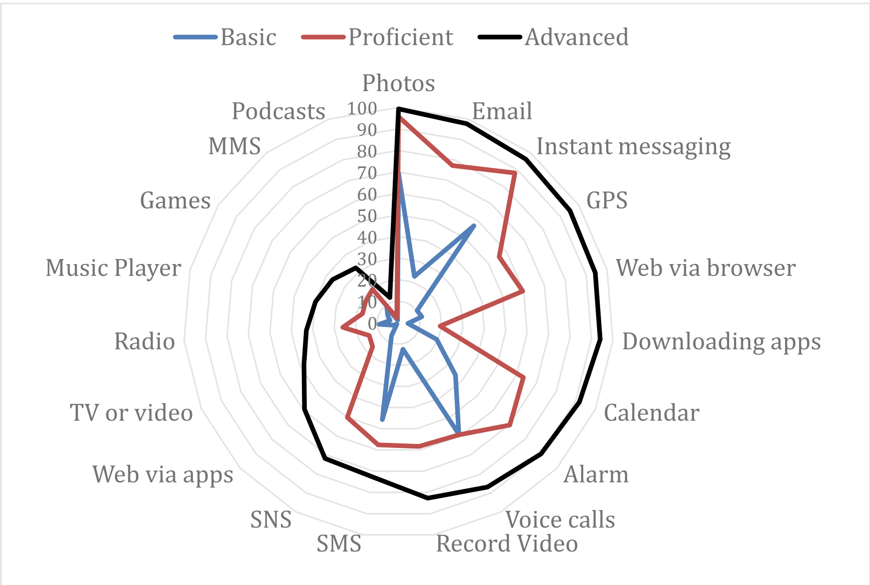

Fig. 4.2 Percentage of panelists by cluster who use each function

Table 4.2 Percentage of panelists in each cluster who use the functions

	Basic (%)	Proficient (%)	Advanced (%)	Total (%)
Taking photographs	*58.2	*97.7	*99.4	87.9
Instant messaging	47.1	*87.8	*98.5	80.1
Ordinary voice calls	*66.4	*56.2	*89.6	67.7
Email	20.2	*71.1	*98.1	65.0
Alarm clock and reminders	32.3	*67.9	*91.0	64.7
SMS	41	*58.6	*74.4	58.2
Calendar	17.7	*58.1	*94.4	57.2
Viewing websites via browser	5.5	*57.2	*95.5	53.8
GPS and maps	8	*52.6	*96.2	52.5
Recording video	3.4	*55.5	*86.8	50.2
Social network sites	5.5	42.7	*76.8	42.0
Downloading apps	1.9	26.5	*91.9	37.3
Listening to the radio	8.8	20.1	*51.8	25.5
Viewing websites via apps	1.0	14.7	*65.3	24.4
Watching TV or video	1.3	13.4	*54.2	21.0
MMS Multimedia Message Service	2.1	20.6	36.2	19.9
Using the phone as a music player	1.7	14.0	48.0	19.7
Games	4.4	15.9	41.8	19.7
Listening to podcasts	0.6	2.3	14.7	5.1

*Shows the functions used by most panelists in each cluster

The advanced cluster included 531 panellists, accounting for 26.3% of the sample. Most of them use all the functions used by the proficient cluster, and all the functions mentioned in the survey, except for four (Table 4.2). What most sets this group apart is that most of them download new apps, whereas this is not common in the other two clusters (Fig. 4.2, Table 4.2).

Gender is independent of the level of use ($\chi^2(2) = 2.720$, $p > 0.05$). Age, in contrast, is associated with the level of use.[6] Individuals aged 75 and over tended to be concentrated in the basic cluster, with most of those 80 and over being part of this cluster. In contrast, the advanced cluster included a significantly higher proportion of the younger old (those between 60 and 64 years old). Education and income level were also associated with levels of use. In particular, those with a primary school education or less were more concentrated in the basic cluster, whereas those

[6] $\chi^2(8) = 113.9$, p =.000. As an ANOVA was not technically possible, we conducted a crosstab with age grouped into 5-year segments.

who completed tertiary education tended to be concentrated in the advanced cluster ($\chi^2(6) = 82.9$, $p = 0.000$). Those with declared income above the average also had a relatively higher presence in the advanced cluster ($\chi^2(6) = 65.4$, $p = 0.000$).

4.4.3 Reflections on Use

According to our analysis of the focus groups, several factors influence the diversity of smartphone use between basic, proficient and advanced users. While all users tend to question digital technologies, basic users often have limited digital trajectories. Values, style and habits influence their decision to limit smartphone use.

4.4.3.1 Basic Users

Basic users are often new users with little experience of digital technologies. Sometimes the smartphone is the only device they have with which to access the Internet. Furthermore, basic users are often not autonomous in their smartphone use and feel limited in their abilities.

FG2-65B uses a smartphone but she is used to communicating by other means. She thus puts limits on her smartphone in accordance with her customs and values.

"*For 45 or 50 years I have lived without a mobile. (…) Fortunately, I have my family here and I prefer to see them. However, in an emergency I usually use WhatsApp. But always very short messages (…). This happened to me with the landline [telephone]. (…) I have never had long conversations on the landline, just the minimum I needed*."

FG3-77 describes herself as old-fashioned. Although she has access to the technology and the skills to use it, she prefers to use analogue systems.

"*I'm a bit old-fashioned and I use the landline to talk about important things. (…) I'm in favour of science and information. For example, a person without information is a person without an opinion. You go to the computer and you immediately know what is happening, in just a moment. It's immediacy. I'm very much in favour of all of this. But I prefer my style, to read the newspaper at my own pace*."

FG2-65A used to be an indirect user, as she delegated the use of the smartphone to her late husband. Now she is a delighted new smartphone user, although she sees it as being in competition with face-to-face interaction.

"*All this about technologies is very interesting, but I think contact is better than the mobile. (…) In the morning there are twelve of us and we all go to have breakfast together; we leave the grandchildren at school and go to a bar in a side street. That's the best therapy. We have breakfast there and when it's 11.00am we say "time's up, time to go". But that's the best therapy for me. Not WhatsApp, none of that*."

4.4.3.2 Proficient and Advanced Users

Proficient users often have extensive experience with digital technologies and have adopted smartphones as part of their digital development, although they often question technology.

FG2-78B adopted the smartphone in response to social pressure. Although she is confident about using technologies, she does not like the smartphone and prefers face-to-face interaction.

"*I didn't want one of these telephones [smartphones], but in the end, I gave in because everyone in the group had one and I wanted to stay in my group, so I bought one. But I'm not addicted to it at all. (…) Now I will say one thing: I don't envy today's youth compared to my childhood in the village. The WhatsApp we used to have consisted of things like "you know that so-and-so is getting married to so-and-so" or "we're meeting up on Sunday, spread the word."*"

FG1-72B has extensive experience with digital technologies and adopted smartphones as part of her continuing use of these technologies.

"*My daughter brought home an out-of-date computer from work and said "Mum, do you want it?" and I began to use it a bit. (The smartphone) is practically the same, with little differences. I began with one of those mobile phones – the tiny ones – and then my son gave me this one*."

FG3-68B reports on her addiction to the Internet; she has been using it for more than ten years and uses a variety of devices. Nevertheless, she is willing to learn more.

"*I'm an addict. I found my philosopher's stone with the Internet, with all these devices (…), I hardly use the landline. And yet I use the smartphone, the tablet when I want to share things with my family; we share them on the computer. I use everything depending on the speed I need or the type of communication. I'm just not good at it (…) I can use these things, but I'm limited by certain technicalities that they are better at than me. Look, the latest book that everybody is talking about. It's called "Patria" ["Homeland"], a huge book, they (her sons) downloaded it for me, and I read it in one go*."

FG2-69 and FG2-65A are both advanced users and are willing to explore new apps.

FG2-69 "*The other day at a funeral home they were playing some lovely music; there was a girl, (doing something with her smartphone) but we didn't know what she was doing. So, I asked my friends, and we downloaded the app*."

FG2-65A "*I don't have that one. What app is it?*"

FG2-69 "*When you hear some music, it identifies the group or singer*."

4.5 Discussion

Our study focuses on understanding the uses of a digital technology that is already in the market and widely used in Spain: smartphones. It also focuses on their use by older people, in order to characterise their diverse uses and understand how to make current technologies more inclusive. With some exceptions, this approach is not common in HCI research with older people. Most research in HCI with older people refers to the design, development and evaluation of prototypes with or for older people (Durick et al. 2013). And most research on the use of products does not include older people, or does not carry out intergenerational analysis to identify how usage changes throughout a lifetime.

Although there is some concern regarding the bias of intelligent systems in terms of race, gender or religion (Hajian et al. 2011), less attention has been paid to age discrimination, or ageism. Older people are a minority in digital media, in terms of both access and use. Minorities are poorly represented in intelligent systems (Hajian et al. 2016), because these systems are often built on predictions and correlations (Bonchi et al. 2017) that are acceptable if they suit 80% of the population. Data granularity (Kitchin 2014) must be considered in order to take into account the different ways in which older people, as a minority in the digital world, use digital media, and therefore better incorporate their uses into intelligent systems.

Mobile communication patterns are different depending on age, just as personal communication patterns and the use of media change throughout life (Charness et al. 2001; Ling et al. 2012). The tracking study shows how older generations use smartphones less often than others, but also that some features are more commonly used by older people compared to younger generations.

Mobile communication patterns also change over time. Our panellists used their smartphones more often and accessed more apps in 2016 than in 2014 However, differences are only statistically significant among younger cohorts. This could be influenced by the fact that digital adoption is growing faster among individuals aged over 65 (Pew Research Center 2017; Eurostat 2018). It is therefore to be expected that there will be inequalities in terms of skills and usage (Van Dijk 2006) among new adopters, who are today late adopters of smartphones and probably have fewer digital skills than early adopters.

Despite being a minority in the digital world, among older smartphone users almost 70% are proficient or advanced users for whom the smartphone plays a key role, and they use it in a way that is different to other generations.

Finally, the focus groups help us to understand the reasons why some older individuals use smartphones more than others. Previous studies found that the most common explanations for non-use of the Internet include motivational reasons (lack of interest), material reasons (lack of material access) and skills (lack of skills) (Van Dijk and Hacker 2000). Motivational reasons increased in importance over time (Helsper and Reisdorf 2016). Given that all the focus group participants were smartphone users, the most common explanation for not using smartphones more often was based on motivational reasons. They argue that values, style, habits and long-term perspective influence their decision on whether or not to use smartphones more frequently. Moreover, there are positive and negative perceptions of smartphones among basic and proficient or advanced users. All of them, to a greater or lesser extent, question the use of smartphones. While it is often presumed that non-users are missing out on the benefits of ICT (e.g. Rogers 2003; Morris et al. 2007; Peacock and Künemund 2007) the focus group participants made a conscious decision to limit the use of their smartphones, and to meet their information and communication needs by other means better suited to their context, interests or habits. Otherwise, probably influenced by the fact that all the participants are women, most of them mentioned their limited skills, especially compared with younger generations. Moreover, limited digital trajectories associated with limited skills are more common among basic users, who achieve their communication or socialisation goals by other means.

The analysis we carried out in this paper allowed us to combine reported use and tracked use. Specifically, surveys and focus groups provide an account of reported use, while tracking systems record tracked use. Beyond actual use, reported use analyses what people say they do in their everyday life, which could be different to what they actually do. In contrast, tracked use is often described as an expression of human behaviour e.g. (Böhmer et al. 2011; Ferreira et al. 2014), although it is often a mixture of human actions and automated or programmed activities. In the case of smartphones, logs can report how long the screen has displayed the content of an app, although this does not necessarily mean that the user was using the device. The timeout feature can keep the screen on after the user has finished their activities. The duration of logs is thus influenced by the screen timeout selected by the user. The number of logs could also be influenced by other features, including ambient display, interactive notifications, priority notifications and unlocking systems. For example, ambient display turns the screen on, opening an app whenever there is an incoming notification. This is counted as a new log in tracking systems and therefore as a new user activity, even when this is not the case. Thus, similarly to reported use, tracked use is related with usage, but is not describing actual use, is just analysing the activities of smartphones. Thus, each research method, despite its own biases, contributes to understand smartphone usage.

To counterbalance this effect, in this chapter we triangulated the results of different methods and, beyond the raw data, presented a comparative analysis of how different groups use smartphones differently.

4.6 Conclusion

We studied the diversity of smartphone use among older people in Spain through the triangulation of tracked use, reported use and reflections on use. We showed how older people are a minority and a heterogeneous group regarding smartphone use in Spanish society. The tracked use study showed how the divide in smartphone use has increased between 2014 and 2016 among younger and older people. According to the reported use, older Internet users (60+) in Spain constitute a diverse user group, among which proficient and advanced users represent more than 70%. Finally, the focus groups showed that basic smartphone users meet their information and communication needs by other means better suited to their habits and values. To avoid structural ageism, there is therefore a need to take into account that older people are a minority, as well as a heterogeneous user group, in the design of intelligent systems based on smartphone logs.

Acknowledgements We are indebted to all the participants in our study. This research project has been partially funded by the Spanish Ministry of Economy and Competitiveness (FJCI-2015-24120) and the Social Sciences and Humanities Research Council of Canada through the Ageing + Communication + Technologies project (895-2013-1018).

References

Alvarez-Lozano J, Osmani V, Mayora O et al (2014) Tell me your apps and I will tell you your mood: correlation of apps usage with bipolar disorder state. In: Proceedings of the international conference on pervasive technologies related to assistive environments (Petra 2014). Association for Computing Machinery (ACM), pp 1–7

Banovic N, Brant C, Mankoff J et al (2014) Proactive tasks: the short of mobile device use sessions. In: Proceedings of the SIGCHI conference on human-computer interaction with mobile devices and services (MobileHCI 2014). ACM, pp 243–252

Böhmer M, Hecht B, Schöning J et al (2011) Falling asleep with Angry Birds, Facebook and Kindle: a large scale study on mobile application usage. In: Proceedings of the international conference on human computer interaction with mobile devices and services (MobileHCI 2011). ACM, Nueva York, NY, pp 47–56

Bonchi F, Hajian S, Mishra B, Ramazzotti D (2017) Exposing the probabilistic causal structure of discrimination. Int J Data Sci Anal 3:1–21. https://doi.org/10.1007/s41060-016-0040-z

Castells M, Fernández-Ardèvol M, Linchuan Qiu J et al (2006) Mobile communication and society: a global perspective. The MIT Press, Cambridge, MA

Charness N, Parks DC, Sabel BA (eds) (2001) Communication, technology and aging: opportunities and challenges for the future. Springer, New York, NY

Coupland N, Coupland J (1993) Discourses of ageism and anti-ageism. J Aging Stud 7:279–301. https://doi.org/10.1016/0890-4065(93)90016-D

De Montjoye Y-A, Quoidbach J, Robic F et al (2013) Predicting personality using novel mobile phone-based metrics. In: Greenberg A, Kennedy W, Bos N (eds) Social computing, behavioral-cultural modeling and prediction. SBP 2013, pp 48–55

Durick J, Robertson T, Brereton M et al (2013) Dispelling ageing myths in technology design. In: Proceedings of the Australian computer-human interaction conference (OzCHI 2013), pp 467–476

Eurostat (2017) Digital economy and society in the EU: a browse through our online world in figures. In: Digital economy and society http://ec.europa.eu/eurostat/cache/infographs/ict/index.html

Eurostat (2018) Individuals internet use. Last internet use in the last 3 months. Table [isoc_ci_ifp_iu]. http://ec.europa.eu/eurostat/web/products-datasets/-/isoc_ci_ifp_iu. Accessed 1 Mar 2018

Ferdous R, Osmani V, Mayora O (2015) Smartphone app usage as a predictor of perceived stress levels at workplace. In: Proceedings of international conference on pervasive computing technologies for healthcare, pp 225–228. https://doi.org/10.4108/icst.pervasivehealth.2015.260192

Fernández-Ardèvol M, Arroyo L (2012) Mobile telephony and older people: exploring use and rejection. Interact Stud Commun Cult 3:9–24. https://doi.org/10.1386/iscc.3.1.9_1

Fernández-Ardèvol M, Sawchuk K, Grenier L (2017) Maintaining connections: octo- and nonagenarians on digital "use and non-use". Nord Rev 38:39–51. https://doi.org/10.1515/nor-2017-0396

Ferreira D, Dey AK, Kostakos V (2011) Understanding human-smartphone concerns: a study of battery life. In: Proceedings of the conference on pervasive computing (Pervasive 2011), pp 19–33

Ferreira D, Goncalves J, Kostakos V et al (2014) Contextual experience sampling of mobile application micro-usage. In: Proceedings of the international conference on human-computer interaction with mobile devices and services, pp 91–100. https://doi.org/10.1145/2628363.2628367

Friemel TN (2016) The digital divide has grown old: determinants of a digital divide among seniors. New Media Soc 18:313–331. https://doi.org/10.1177/1461444814538648
Fundación Telefónica (2017) Sociedad Digital en España 2017
Gilleard C, Jones I, Higgs P (2015) Connectivity in later life: the declining age divide in mobile cell phone ownership. Sociol Res Online 20:3. https://doi.org/10.5153/sro.3552
Hajian S, Bonchi F, Castillo C (2016) Algorithmic bias: from discrimination discovery to fairness-aware data mining Sara. In: Proceedings of the international conference on knowledge discovery and data mining (KDD 2016), pp 2125–2126
Hajian S, Domingo-Ferrer J, Martinez-Balleste A (2011) Discrimination prevention in data mining for intrusion and crime detection. In: Symposium on computational intelligence in cyber security (IEEE SSCI 2011), pp 47–54. https://doi.org/10.1109/cicybs.2011.5949405
Helsper EJ, Reisdorf BC (2016) The emergence of a "digital underclass" in Great Britain and Sweden: changing reasons for digital exclusion. New Media Soc, 1–18. https://doi.org/10.1177/1461444816634676
Higgs P, Gilleard CJ (2015) Rethinking old age: theorising the fourth age. Palgrave Macmillan, London, United Kingdom
Huangfu J, Cao J, Liu C (2015) A context-aware usage prediction approach for smartphone applications. In: Yao L, Xie X, Zhang Q et al. (eds) Advances in services computing (APSCC 2015). Springer Verlag, pp 3–16
Ikebe Y, Katagiri M, Takemura H (2012) Friendship prediction using semi-supervised learning of latent features in smartphone usage data. In: Proceedings of the international conference on knowledge discovery and information retrieval (KDIR 2012)
Jacobetty P, Fernández-Ardèvol M (2017) Older audiences and digital media: Spain, 2016. Preliminary results
Kitchin R (2014) Big data, new epistemologies and paradigm shifts. Big Data Soc 1:1–12. https://doi.org/10.1177/2053951714528481
Leme RR, Zaina LAM, Casadei V (2014) Interaction with mobile devices by elderly people: the Brazilian scenario. In: Proceedings of the international conference on advances in computer-human interactions interaction (ACHI 2014), pp 21–26
Ling R, Bertel TF, Sundsøy PR (2012) The socio-demographics of texting: an analysis of traffic data. New Media Soc 14:281–298. https://doi.org/10.1177/1461444811412711
Litt E (2013) Measuring users' internet skills: a review of past assessments and a look toward the future. New Media Soc 15:612–630. https://doi.org/10.1177/1461444813475424
Loos E, Haddon L, Mante-Meijer EA (eds) (2012) Generational use of new media. Ashgate, Farnham, UK
Maggiore G, Santos C, Plaat A (2014) Smarter smartphones: Understanding and predicting user habits from gps sensor data. In: Shakshuki EM (ed) International conference on future networks and communications (FNC 2014). Elsevier B.V., pp 297–304
Mascheroni G, Ólafsson K (2016) The mobile internet: access, use, opportunities and divides among European children. New Media Soc 18:1657–1679. https://doi.org/10.1177/1461444814567986
Mooi E, Sarstedt M (2011) Cluster analysis. In: A concise guide to market research. Springer, Berlin, Heidelberg
Morris A, Goodman J, Brading H (2007) Internet use and non-use: views of older users. Univers Access Inf Soc 6:43–57. https://doi.org/10.1007/s10209-006-0057-5
Naab T, Schwarzenegger C (2017) Why ageing is more important than being old: understanding the elderly in a mediatized world. Nord Rev 38:93–107. https://doi.org/10.1515/nor-2017-0400
ONTSI (2017) Las TIC en los hogares españoles: Estudio de demanda y uso de servicios de telecomunicaciones y sociedad de la información
Park YJ (2015) My whole world's in my palm! The second-level divide of teenagers' mobile use and skill. New Media Soc 17:977–995. https://doi.org/10.1177/1461444813520302
Peacock SE, Künemund H (2007) Senior citizens and internet technology: reasons and correlates of access versus non-access in a European comparative perspective. Eur J Ageing 4:191–200. https://doi.org/10.1007/s10433-007-0067-z

Pearce KE, Rice RE (2013) Digital divides from access to activities: comparing mobile and personal computer internet users. J Commun 63:721–744. https://doi.org/10.1111/jcom.12045

Pew Research Center (2017) Tech adoption climbs among older adults. Washington, DC

Rogers EM (2003) The digital divide. Convergence 7:96–111

Rosales A, Fernández-Ardèvol M (2016a) Smartphones, apps and older people's interests: from a generational perspective. In: Proceedings of the conference on human-computer interaction with mobile devices and services (Mobile HCI 2016). Association for Computing Machinery, Inc, New York, NY, pp 491–503

Rosales A, Fernández-Ardèvol M (2016b) Beyond WhatsApp: older people and smartphones. Rom J Commun Public Relations 18:27–47. doi:https://doi.org/10.21018/rjcpr.2016.1.200

Sawchuk K, Crow B (2011) Into the grey zone: seniors, cell phones and milieus that matter. WI J Mob Media 5

Schäfer MT, Van Es K (2017) The datafied society: studying culture through data. Amsterdam University Press

Singh VK, Freeman L, Lepri B, Pentland A (2013) Predicting spending behavior using socio-mobile features. In: Proceedings on the international conference on social computing, pp 174–179

Taipale S (2016) Do the mobile-rich get richer? Internet use, travelling and social differentiations in Finland. New Media Soc 18:44–61. https://doi.org/10.1177/1461444814536574

Van Dijk J (2006) Digital divide research, achievements and shortcomings. Poetics 34:221–235. https://doi.org/10.1016/j.poetic.2006.05.004

Van Dijk J, Hacker K (2000) The digital divide as a complex and dynamic phenomenon. Annu Conf Int Commun Assoc 1–20. https://doi.org/10.1016/s0360-1315(00)00035-x

Yan T, Chu D, Ganesan D et al (2012) Fast app launching for mobile devices using predictive user context. In: Proceedings of the conference on mobile systems, applications, and services (MobiSys 2012). pp 113–126

Andrea Rosales is Post-Doctoral Researcher at the Universitat Oberta de Catalunya. She studies the everyday practices of older people with digital mobile technologies, how this could be used in the design of new technologies that consider the interests, values and everyday practices of older people. She combines qualitative and quantitative methods, including the use of passive metering that allow quantifying the uses of mobile devices to predict users' behaviour.

Mireia Fernández-Ardèvol is a Senior Researcher at the IN3 (Internet Interdisciplinary Institute), Universitat Oberta de Catalunya. Since 2003, her primary research interest is on the social and economic aspects of mobile communication, while at present she is focused on the analysis of the intersection between digital (mobile) communication and the processes of aging. She leads or participates in research projects aimed at critically disentangling the role of digital technologies in breaking/reinforcing digital divides. She has published in prestigious publishers as MIT Press, as well as in high-impact journals such as Media, Culture & Society, New Media & Society or Mobile Media & Communication.

Chapter 5
Seniors and Self-tracking Technology

Clara Caldeira and Yunan Chen

5.1 Introduction

While older adults use self-tracking for health more than any other age group in the U.S., they seldom use self-tracking technology (Fox and Duggan 2013). Self-tracking can be used for many purposes, including monitoring health indicators, learning about how one responds to different scenarios, and supporting behavior change. Each of these actions can be part of seniors' health management activities, and technology has the potential to facilitate and augment this practice (e.g., by reducing the effort required or assisting users to interpret their data). While the majority of self-tracking industry and research focuses on the younger population, seniors have particular needs. In comparison to younger age groups, they have a higher prevalence of chronic illness (Ward et al. 2014), track different health indicators, and use different tools to track health information (Fox and Duggan 2013). In order for seniors to benefit from the tools provided by self-tracking technology, it is necessary to design systems more aligned with their needs and practices.

Self-tracking refers to repeatedly measuring and recording information about oneself. In the case of self-tracking for health, such information may include activities such as medication intake and health indicators such as blood pressure. Terms such as self-monitoring, Personal Informatics, and Quantified Self can refer to similar practices. We utilize self-tracking as an umbrella term.

In this chapter, we provide a review of seniors' use of self-tracking and self-tracking technology. We describe relevant findings and highlight opportunities for future research. Our goals are to introduce the reader to this area of research,

C. Caldeira (✉) · Y. Chen
University of California, Irvine, CA, USA
e-mail: claram@uci.edu

Y. Chen
e-mail: yunanc@uci.edu

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_5

discuss seniors' known tracking practices, and the existing challenges to the design, adoption, and use of self-tracking technology for seniors. Although self-tracking techniques can be used for a range of purposes, including financial transactions or time spent commuting, we focus on health because to the best of our knowledge, most research involving self-tracking and seniors has focused on health applications. However, we highlight that given differences in seniors' perspectives, goals, and situations in different aspects of life (e.g., finances, retirement), it is likely that they will have different needs in other kinds of self-tracking as well. We do not include the perspectives of caregivers or assistive technology for seniors as they are outside of the scope of this chapter.

5.2 Self-tracking

The practice of registering information about oneself has existed as long as the written language (Rettberg 2014). Self-tracking consists of repeatedly measuring and recording information about oneself. The data collected might involve behavior (e.g., sleep), physiological measurements (e.g., heart rate), and contextual information (e.g., calendar appointments, weather). These data might be quantitative or qualitative (Li et al. 2011).

There are five main reasons behind tracking. First, self-knowledge can include learning about habits (e.g., how often one eats fruit), or learning about how an illness manifests (e.g., when symptoms occur). Second, behavior change is based on changing a habit, either by acquiring or eliminating it. Third, self-experimentation is based on evaluating the effects of a particular behavior or circumstance by self-tracking both when it is present and when it is not. Fourth, assessment involves temporarily observing a behavior or other measurement (e.g., measuring blood pressure daily for a week to estimate its average). Fifth, monitoring refers to continuously measuring a variable to observe short term or long-term patterns (e.g., how a behavior changes over the course of a week or a year) (Intille 2004; Li et al. 2011; Choe et al. 2014; Karkar et al. 2015; Caldeira et al. 2016).

Given the diverse possibilities in methods and reasons for tracking, this practice can take place very differently for different populations. Most current self-tracking technologies leverage mobile Internet connected devices. We consider self-tracking technology any digital system (both apps and devices) that help users collect or store their data. They include illness specific devices such as glucose meters and general-purpose systems such as activity trackers. Activity trackers are among the main self-tracking tools currently available, and the majority of papers included in this review focus on this kind of system. Their functionalities, assumptions, visual design, and advertising are focused on young and middle-aged adults. This focus is partially due to the relationship of self-tracking system industry with the Quantified Self community, which was created in the Silicon Valley and attracts a majority of technology enthusiasts (Choe et al. 2014). Assumptions held by these systems (e.g., more exercise is always better) may not hold for many seniors who have cardiovascular diseases, physical limitations due to disability or illnesses such as chronic pain, osteoporosis, and arthritis. These differences in needs and purposes behind tracking are particularly visible in the case of health, as the health of seniors differs from younger populations.

5.3 Method

This chapter provides an overview of research (Grant and Booth 2009) of literature investigating self-tracking among older adults. It covers more than 50 papers published between 2007 and 2017 in the fields of HCI and Medical Informatics. These papers were obtained through searches using keywords relevant to each topic (e.g., seniors, elderly, quantified self) in multiple search engines (e.g., ACM Digital Library, hcibib.org, Google Scholar). Additional papers were found iteratively by scanning each paper's references. Each paper included in this review met three criteria: written in English, focuses on self-tracking, and focuses primarily on seniors or provides specific data about this population (e.g. Fox and Duggan 2013). These papers were analyzed thematically. They provide insights into seniors' current use of self-tracking, their opinions and perspectives about self-tracking technology, and existing barriers to adoption and use. These findings are discussed in the following sections.

5.4 Seniors' Use of Self-tracking

Seniors' self-tracking practices and goals differ from other age groups. Unlike the younger age groups who primarily track to pursue fitness goals, seniors are more likely to track health indicators not related to fitness, such as blood pressure and blood glucose. In comparison with younger adults, they are also much less likely to use technologies such as mobile phones and computers to track, and more likely to use paper (Fox and Duggan 2013). They often use just memory rather than recording data, due to the effort required, disruption of routine, difficulty using tools, avoiding thinking about illness, and fearing to lose the data (Miller et al. 2013). Older adults' current use of technologies for tracking exercise focuses on monitoring and assessment rather than behavior change, as they do not believe it to be helpful as a motivation tool for increasing exercise habits (Caldeira et al. 2016, 2017). This issue explains the low adoption of tracking technology by seniors, and it is influenced by how they are designed for younger users' needs.

Studies investigating seniors' interests and use of specific tools have found promising results. Seniors have expressed interest in tracking several kinds of information (e.g., rest, social interactions, symptoms, and weight) (Davidson and Jensen 2013). Many studies have focused on tracking for the management of chronic illness among seniors, such as diabetes (Arnhold et al. 2014; Lo et al. 2014;

Whitlock et al. 2015), heart health (Karshmer and Karshmer 2004; Lorenz et al. 2007; Mohan et al. 2008), pain management (McCann et al. 2009; Barg-Walkow et al. 2013, 2014; Tsai et al. 2015), medication tracking (Sailer et al. 2015), and fall detection (Gonzalez et al. 2014).

Research on the use of technology for tracking exercise has led to mixed results for the older adult population. Step counting has shown a significant impact, such as 23–83% increase in step count after 6 months, and improvements in fear of falling, locomotive function, leg strength, walking speed, blood pressure, and weight (Snyder et al. 2011; Yamada et al. 2012; Ashe et al. 2015). In a study with participants over 50 years old using activity trackers, 45% reported increased motivation for healthier habits, and 46% reported increased activity, improved sleep or eating habits. Participants enjoyed learning about their exercise and sleep habits and confirming activity levels (AARP 2015; Burton 2016). Several other studies have also found positive results and experiences (Rasche et al. 2015; McMahon et al. 2016; Phillips et al. 2016; Schlomann et al. 2016). However, multiple studies found no significant increases in activity levels when incorporating a Fitbit into an existing intervention (McMurdo et al. 2010; Thompson et al. 2014). Strategies used to promote or facilitate physical activity have included personalized goal setting, problem solving, social comparisons and support (King et al. 2013), haptic feedback (Qian et al. 2010), wearable camera, activity tracker (Harvey et al. 2016), and video (Bagalkot and Sokoler 2011).

5.5 Barriers to Self-tracking Technology Adoption

Several factors limit seniors' adoption of self-tracking technology: mismatch between their needs with those of younger users, poor design for older adults, low perceived usefulness, ineffective motivation strategies, chronic illness related challenges, and attitude towards self-tracking technology. Table 5.1 shows a summary of these barriers, along with examples.

Due to the focus on younger users, existing technology does not meet many of seniors' needs. Older adults have shown more interest in tracking steps and heart rate, while younger users are more interested in sleep and distance (Rasche et al. 2016; Schlomann et al. 2016). Although the reason for the difference in preferences is unknown, it is likely that it is influenced by different goals, as seniors are more likely to use tracking as a tool in illness management, and younger users are more interested in prevention and fitness (Fox and Duggan 2013). Goals such as 10,000 daily steps can also cause overexertion in older adults (Schlomann et al. 2016).

Poor design for seniors is another issue that hinders the use of self-tracking technology. Issues such as inaccuracy, perceived inaccuracy, unclear instructions, and discomfort (AARP 2015; Burton 2016), difficulties setting up a device and interpreting data (Mercer et al. 2016), and insufficient error prevention (Preusse et al. 2017) discourage continued use of wearable activity trackers. Lack of accuracy can be a substantial problem for seniors as they value it more than other populations

(Rasche et al. 2016). Validation studies have found that activity trackers underestimated steps of free walking participants (i.e., those who did not use walk aids) by up to 27%, and accuracy was worse among those who used walkers (Floegel et al. 2016). For seniors who walk slowly or use walking aids, ankle worn devices tend to be more accurate (Simpson et al. 2015; Floegel et al. 2016; Klassen et al. 2016). Failing to detect steps when exercising differently than expected by the device, such as holding a treadmill bar, can also cause frustration in users (Fausset et al. 2013).

Perceived usefulness of exercise tracking devices is low, particularly among seniors who are already physically active (Fan et al. 2012). In general, seniors have been found to use these tools for monitoring purposes but not as a behavior change tool. This perception is attributed to seniors already knowing their habits and having little variation in routine, and finding technology less motivating than the benefits of exercise (e.g., reduced pain) (Caldeira et al. 2017).

Since seniors are more likely to use tracking as a tool for managing chronic conditions, they also experience more challenges caused by or related to these diseases. Seniors who use self-tracking to manage chronic conditions can experience an augmented awareness of the disease and its ill effects. Self-tracking symptoms or indicators related to a disease (e.g., blood pressure) can become a reminder of the users' health issues (Karshmer and Karshmer 2004). Anker et al. have described this

Table 5.1 Existing barriers for the use of self-tracking technology among seniors

Mismatch in tracking needs with younger age groups
Interested in tracking different data (e.g., heart rate, steps)
A higher focus on chronic illness management
Goals can be too ambitious for seniors (e.g., 10,000 steps/day)
Poor design for older adults
Lower accuracy of step tracking among seniors who walk slowly, use walking aids, or hold the handle on a treadmill
Wearable device bothers seniors' skin
Difficulties with setting up the device, syncing data, interpreting data
Low perceived usefulness
Less motivating than other benefits (e.g., reduced pain)
Already knowing habits, low variation in routine
Not provide enough benefits in comparison with paper (monitoring)
Inadequate motivation strategies
Theory-based strategies have a lower effect (e.g., goal setting)
Pre-existing motivation affects response to different strategies
Negative impact on Self-efficacy or Locus of control
Challenges related to chronic illness
Coping with illnesses
Reinforcing stigmatized aspects of aging
Increased awareness of illness
Attitude towards self-tracking technology
Distrusting system, preferring health provider
Quick abandonment
Increased rejection of tracking technology with age

experience as unpleasant, evoking intense negative emotions (Ancker et al. 2015). The stigma associated with old age, illness, and disability can cause resistance to the adoption of technology for health and assistance. Due to stigma, many seniors prefer mainstream tools (Light et al. 2015) and reject devices that have a medical aesthetic or are designed specifically for older adults (Durick et al. 2013). Even seniors in poor health conditions can often perceive other older adults as having worse health (White et al. 2012).

Further, an essential aspect of self-management for older adults is coping with an illness, and the changes it requires. Coping influences seniors' attitudes, which in turn affects the experience and outcomes of using health technology. Tools that highlight issues that have a negative impact on users' psychological well-being may hinder the process of coping with illness.

Theory-based strategies for behavior change (e.g., Transtheoretical Model of Behavior Change, Goal Setting Theory) are used often in self-tracking research and system design, as they increase the impact of interventions (Orji and Moffatt 2018). However, several strategies based on these theories (e.g., goal setting, prompting data collection) are significantly less effective for older adults in comparison with other age groups (French et al. 2014). Seniors are also often more interested in seeing mistakes than regular 'correct' behavior in the tracked data (Lee and Dey 2011). This tendency, along with an increased awareness of one's illness, may influence how they see themselves and their conditions. As a consequence, internal processes such as self-efficacy and health locus of control, which are linked to health management behavior and health outcomes (Cross et al. 2005), could be negatively impacted.

Lastly, different aspects of seniors' attitudes towards self-tracking technology limit their adoption and use. This population can distrust measurements and prefer to interact with a clinician (Karshmer and Karshmer 2004). In a project that investigated an intervention using activity trackers to promote physical activity, only participants who wanted to be active but needed more motivation found it beneficial. Active participants did not see it as useful as a motivational tool, and unmotivated seniors were more interested in playful approaches (Fan et al. 2012). Deployment studies also found that participants' attitudes towards these devices becomes increasingly negative over time, with most participants abandoning after two weeks (Fausset et al. 2013). Older seniors tend to use the devices less consistently, abandon earlier (AARP 2015; Burton 2016) and are more likely to perceive it as a 'gimmick' (Schlomann et al. 2016).

The barriers limiting the use of self-tracking technology are similar to barriers found for other kinds of systems among senior users: low perceived ease of use and usefulness (Conci et al. 2009), frustration, physical and mental limitations, and mistrust (Gatto and Tak 2008). However, the specific instances where these barriers have been identified reveal that seniors have very particular needs that are not addressed by existing technologies.

5.6 Overcoming Barriers

The barriers present for the adoption of self-tracking technology by seniors are plentiful and several factors need to be addressed. Primarily, both academia and industry must increase the involvement of seniors in the design of self-tracking devices. Increasing awareness of the benefits of activity trackers for this population is also essential to promote adoption (Fausset et al. 2013). Further, the design of self-tracking tools must become more adaptable to diverse needs, contexts, and abilities.

Seniors' attitudes and perceptions are key to increasing adoption. It is important for more projects to propose and test solutions to these issues through user-centered and participatory design approaches with seniors (Mitzner and Dijkstra 2017). Future research should investigate attitudes toward exercise, behavior change, and adoption of technology to inform the design of devices and interventions (Araullo and Potter 2016). Activity trackers should aim to meet seniors' goals, become more straightforward to set up, comfortable and unobtrusive to wear and become more engaging. Detailed and easy instructions, transparency about data collection, robustness, comfort, and targeting specific conditions are also required (AARP 2015; Burton 2016). Specific appropriate guidelines (e.g., ideal step count for seniors) could also help with interpreting data and setting goals (Schlomann et al. 2016). Making mainstream technology more friendly to seniors could help to reduce the barriers caused by stigma, and lead to cost-effective tools (Helal et al. 2008; Durick et al. 2013).

It is likely that cohort effects influence some of these barriers. Current challenges in design and adoption of technology for seniors are expected to be partially mitigated with time as technology improves, its use to assist seniors becomes more common, and individuals who are familiar with technology age into late life (Yusif et al. 2016). Because individuals' attitudes and preferences are affected by past life experiences (DeFriese and Ory 1998), it can be difficult to understand what findings are due to aging, and which are generational (Dean et al. 1986). However, it is likely that many aspects of existing barriers are not generation specific, as seniors' health and context are most likely partially responsible for several known barriers—including issues regarding accuracy, and the perceived usefulness of devices. Data on multiple cohorts are necessary to understand the effects of new technology on seniors (Casilari and Oviedo-Jiménez 2015). Still, working towards addressing the current known barriers is likely to benefit future generations of older adults.

5.7 Research Gaps and Future Directions

Beyond addressing barriers, there are opportunities for further research in other aspects of older adults' use of self-tracking technologies. Future studies investigating self-experiments, different kinds of tracking, and focusing on underrepresented populations could lead to valuable contributions.

Because assumptions and myths that underestimate seniors' health and abilities are common, research often focuses on seniors' deficits, illnesses, disabilities (Durick et al. 2013) and alienate the seniors who do not fit in those assumptions. Community-dwelling seniors do not necessarily share the same needs as the younger population, as their context is different (Durick et al. 2013). Thus, focusing on this population of capable but different senior users is important.

Self-experimenting can be a powerful application of self-tracking (Karkar et al. 2015), but little research has investigated this direction with seniors. This kind of tracking is particularly interesting for this population because seniors are very diverse, often needing to manage different conditions, past medical issues, and special needs. Seniors have the potential to benefit from self-experimentation, such as having more agency in their care and being able to make better-informed decisions about their health.

There is also much that can be pursued in regards to tracking that is not related to health care (e.g., Durrant et al. 2017). Better understanding this population's interests, perspectives, and usage of different kinds of tracking could inform the design of useful tools for them, while at the same time generating valuable in-sights for health-focused tracking.

A better representation of seniors' in their diverse contexts is necessary to design technologies that meet their needs. While a few of the cited works include a large representative sample of seniors (e.g., Fox and Duggan 2013, most studies in this area have focused on small samples with low diversity. Seniors with different health contexts, ages, and professional background might have different perspectives towards self-tracking and self-tracking technology (Dugas et al. 2018).

Further, many studies exclude or under represent seniors in their participants or subjects. This issue is aggravated by the evidence of stigma and rejection of tools meant for older adults. Increasing the inclusion of this population in regular studies could provide more insights about the perspectives of independent older adults, and promote design that considers their needs (Davidson and Jensen 2013), even for systems that are not designed particularly for this population. While systems have been designed specifically for seniors (Tedesco et al. 2017), many of them might prefer to use technology designed for the general population.

Lastly, many technologies for senior health target older adults with special needs or their caregivers. However, the aging process is gradual, and there is potential for leveraging both self-tracking and monitoring to offer adequate support for seniors who are at risk for cognitive decline but are still independent. Because self-tracking is more empowering in comparison with monitoring by a third party, it could help fulfill some of the functions of monitoring while lowering issues caused by stigma or power imbalance. This approach can be implemented by sharing tracked data with seniors' adult children (Binda et al. 2017).

5.8 Pursuing Actionable Insights

Most of the research investigating seniors' use of self-tracking has been published in the Medical Informatics field, and their reported findings are often not granular enough to inform technology design. Medical informatics articles often investigate tools that are similar to the work found in the HCI literature. However, they tend to focus on medically relevant outcomes, such as changes in activity levels and hospital admission rates, rather than on the system itself (e.g., Snyder et al. 2011; Yamada et al. 2012; Ashe et al. 2015). These studies tend to evaluate complex intervention programs that include elements such as educational materials, communication with clinicians, and multi-component systems (e.g., McMurdo et al. 2010; Thompson et al. 2014). This literature seeks to validate interventions' effectiveness, prioritizing this measure over understanding the elements that influence effectiveness, such as system design and user experience.

These projects help us to understand the impact that technological tools have on measurable health indicators (e.g., strength, physical fitness), and healthcare outcomes (e.g., costs of care over a period, rates of hospital readmission). They provide evidence of the health benefits of many health technologies, an essential aspect of evaluating these systems that the HCI field does not address. Evidence about the benefits of health technology supports future studies in HCI. However, these methods cannot provide insights into what kinds of elements of intervention influenced the results.

As argued by Klasnja et al. (2017), moving the field forward requires testing smaller elements of an intervention, such as single elements of an interface, rather than an entire system. The results of a multi-element intervention inform us about how successful that strategy is, but does not evaluate which components are responsible for the success. Understanding the role and influence of different elements in technology is essential for improving upon existing systems. Thus, it is crucial for future research to approach seniors' relationship with self-tracking through design focused studies, that inform us about which elements of tracking systems lead to improvements in their use by seniors.

References

AARP (2015) Building a better tracker: older consumers weigh in on activity and sleep monitoring devices

Ancker JS, Witteman HO, Hafeez B et al (2015) "You get reminded you're a sick person": personal data tracking and patients with multiple chronic conditions. J Med Internet Res 17:e202

Araullo J, Potter LE (2016) Promoting physical activity in seniors: future opportunities with emerging technologies. In: Proceedings of the 2016 ACM SIGMIS conference on computers and people research. ACM, pp 57–64

Arnhold M, Quade M, Kirch W (2014) Mobile applications for diabetics: a systematic review and expert-based usability evaluation considering the special requirements of diabetes patients age 50 years or older. J Med Internet Res 16:e104

Ashe MC, Winters M, Hoppmann CA et al (2015) “Not just another walking program”: everyday activity supports you (EASY) model—a randomized pilot study for a parallel randomized controlled trial. Pilot Feasibility Stud 1:4

Bagalkot N, Sokoler T (2011) MagicMirror: towards enhancing collaborative re-habilitation practices. In: Proceedings of the ACM 2011 conference on computer supported cooperative work. ACM, pp 593–596

Barg-Walkow LH, McBride SE, Morgan MJ et al (2013) How do older adults manage osteoarthritis pain? The need for a person-centered disease model. Proc Hum Factors Ergon Soc Annu Meet 57:743–747. https://doi.org/10.1177/1541931213571162

Barg-Walkow LH, McBride SE, Morgan Jr MJ et al (2014) Efficacy of a system for tracking and managing osteoarthritis pain for both healthcare providers and older adults. In: Proceedings of the international symposium on human factors and ergonomics in health care. Sage, New Delhi, India, pp 108–111

Binda J, Park H, Carroll JM et al (2017) Intergenerational sharing of health data among family members. In: Proceedings of the 11th EAI international conference on pervasive computing technologies for healthcare. ACM, pp 468–471

Burton KE (2016) Evaluating activity and sleep tracking technologies for older adults. Georgia Institute of Technology

Caldeira C, Bietz M, Chen Y (2016) Looking for the unusual: how older adults utilize self-tracking techniques for health management. In: Proceedings of the 10th EAI international conference on pervasive computing technologies for healthcare, pp 227–230

Caldeira C, Bietz M, Vidauri M et al (2017) Senior care for aging in place: balancing assistance and independence. In: Proceedings of the 2017 ACM conference on computer supported cooperative work and social computing. ACM, pp 1605–1617

Casilari E, Oviedo-Jiménez MA (2015) Automatic fall detection system based on the combined use of a smartphone and a smartwatch. PLoS ONE 10:e0140929

Choe EK, Lee NB, Lee B et al (2014) Understanding quantified-selfers’ practices in collecting and exploring personal data. ACM, New York, NY, USA, pp 1143–1152

Conci M, Pianesi F, Zancanaro M (2009) Useful, social and enjoyable: mobile phone adoption by older people. In: IFIP conference on human-computer interaction. Springer, pp 63–76

Cross MJ, March LM, Lapsley HM et al (2005) Patient self-efficacy and health locus of control: relationships with health status and arthritis-related expenditure. Rheumatology 45:92–96

Davidson JL, Jensen C (2013) What health topics older adults want to track: a participatory design study. In: Proceedings of the 15th international ACM SIGACCESS conference on computers and accessibility. ACM, p 26

Dean K, Hickey T, Holstein BE (1986) Self-care and health in old age: health behaviour implications for policy and practice. Routledge, London

DeFriese GH, Ory MG (1998) Self care in later life: research, program, and policy issues. Springer Publishing, New York

Dugas M, Crowley K, Gao GG et al (2018) Individual differences in regulatory mode moderate the effectiveness of a pilot mHealth trial for diabetes management among older veterans. PLoS ONE 13:e0192807. https://doi.org/10.1371/journal.pone.0192807

Durick J, Robertson T, Brereton M et al (2013) Dispelling ageing myths in technology design. In: Proceedings of the 25th australian computer-human interaction conference: augmentation, application, innovation, collaboration. ACM, pp 467–476

Durrant A, Kirk D, Trujillo Pisanty D et al (2017) Transitions in digital person-hood: online activity in early retirement. In: Proceedings of the 2017 CHI conference on human factors in computing systems. ACM, pp 6398–6411

Fan C, Forlizzi J, Dey A (2012) Considerations for technology that support physical activity by older adults. In: Proceedings of the 14th international ACM SIGACCESS conference on computers and accessibility. ACM, pp 33–40

Fausset CB, Mitzner TL, Price CE et al (2013) Older adults' use of and attitudes toward activity monitoring technologies. In: Proceedings of the human factors and ergonomics society annual meeting. Sage, Los Angeles, CA, pp 1683–1687
Floegel TA, Florez-Pregonero A, Hekler EB et al (2016) Validation of consumer-based hip and wrist activity monitors in older adults with varied ambulatory abilities. J Gerontol Ser Biomed Sci Med Sci 72:229–236
Fox S, Duggan M (2013) Tracking for health. Pew Research Center's Internet & American Life Project
French DP, Olander EK, Chisholm A et al (2014) Which behaviour change techniques are most effective at increasing older adults' self-efficacy and physical activity behaviour? A systematic review. Ann Behav Med 48:225–234
Gatto SL, Tak SH (2008) Computer, internet, and e-mail use among older adults: benefits and barriers. Educ Gerontol 34:800–811
Gonzalez ET, Jones AM, Harley LR et al (2014) Older adults' perceptions of a neckwear health technology. In: Proceedings of the human factors and ergonomics society annual meeting. Sage, Los Angeles, CA, pp 1815–1819
Grant MJ, Booth A (2009) A typology of reviews: an analysis of 14 review types and associated methodologies. Health Inf Libr J 26:91–108
Harvey JA, Skelton DA, Chastin SF (2016) Acceptability of novel life logging technology to determine context of sedentary behaviour in older adults. AIMS Public Health 3:158–171
Helal A, Mokhtari M, Abdulrazak B (2008) The engineering handbook of smart technology for aging, disability and independence. Wiley, Hoboken
Intille SS (2004) Ubiquitous computing technology for just-in-time motivation of behavior change. Medinfo 107:1434–1437
Karkar R, Zia J, Vilardaga R et al (2015) A framework for self-experimentation in personalized health. J Am Med Inform Assoc 23:440–448
Karshmer JF, Karshmer AI (2004) A computer-based self-health monitoring system for the elderly living in a low income housing environment. In: K Miesenberger, J Klaus, WL Zagler, D Burger (eds) International conference on computers for handicapped persons. Springer, New York, pp 385–391
King AC, Hekler EB, Grieco LA et al (2013) Harnessing different motivational frames via mobile phones to promote daily physical activity and reduce sedentary behavior in aging adults. PLoS ONE 8:e62613
Klasnja P, Hekler EB, Korinek EV et al (2017) Toward usable evidence: optimizing knowledge accumulation in HCI research on health behavior change. In: Proceedings of the 2017 CHI conference on human factors in computing systems. ACM, pp 3071–3082
Klassen TD, Simpson LA, Lim SB et al (2016) "Stepping Up" activity poststroke: ankle-positioned accelerometer can accurately record steps during slow walking. Phys Ther 96:355–360
Lee ML, Dey AK (2011) Reflecting on pills and phone use: supporting awareness of functional abilities for older adults. ACM, New York, NY, USA, pp 2095–2104
Li I, Dey AK, Forlizzi J (2011) Understanding my data, myself: supporting self-reflection with ubicomp technologies. In: Proceedings of the 13th international conference on ubiquitous computing. ACM, New York, NY, USA, pp 405–414
Light A, Leong TW, Robertson T (2015) Ageing well with CSCW. In: ECSCW 2015: proceedings of the 14th European conference on computer supported cooperative work, 19–23 September 2015, Oslo, Norway. Springer, pp 295–304
Lo H-C, Tsai C-L, Lin K-P et al (2014) Usability evaluation of home-use glucose meters for senior users. In: International conference on human-computer interaction. Springer, pp 424–429
Lorenz A, Mielke D, Oppermann R et al (2007) Personalized mobile health monitoring for elderly. In: Proceedings of the 9th international conference on human computer interaction with mobile devices and services. ACM, pp 297–304

McCann L, Maguire R, Miller M et al (2009) Patients' perceptions and experiences of using a mobile phone-based advanced symptom management system (ASyMS\copyright) to monitor and manage chemotherapy related toxicity. Eur J Cancer Care (Engl) 18:156–164
McMahon SK, Lewis B, Oakes M et al (2016) Older adults' experiences using a commercially available monitor to self-track their physical activity. JMIR mHealth uHealth 4:e35
McMurdo ME, Sugden J, Argo I et al (2010) Do pedometers increase physical activity in sedentary older women? A randomized controlled trial. J Am Geriatr Soc 58:2099–2106
Mercer K, Giangregorio L, Schneider E et al (2016) Acceptance of commercially available wearable activity trackers among adults aged over 50 and with chronic illness: a mixed-methods evaluation. JMIR mHealth uHealth 4:e7
Miller S, Mutlu B, Lee J (2013) Artifact usage, context, and privacy management in logging and tracking personal health information in older adults. In: Proceedings of the human factors and ergonomics society annual meeting. Sage, Los Angeles, CA, pp 1027–1031
Mitzner TL, Dijkstra K (2017) Evaluating user-centered design of e-health for older adults. In: Health care delivery and clinical science: concepts, methodologies, tools, and applications, p 338
Mohan P, Marin D, Sultan S et al (2008) MediNet: personalizing the self-care process for patients with diabetes and cardiovascular disease using mobile telephony. In: Engineering in medicine and biology society, EMBS 2008. 30th annual international conference of the IEEE. IEEE, pp 755–758
Orji R, Moffatt K (2018) Persuasive technology for health and wellness: state-of-the-art and emerging trends. Health Inform J 24:66–91
Phillips LJ, Petroski GF, Conn VS et al (2016) Exploring path models of disablement in residential care and assisted living residents. J Appl Gerontol https://doi.org/10.1177/0733464816672048
Preusse KC, Mitzner TL, Fausset CB et al (2017) Older adults' acceptance of activity trackers. J Appl Gerontol 36:127–155
Qian H, Kuber R, Sears A (2010) Maintaining levels of activity using a haptic personal training application. In: CHI'10 extended abstracts on human factors in computing systems. ACM, New York, NY, USA, pp 3217–3222
Rasche P, Wille M, Theis S et al (2015) Activity tracker and elderly. In: 2015 IEEE international conference on computer and information technology; ubiquitous computing and communications; dependable, autonomic and secure computing; pervasive intelligence and computing (CIT/IUCC/DASC/PICOM). IEEE, pp 1411–1416
Rasche P, Wille M, Theis S, Schäfer K, Schlick CM, Mertens A (2016) Self monitoring—an age-related comparison. In: D de Waard, KA Brookhuis, A Toffetti, A Stuiver, C Weikert, D Coelho, D Manzey, AB Ünal, S Röttger, N Merat (eds). Proceedings of the Human Factors and Ergonomics Society Europe Chapter 2015 Annual Conference (pp.7–19)
Rettberg JW (2014) Seeing ourselves through technology: how we use selfies, blogs and wearable devices to see and shape ourselves. Palgrave Macmillan, London
Sailer F, Pobiruchin M, Wiesner M et al (2015) An approach to improve medication adherence by smart watches. In: MIE, pp 956–958
Schlomann A, von Storch K, Rasche P et al (2016) Means of motivation or of stress? The use of fitness trackers for self-monitoring by older adults. Motivierend oder überfordernd? Die Nutzung von Fitness Trackern zum Selbst-Monitoring älterer Menschen. HeilberufeScience 7:111–116
Simpson LA, Eng JJ, Klassen TD et al (2015) Capturing step counts at slow walking speeds in older adults: comparison of ankle and waist placement of measuring device. J Rehabil Med 47:830–835
Snyder A, Colvin B, Gammack JK (2011) Pedometer use increases daily steps and functional status in older adults. J Am Med Dir Assoc 12:590–594
Tedesco S, Barton J, O'Flynn B (2017) A review of activity trackers for senior citizens: research perspectives, commercial landscape and the role of the insurance industry. Sensors 17:1277
Thompson WG, Kuhle CL, Koepp GA et al (2014) "Go4Life" exercise counseling, accelerometer feedback, and activity levels in older people. Arch Gerontol Geriatr 58:314–319

Tsai W-C, Chang C-L, Lin H (2015) The design of pain management and creative service for older adults with chronic disease. In: International conference on human aspects of IT for the aged population. Springer, pp 201–210

Ward BW, Schiller JS, Goodman RA (2014) Peer reviewed: multiple chronic conditions among us adults: a 2012 update. Prev Chronic Dis 11:E62

White GE, Connelly KH, Caine KE (2012) Opportunities for ubiquitous computing in the homes of low SES older adults. In: Proceedings of the 2012 ACM conference on ubiquitous computing. ACM, pp 659–660

Whitlock LA, McLaughlin AC, Harris M, Bradshaw J (2015) The design of mobile technology to support diabetes self-management in older adults. In: International conference on human aspects of IT for the aged population. Springer, pp 211–221

Yamada M, Mori S, Nishiguchi S et al (2012) Pedometer-based behavioral change program can improve dependency in sedentary older adults: a randomized controlled trial. J Frailty Aging 1:39–44

Yusif S, Soar J, Hafeez-Baig A (2016) Older people, assistive technologies, and the barriers to adoption: a systematic review. Int J Med Inf 94:112–116

Clara Caldeira is a Ph.D. candidate in the Informatics department at the University of California, Irvine. Her research on the fields of HCI and Health Informatics focuses on technology for self-care, particularly among older adults, and people with chronic conditions. Clara received a Master's degree in Informatics from UC Irvine in 2018 and a Bachelor's degree in Computer Science from the University of Brasilia in 2013.

Yunan Chen is an Associate Professor of Informatics at the University of California, Irvine. Her research interests lie in the intersection of Human-Computer Inter-action, Computer Supported Cooperative Work, and Health Informatics. In particular, she is interested in clinical documentation, patient-provider interaction and personal information management during chronic care. Yunan received a PhD degree from the iSchool at Drexel University in 2008, and a Bachelor of Medicine degree from China Medical University in 2003

Chapter 6
Designing Mid-Air Gesture Interaction with Mobile Devices for Older Adults

Michela Ferron, Nadia Mana and Ornella Mich

6.1 From the Compensation Model to Engagement

Within the field of Human-Computer Interaction (HCI), ageing has become a primary research area that is expected to grow even more. However, the dominant research approach of HCI for older people seems to be a step behind with respect to the mainstream trend of HCI, which values the emotional aspects of user experience (UX), the empowerment of users and value-sensitive design (Harrison et al. 2011).

Indeed, a major strand of research in this field has conceptualized ageing as a slow but steady process that eventually leads to functional decline and extended needs. This strand has been mainly focusing on designing assistive technologies that can compensate for older people's frailties and disabilities. Consistently with the first wave of HCI, inspired by engineering and human factors and devoted to optimizing the fit between humans and computers (Harrison et al. 2011), this approach is functional for inclusive design, and for accommodating cognitive and physical decline occurring with ageing by compensating such decline and focusing on usability and accessibility. However, if taken alone, it is biased and incomplete.

Another important research area involving older adults and HCI has aimed at designing technology to support healthy ageing, independent living and those other needs that are assumed to arise with ageing, fostering an active lifestyle and computer-mediated communication with peers and relatives. These aspects are consistent with

M. Ferron (✉) · N. Mana · O. Mich
Fondazione Bruno Kessler, Trento, Italy
e-mail: ferron@fbk.eu

N. Mana
e-mail: mana@fbk.eu

O. Mich
e-mail: mich@fbk.eu

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_6

the second wave of HCI, along with effective methods to involve older people into the design process, such as participatory design and contextual inquiry (Bødker 2006).

In the third wave of HCI, focused on embodied interaction, empowerment of users and value-sensitive design (Harrison et al. 2011), contexts of use of technology broadened and spread to our homes and everyday lives, by valuing emotional aspects of user experience. However, when designing for older adults, it seems that these aspects are not commonly taken into consideration (Rogers and Marsden 2013) and technological solutions are still designed to compensate for some kind of lack or frailty (Ryan et al. 1992). Nevertheless, research has now widely shown that the ageist stereotype does not generally apply to older adults, who are not intrinsically reluctant towards technology and consider themselves as active actors in society.

New approaches can be adopted to reframe the relationship between ageing and technology, overcoming the compensation model towards the empowerment of people, the inclusion of pleasure, the value-based design and the development of new interaction modalities. Among the latter, there is mid-air gesture interaction, i.e. interaction based on the automatic recognition of user's hand and arm movements around the device. To date, mid-air gesture interaction has received a growing attention in HCI, but so far, research has mainly targeted younger users because this kind of interaction is often described as fun, targeted for the technology-savvy, and thus often used in gaming and entertaining contexts. Although mid-air gestures can potentially make the interaction not only fun but also easy, intuitive and natural, this novel way of interacting with technology has not been targeted to older users yet. However, mid-air gesture interaction cannot only overcome some accessibility issues occurring with age, but also make the interaction more pleasant and engaging for older users too.

In this chapter, we (1) present the main characteristics of mid-air gesture interaction and discuss the most prominent design challenges for older adults, (2) describe how we approached the design of this kind of interaction through a user-centered approach, and finally (3) we propose a set of recommendations for the design of mid-air gesture interaction with mobile devices for older adults.

6.2 Mid-Air Gesture Interaction and Design Challenges

Gestures, classified in touch-based and mid-air gestures, have become one of the main ways to interact with digital tools. In particular, mid-air gestures cover different types of interaction, such as manipulation of digital objects (Cockburn et al. 2011), menu selection (Ni et al. 2011) or text entry (Markussen et al. 2014), and are becoming increasingly popular due to the availability of effective automatic gesture recognition technology.

Mid-air gestures can be categorized in micro and macro gestures. The former involve the movement of a finger or a hand (Wigdor and Wixon 2011), whereas the latter comprise arm or body movement (England 2011). Some activities may be more compatible with either micro (e.g., interaction with mobile devices) or macro air gestures (e.g., for health and rehabilitation applications), whereas others are compatible with both (e.g., for entertainment, where micro air gestures are suitable for leap motion or tablet devices and macro gestures for Kinect device; Cronin 2014).

Mid-air gestures can also be classified according to their mapping to the intended task (Hurtienne et al. 2010; Ruiz et al. 2011) in: (1) real-world metaphorical gestures, which are representations of everyday-life actions or objects (e.g., the gesture of opening a book for opening the menu of an application), (2) physical/deictic gestures, which refer to spatial information and comprise a direct relation between the gesture and a manipulated object, (3) symbolic gestures, which are highly conventional and require learning and interpretation (e.g., tracing an "M" with the hand to open the Menu), and (4) abstract gestures, characterized by arbitrary mapping (e.g., moving the arm upward for opening the menu). Especially when targeting beginners, occasional users and diverse user groups such as older adults, designing for intuitive use is crucial for an effective interaction. For an effective interaction, the system should allow users to apply prior knowledge (Hurtienne and Blessing 2007). To this end, metaphorical or physical/deictic gestures should be preferred to increase logical functionality and make recall easier. Concerning memorability, Nacenta et al. (2013) also found that user-defined gestures are easier to remember.

Most studies evaluating gestural interfaces for older adults fall within the gaming and physical activity contexts. In these areas, research focusing on the acceptance of mid-air gestures found a generally positive attitude of older adults towards this type of interaction. For example, Gerling et al. (2013) compared two types of interaction (computer mouse and gesture-based) with younger and older adults, and found that older participants used the motion-based controls efficiently and overall enjoyed the interaction, not perceiving it as more exhausting than younger participants. Interestingly, older adults welcomed fatigue to a certain extent, whereas younger participants considered the increased physical effort as a negative aspect of the interaction. Gerling et al. (2012) created four static and four dynamic gestures for a full-body motion-control game in collaboration with a physical therapist in a nursing home, and found that playing the gestural game had a beneficial effect on participants' mood. However, they also pointed out that recalling gestures was a difficult challenge for seniors. Hassani et al. (2011) developed a robot that helped seniors to perform physical exercises and compared two simple input modalities: touch and gesture-based. To move to the next exercise, participants had to tap a touch device or perform a next gesture. Participants rated the mid-air gesture interaction more positively compared to the touch interaction, suggesting that they found it an easy interaction modality.

When designing gesture interaction, social acceptability has to be considered above all due to politeness conventions for gestural use depending on the cultural context (Vaidyanathan and Rosenberg 2014). For example, Rico and Brewster (2010) examined the social acceptability of eight common body and device-based gestures, where the former involved body movements without using a mobile device (i.e., head nodding), while the latter involved touching or moving a mobile device (i.e., shaking a mobile phone). The authors found that both location and audience can significantly impact on users' willingness to perform gestures. In particular, location providing more privacy and familiar audiences showed higher acceptability rates.

Moreover, device-based gestures, which clearly showed that the action was related to the interaction with a mobile device, were more likely to be used than body-based gestures. Although participants in this study were aged from 22 to 55 for the survey-based study, and from 21 to 28 for the field study, these results suggest that gestures may be generally acceptable in public settings if they are clearly device-based. Few studies investigated gesture acceptance for older adults, especially in private, indoor settings. For example, Bobeth et al. (2012) used the technology acceptance questionnaire (TAM; Venkatesh and Bala 2008) to assess the acceptance of freehand gesture-based menu interactions in a private TV-control setting, and found a high level of acceptance in terms of usability, behavioral intention and enjoyment.

Also, memorability and fatigue (gorilla arm effect; Boring et al. 2009) should be paid particular attention when designing gestures for seniors. Concerning memorability, Nacenta et al. (2013) found that user-defined gestures are easier to remember. With regard to fatigue, centralized positions of the arms with minimal joint extensions were found to be less tiring (Hincapié-Ramos et al. 2014).

6.3 The ECOMODE Project: A Series of Studies on Designing Mid-Air Gesture Interaction

Designing effective mid-air gesture is challenging because current technology still lacks robustness and reliability to compel to restrictive environmental operating conditions: for example, neither video nor infrared technologies reliably work outdoors. In order to tackle these limitations, new sensing technology is under development in the ECOMODE project, funded by the EU H2020. The project aims at realizing a new generation of low-power multimodal human-computer interfaces for mobile devices, combining voice commands and mid-air gestures, by exploiting an event-driven compressive (EDC) biology-inspired technology (Camunas-Mesa et al. 2012).

The design of the ECOMODE technology followed an iterative approach based on the user-centered framework (Maguire 2001): it started by investigating users' needs and desires through reviewing the literature, testing commercial tools and organizing studies with target users (Mana et al. 2017) (see Fig. 6.1—Understand). The findings of this first step guided the interaction design, informing the design of the prototype, which was finally evaluated with experts and end users. The process was then iteratively repeated to further refine the design specifications and improve the technology, until the final version.

Here, we describe a series of studies that we carried out to understand the design space and how older users approach and perceive mid-air gesture interaction (Table 6.1).

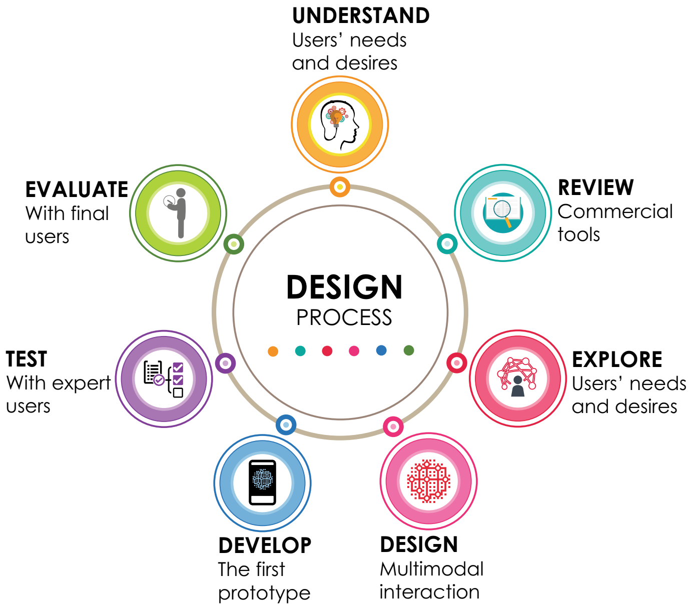

Fig. 6.1 The iterative design process of the ECOMODE technology

6.3.1 Understanding the Design Space

To reach a global view of the boundaries of our design space, we carried out preliminary research with experts and older users (Ferron et al. 2015). We performed interviews with experts to investigate current practices concerning the use of digital technologies among older adults, their needs and desires, aiming to detect an appropriate use case for the development of multimodal (mid-air gestures and speech) interaction. Experts highlighted that, in their experience, older adults tended to regard the tablet as a means of entertainment and to maintain social connections, showing interest in learning to use the camera and to share pictures with others. We conducted a study involving six older adults, asking them to use smartphones and tablets to take photographs with a traditional touchscreen. In this preliminary study, we aimed at detecting common pitfalls that mid-air and speech interaction could overcome.

Both the interviews and our observations showed that older adults were generally interested in learning to use tablet PCs, especially if they support their needs (e.g., to communicate with relatives). However, experts also highlighted that hardware components of tablet PCs (e.g., on/off button, charging port) may be uncomfortable because of being too little or fragile. Moreover, dexterity issues may cause problems for senior citizens performing touch gestures and introduce difficulties in selecting small icons, whereas low vision may cause problems in reading small labels.

Table 6.1 Summary of user studies, description of participants and main results

Study	What	Participants	Method	Results
Understanding the design space (Sect. 3.1; Ferron et al. 2015)	Investigation of user needs and practices related to digital technologies among older adults	2 senior association experts; 6 older adults	Interview; observation of interaction with touchscreen mobile devices	First conceptualization of the design space; Characterization of target users and their needs
Test with commercial tools (Sect. 3.2; internal project report)	Investigation of existing tools on the market targeted to older adults, employing mid-air gesture interaction	A pool of experts; 2 older adults	Practical tests; observation of think aloud sections	Characterization of target users respect to the interaction based on mid-air gesture
Process for designing a gesture set (Sect. 3.3; internal project report)	Design of a new gesture set through a participatory and task-based approach	3 older adults	Video recording; passive observation; questionnaires	A set of mid-air gestures; a list of guidelines for designing effective gestures
Exploring the UX of mid-air gesture interaction with mobile technology (Sect. 3.4; Schiavo et al. 2016)	Overview of WoZ methods in HCI for older adults	–	Wizard-of-Oz (WoZ) approach	The WoZ technique improves engagement and participation in the design process
Satisfaction and comfort (Sect. 3.5; Mana et al. 2017)	Investigation of perceived satisfaction and comfort of multimodal interaction (mid-air gestures + speech)	10 older adults	Video recording; passive observation; questionnaires	Characterization of target users with respect to the multimodal interaction

(continued)

Table 6.1 (continued)

Study	What	Participants	Method	Results
Mid-air gesture interaction: older adults vs middle-aged and younger adults (Sect. 3.6; Mana et al. 2017)	Comparison of different types of users with respect to the mid-air gestures interaction	10 older adults; 10 middle aged; 10 younger adults	Video recording; passive observation; interviews	In-depth knowledge of how older adults use mid-air gesture-based interaction compared to users of different age
Data collection of a mid-air gestures dataset (Sect. 3.7; Ferron et al. 2018)	Collection of video recording of older adults performing different mid-air gestures	20 older adults	Observations; questionnaires	Consolidation of knowledge related to older adults and mid-air gesture-based interaction
Fatigue and mid-air gesture interaction (Sect. 3.8; Ferron et al. 2018)	Investigation of fatigue perceived by the older adults while using a tablet interacting with mid-air gestures	17 older adults	Questionnaires	A continuous short interaction (less than 6 min) based on mid-air gestures is feasible for older adults
Unfolding the values of mid-air gesture interaction (Sect. 3.9; internal project report)	Investigation of the perceived benefits and values related to mid-air gestures used for accomplishing a task resembling an example of daily activity for older adults	22 older adults	UX Laddering technique	Older adults value the fact that mid-air gesture-based interaction does not need fine movements and it allows interacting with the device with unclean hands

Finally, we confirmed that gestures designed for older adults should be natural and easy to memorize and perform, in order to make the technology more pleasant, inclusive and acceptable (Jayroe and Wolfram 2012; Pernice and Nielsen 2012).

6.3.2 Test with Commercial Tools

To investigate the characteristics of existing tools on the market targeted to older adults and employing different interaction modalities, we asked a pool of experts to test nine commercial tools based on touch, mid-air gestures and voice interaction. Four of these were tested on tablet (Eldy,[1] Wave-o-rama,[2] Breezie[3] and Myo Air Gesture Armband[4]), four on smartphone (Apple Siri, Aire Gesture Control,[5] Easy Smartphone[6] and Big Launcher[7]), and one on smartwatch (Samsung Geo 2 Neo[8]). Four were specifically designed for elderly people and two of them (EasySmart Phone and Big Launcher) were launchers. Four systems (Myo, Wave-o-rama, Air Gesture Control, and Geo 2 Neo) included mid-air gesture interaction, although three were still limited at the time of the expert evaluation.

Then, in order to better explore UX and ergonomic aspects of mid-air gesture interaction in an entertainment context, we conducted an exploratory study with two participants employing the Myo Air Gesture Armband; it allows for controlling computer applications by a set of touchless gestures. We observed difficulties in remembering the sequence of gestures and in performing the unlock gesture, which participants found uncomfortable. Overall, participants considered the interaction modality interesting, fun and playful, but also not efficient. They suggested alternative applications of touchless interaction, e.g., remote control of applications with dirty hands. Furthermore, the study highlighted the importance of minimal physical effort (e.g., avoiding strong pressure or excessive rotation of the wrist and forearm). Similarly, complex mid-air gestures that are difficult to memorize (e.g., combination of more basic gestures) should be avoided or limited.

[1] http://www.eldy.org/.

[2] http://www.nanocritical.com/wave-o-rama/.

[3] https://www.breezie.com/.

[4] https://www.myo.com/.

[5] https://play.google.com/store/apps/details?id=in.tank.corp.proximity&hl=en.

[6] https://play.google.com/store/apps/details?id=com.ewtech.launcher&hl=it.

[7] https://play.google.com/store/apps/details?id=name.kunes.android.launcher.activity&hl=en

[8] http://www.samsung.com/it/consumer/mobile-devices/wearables/gear/SM-R3810ZKAITV/.

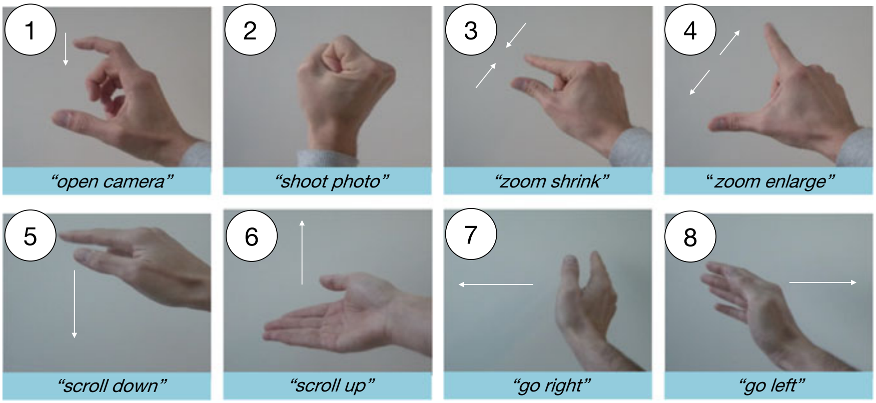

Fig. 6.2 The mid-air gesture set, result of the participatory design session

6.3.3 Design of a Gesture Set

We followed a participatory and task-based approach to design a usable and effective set of mid-air gestures (Nielsen et al. 2004). Taking pictures was the task chosen, which had to be performed with a tablet not resting on a surface but held in a hand. Three adults were involved. They worked separately, using the same tablet, a Samsung Galaxy TabS with a display of 10.5″, and following the same list of subtasks (open the camera app, select a special effect, zoom in or out, take the picture, open the galley, scroll back and forth). Each person was asked to freely design and then describe a mid-air gesture for each of the subtasks. The resulting mid-air gestures were analyzed by two usability experts, who selected them and defined the final set (Fig. 6.2).

Some general considerations made by the three participants involved in this study were:

- the tablet PC is heavy (more or less 500 gr with the cover); holding it with a single hand while performing mid-air gestures with the other one to interact is tiresome;
- it is fundamental to check the field of view of the camera on the tablet, to be sure that also mid-air gestures performed not exactly in front of the tablet are recognized;
- in order to understand if a gesture has been recognized, it is crucial to get a feedback.

6.3.4 The Wizard of Oz Approach

In order to explore the UX of mid-air gesture interaction with mobile technology for elderly users, we conducted a series of studies implementing the Wizard-of-Oz (WoZ) approach (Green and Wei-Haas 1985), which has been shown valuable for developing gesture interfaces (Carbini et al. 2006). WoZ experiments simulate the response of an apparently fully functioning system, whose missing functions are supplemented by a human operator called "wizard".

This approach offers the advantage of testing new user interface concepts before the technology is mature enough, considering different scenarios. It also facilitates gathering qualitative and quantitative data on user's preferences and usage patterns, and depending on the study setup, it might enable creative responses. Older adults can contribute at various stages of the design process, for example providing their opinions on the prototypes or discussing features of future technology. The WoZ technique, which supports older adults in the physical exploration of technological prototypes, can also improve their engagement and participation in the design process (Schiavo et al. 2016).

6.3.5 Satisfaction and Comfort

To explore the perceived satisfaction and comfort of multimodal interaction—gestures + speech—with a tablet device, an exploratory study with WoZ was conducted by involving ten volunteers (5 females; M = 69; SD = 3.62). The participants were asked to perform multimodal interaction with a tablet device while taking pictures by using a set of predefined mid-air gestures and voice commands (Mana et al. 2017). The video recordings of the experimental sessions were analyzed to measure the distance between gesture and tablet device, as well as the distance between user's face and tablet: most of the participants (8 out of 10) performed the gestures very close to the device (6–15 cm), whereas they held it at about 30–40 cm from the face.

By asking the participants to self-report satisfaction, ratings for taking photos with the tablet device using a multimodal interaction were on average high: on a scale from 1 to 5, participants reported a mean value of 4.4 (SD = 0.48). Four participants stated they would use this device during a trip outdoor. On average, holding the tablet with one hand was not perceived as an obstacle (M = 4.10, SD = 0.99) and making gestures using the tablet was considered quite comfortable (M = 3.75, SD = 1.03).

6.3.6 Mid-Air Gesture Interaction: Older Adults vs Middle-Aged and Younger Adults

To go deeper into how older adults approach mid-air gesture interaction, we explored with a WoZ study how older (65+), middle-aged (55–65 years old) and younger adults (25–35) used mid-air gestures and voice commands interaction in a common activity, such as taking photos with a tablet device. We proposed the use of both mid-air gestures and vocal commands to create a more natural interaction, even if here we focus specifically on mid-air gestures.

Thirty participants (10 for each age group, 5 females and 5 males for each group) were asked to take some pictures with a tablet by using the set of predefined mid-air gestures and voice commands (Mana et al. 2017). They were video-recorded, observed during the experimental session and interviewed at the end to collect their comments, feeling and preferences.

Results showed that all groups could correctly replicate the gestures presented in the training session, even if they performed the mid-air gestures with a certain variability. Moreover, probably due to their familiarity with touchscreen interfaces, younger participants tended to use only one finger (mostly their index finger) instead of the entire hand, performing small and rapid movements. On the contrary, older adults tended to exaggerate their movements, making wide and ample gestures with the whole hand. We found that participant remarks were generally positive regarding the comfort of performing the mid-air gesture with one hand and holding the tablet with the other. However, it should be taken into account that none of our participants (including older adults) reported any significant physical impairments and that the tablet device used in the study was lighter (272 g) compared to similar models in the market.

6.3.7 Data Collection of a Mid-Air Gestures Dataset

Within the ECOMODE project, we conducted a data collection aimed at building a dataset of mid-air gestures to be used for training the automatic recognition algorithm, involving 20 older adults (10 females; M = 71 years-old; SD = 8.61) (Ferron et al. 2018). We grouped our participants, according to Gregor and colleagues' classification (2002), as follow: 13 were "fit older adults" (able to live independently, with no main disabilities), 6 were "frail older adults" (with one or more disabilities, or a general reduction of their functionalities), and 1 was a "disabled older adult" (with long-term disabilities). The prototype used for our data collection consisted of the ECOMODE camera attached to a tablet PC running an application that showed video descriptions of the multimodal gestures to be performed. The experimenter used the Mobizen mirroring application (https://www.mobizen.com/) to control the participant's device from her notebook PC. Before starting the session, each participant was instructed about the distance to hold the device from the lips (about 30 cm) and about the distance from the camera to make the gesture.

During the data collection, we observed that most of them (13 out of 17—three participants carried out the task sitting on a chair with the tablet PC placed on a table, due to physical problems—see Fig. 6.3) tended to hold the tablet PC more distant (about 40–45 cm) than the recommended 30 cm, to have space for performing the hand gesture (Fig. 6.4). Moreover, the majority of participants (65%) performed the gestures too close to the camera to be appropriately recorded (see Fig. 6.5). No gesture was felt complex to be performed by the participants, but a certain variability (in particular different tablet orientation and gesture amplitude) was observed between subjects. About 60% of the elderly participants often performed the gestures partially

Fig. 6.3 The ECOMODE prototype: resting on the table, held in hand

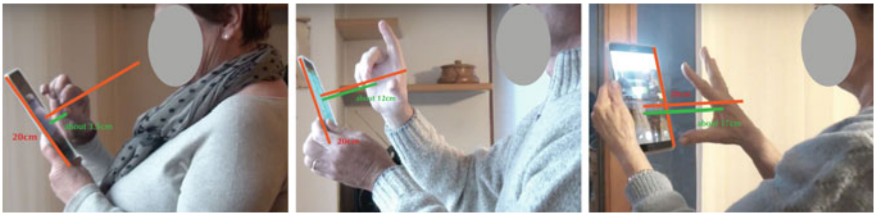

Fig. 6.4 Data collection issues: gestures performed too close to the camera

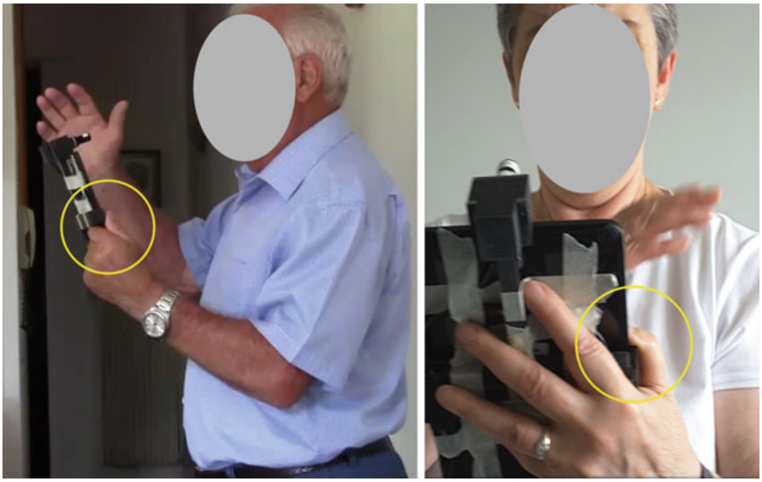

Fig. 6.5 Problems in holding the tablet (thumb on the screen)

out of the camera field of view. This issue and the previous one should guide the choice of the optics, and highlight the need to include appropriate feedback and feedforward.

Some users complained about the difficulty of holding the tablet without touching the screen, or being afraid of dropping it. Indeed, we noticed that they sometimes

Fig. 6.6 Case of the ECOMODE camera: front, back

put the thumb on the screen (see Fig. 6.5), preventing a correct interaction. For this reason, a new case for the ECOMODE camera was designed (see Fig. 6.6).

6.3.8 Fatigue and Mid-Air Gesture Interaction

To further understand how fatigue would increase with interaction time, we investigated with a group of 17 older adults (8 females; M = 69 years-old; SD = 7.3) the fatigue they perceived while performing mid-air gestures in front of the ECOMODE prototype. In particular, we asked participants to carry out a series of predefined interaction tasks. Within three intervals of three minutes each, we asked participants to score their perceived exertion on the Italian version of Borg's CR10 Scale (Borg 1998), which is tailored to physical exertion and maps 10 numeric ratings to verbal cues on a Likert-scale question: "How do you perceive you effort, from 1 to 10 (1 = no effort; 10 = extremely high effort)?" A repeated measures ANOVA showed that the perceived exertion significantly increased between time-points ($F(2, 26) = 21.8$; $p < 0.001$; Mean fatigue at minute 3 = 2.5, SD = 1.9; Mean fatigue at minute 6 = 3.6; SD = 2.2; Mean fatigue at minute 9 = 4.8, SD = 3). This would suggest that a continuous short multimodal interaction (i.e. < 6 min) could be feasible for older adults. Taking into account that in realistic application contexts a continuous prolonged interaction is unlikely, multimodal interaction can be considered a practical way of interacting with technology for the elderly population.

6.3.9 Unfolding the Values of Mid-Air Gesture Interaction

In the previous studies, we investigated mid-air gestures for older adults particularly from the interaction perspective. To move a further step toward the design of mid-air gesture interaction, in another study we explored the perceived benefits and values related to mid-air gestures used for accomplishing a task resembling an example of daily activity for older adults, i.e. mobile photography, by implementing the UX Laddering technique (Vanden Abeele and Zaman 2009) with 22 older participants (12 females; M = 70 years-old; SD = 6.83).

UX Laddering builds upon Means-End Theory proposed by Gutman (1982), according to which people choose a product because its attributes are instrumental to achieve certain consequences and fulfill personal values. One valuable elicitation method for identifying attributes, consequences and values related to a product is laddering (Reynolds and Gutman 1988), an in-depth, one-to-one interviewing method that comprises both qualitative (interviewing) and quantitative techniques (matrix processing) for data acquisition and analysis. Through UX Laddering it is possible to elicit concrete and abstract attributes, functional and psychosocial consequences, and values related to user experiences. In our study, we investigated mid-air gesture interaction by three subsequent phases: (1) product interaction, in which participants used both touchscreen and mid-air gesture interaction (implemented with the WoZ technique) to take pictures to the surrounding environment; (2) preference ranking, in which participants indicated their preferred interaction modality, and (3) laddering interview, in which participants explained their preferences. In addition, to enhance subsequent recall (Kurtz and Hovland 1953), we asked participants to verbalize their thoughts and sensations during the interaction phase, and we elicited alternative situational contexts using photo prompts during the laddering interview.

A preliminary analysis of the collected data highlighted peculiar attributes of mid-air gesture interaction that might be particularly valuable for older adults. One of them is the fact that mid-air interaction does not need fine movements, which was connected to higher accessibility, and in particular contexts to safety (i.e., driving). Moreover, participants appreciated that mid-air gestures allowed them to interact with the device with unclean hands (e.g., while cooking), which they related to a reduced likelihood to damage the device. In addition, they valued the fact that mid-air gestures are a cleaner interaction modality than touchscreen.

6.4 Recommendations for the Design of Mid-Air Gesture Interaction for Older Adults

Based on the user studies and the observation of user interactions, we reviewed the initial gesture set and revised it according to user feedback and ergonomic guidelines. For each gesture (Fig. 6.2), Table 6.2 reports the positive and negative aspects emerged from the user studies, and how we dealt with these issues for the second release of the gesture set.

Elaborating on the results of our studies, the observations of user interactions and the users' comments, and building on previous research, we derive the following recommendations for the design of mid-air gestural interfaces for older adults, although we believe they can also be extended to average users.

Prefer Human-Based Over Technology-Based Gesture Sets. One common approach to define a gesture set is to implement gestures that are easy for the computer's recognition algorithms to recognize. However, this often results in a number of difficulties for the user, such as fatigue, difficulty of performing the gestures, memorability issues, illogical functionality. Gestures should be designed with a user-centered approach, possibly involving users in participatory design sessions and taking into account relevant characteristics of the users (Kortum 2008). Gestures should be intuitive, metaphorically logical toward functionality, easy to remember without hesitation (Hurtienne et al. 2010; Kortum 2008; Schiavo et al. 2017). Also, when designing sequences of gestures (e.g., vertical or horizontal scrolling), different commands should require only small adjustments in order to reduce cognitive load and physical effort.

Respect Ergonomic Principles and Biomechanics of the Hand. From the physical point of view, the design of mid-air gesture interaction interfaces for older adults should take into account poor manual dexterity issues, reduced eyesight and auditory capabilities, and slow speed in gesturing. Gestures should not be physically stressful

Table 6.2 Summary of positive and negative aspects of each item of the gesture set, and proposed solution

Gesture	Positive aspects	Negative aspects	Proposed solution
Open camera *Click gesture*	This gesture did not pose ergonomic constraints or fatigue issues	Despite being easy to perform, participants associated this gesture to the shooting action, rather than the opening the camera	In the revised gesture set, we proposed to use this gesture to map the shooting photo command, designing a new gesture to open the camera
Shoot photo *Fist*	From a semantic point of view, this gesture showed a good mapping to the shooting photo action	The gesture created excessive pressure on the joints and was difficult to perform for people with arthritis	We excluded this gesture from the second dataset, in favor of the click gesture
Zoom shrink *Pinch close* **Zoom enlarge** *Pinch open*	This gesture did not pose ergonomic issues for participants, and mapped well the zoom action both for novice and expert tablet users	–	As this gesture did not pose particular problems, we kept it in the second release of the gesture set

(continued)

Table 6.2 (continued)

Gesture	Positive aspects	Negative aspects	Proposed solution
Scroll down *Wave from up to down* **Scroll up** *Wave from down to up*	Here, we followed the response-effect compatibility principle (Chen and Proctor 2013), directly mapping hand direction with content movement, similarly the "natural scrolling" used in mobile interfaces (hand going downwards to move the content downwards). Most current desktop operating systems use instead the inverted scrolling, i.e. when the user scrolls on one direction, the content scrolls on the other, similarly to how mouse scrolling works. Older adults felt generally comfortable with this mapping, although it might depend of technological familiarity with mouse-controlled devices	The scroll up gesture required an excessive rotation of the wrist, which participants felt uncomfortable	We changed the scroll up gesture to palm facing down to ease the pressure on the wrist
Go right *Wave from right to left* **Go left** *Wave from left to right*	We followed the same compatibility principle of the vertical scrolling, and participants found it natural in relation to the task of scrolling a photo album	–	We kept the gesture in the second release of the dataset

and avoid static and dynamic constraints (Eaton 1997; Ferron et al. 2015; Keir et al. 1998), as well as outer positions and excessive force on joints. Recognition algorithm should be tolerant to non-stressing movements, avoiding the user to remain for long in static positions.

Find a Contextually Appropriate Way to Reduce False Positives. It is important for the system to know when to start and stop interpreting gestures. If the goal is a natural immersive experience, the system should be very tolerant to spontaneous gestures. Unfortunately, this is technically difficult. A solution is to adopt an unblock command, or clutch, which puts the device into a tracking state (Kortum 2008). However, our exploratory study with the Myo Air Gesture Armband with a 76 years-old woman (see Sect. 4.2), suggested that it may be hard for seniors to (1) remember to do the mid-air clutch gesture before every command, and (2) perform the sequence "clutch + command" in a timely manner. For these reasons, we suggest the use of a different input channel for the clutch, such as a voice command or a physical button.

Feedforward and Feedback. While feedforward helps the user to decide what actions to carry out and informs about the sensor's field of view, feedback informs the user about the system status (Vermeulen et al. 2013). Consistently with previous research (Cabreira and Hwang 2016), we observed that it can be challenging for older adults to know where to perform the mid-air gestures, which gestures are available and how to perform them (see Sect. 4.6). Even if recent works have proposed different types of feedback and feedforward (i.e. Delamare et al. 2016), more research is needed on this topic.

Allow Personalization. Our studies (Ferron et al. 2018) showed substantial inter-subject variability in the performance of mid-air gestures, which is consistent with previous works (Carreira et al. 2016). Since each user has his/her own preferences regarding to how performing a gesture (e.g., amplitude, speed or distance), it is recommended to allow manual or automatic dynamic thresholds that can be individually tailored.

Design for Fun, Daily Use and Social Connectivity. Our expert interviews and user studies (Ferron et al. 2015) highlighted the preferred recreational use of tablet devices by older adults, along with initial curiosity and enthusiasm, which however gives way to accessibility issues and fears of damage after the first interactions. In response to the users' needs, the development of mid-air gesture interaction could be directed towards daily and recreational use of tablet devices, such as photography, social connectivity, news reading and Internet surfing, which has not received much attention yet (Carreira et al. 2016). New interaction modalities that take into account the particular needs of the ageing population and focus more on empowering seniors instead of helping them (Rogers and Marsden 2013) are still missing. By overcoming at least some of the accessibility pitfalls of touch and mouse-based interaction, mid-air gesture interaction could sustain mobile technology appropriation and provide additional means for fun.

6.5 Conclusion

The goal of this chapter was to provide a unique perspective on the design of effective mid-air gesture interaction with mobile devices for older adults, by inte-grating research on HCI and ergonomic principles with research on ageing, as well as taking into account user-centred design methods to meet older people's needs and values.

We reported on how we implemented the design of mid-air gesture interaction in ECOMODE, engaging older users as primary actors in providing feedback at each step of the process. We discussed the most prominent design challenges of mid-air gesture interaction and we presented a number of user studies with older adults, following a user-centred and value-based design approach. Finally, we proposed a set of recommendations for the design of mid-air gesture interaction for older adults, based on the literature and on our case studies. Mid-air gestures have the potential to make interaction not only fun, but also easy, intuitive and natural for the older adults. However, making mobile technology more inclusive requires the active engagement of older people in envisioning the design of such technologies in ways that can not only improve accessibility, but also sustain the activities they care about.

References

Bobeth J, Schmehl S, Kruijff E et al (2012) Evaluating performance and acceptance of older adults using freehand gestures for TV menu control. In: Proceedings of the 10th European conference on interactive TV and video. ACM, pp 35–44

Bødker S (2006) When second wave HCI meets third wave challenges. In: Proceedings of the 4th Nordic conference on human-computer interaction: changing roles. ACM, pp 1–8

Borg G (1998) Borg's perceived exertion and pain scales. Human Kinetics, Champaign

Boring S, Jurmu M, Butz A (2009) Scroll, tilt or move it: using mobile phones to continuously control pointers on large public displays. In: Proceedings of the 21st annual conference of the Australian computer-human interaction special interest group: design: open 24/7. ACM, pp 161–168

Cabreira AT, Hwang F (2016) How do novice older users evaluate and perform mid-air gesture interaction for the first time? Paper presented at the proceedings of the 9th Nordic conference on human-computer interaction, Gothenburg, Sweden

Camunas-Mesa L, Zamarreno-Ramos C, Linares-Barranco A et al (2012) An event-driven multi-kernel convolution processor module for event-driven vision sensors. IEEE J Solid-State Circuits 47:504–517

Carbini S, Delphin-Poulat L, Perron L et al (2006) From a Wizard of Oz experiment to a real time speech and gesture multimodal interface. Sig Process 86:3559–3577

Carreira M, Ting KLH, Csobanka P et al (2016) Evaluation of in-air hand gestures interaction for older people. Univers Access Inf Soc 16:1–20

Chen J, Proctor RW (2013) Response–Effect compatibility defines the natural scrolling direction. Hum Factors 55:1112–1129. https://doi.org/10.1177/0018720813482329

Cockburn A, Quinn P, Gutwin C et al (2011) Air pointing: design and evaluation of spatial target acquisition with and without visual feedback. Int J Hum Comput Stud 69:401–414

Cronin D (2014) Usability of Micro- vs. Macro-gestures in camera-based gesture interaction. Diplomarbeit, California Polytechnic State University, San Luis Obispo. (Zitiert auf Seite 21)

Delamare W, Janssoone T, Coutrix C et al (2016) Designing 3D gesture guidance: visual feedback and feedforward design options. In: Proceedings of the international working conference on advanced visual interfaces. ACM, pp 152–159

Eaton C (1997) Electronic textbook on hand surgery. http://www.eatonhand.com

England D (2011) Whole body interaction: an introduction. In: Whole body interaction. Springer, London, pp 1–5

Ferron M, Mana N, Mich O (2015) Mobile for older adults: towards designing multimodal interaction. In: Proceedings of the 14th international conference on mobile and ubiquitous multimedia. ACM, pp 373–378

Ferron M, Mana N, Mich O et al (2018) Design of multimodal interaction with mobile devices. Challenges for visually impaired and elderly users. In: 3rd international conference on human computer interaction theory and applications (HUCAPP). Funchal, Madeira. 140–146

Gerling K, Dergousoff K, Mandryk R (2013) Is movement better? Ccomparing sedentary and motion-based game controls for older adults. In: Proceedings of graphics interface 2013. Canadian Information Processing Society, pp 133–140

Gerling K, Livingston I, Nacke L et al (2012) Full-body motion-based game interaction for older adults. In: Proceedings of the SIGCHI conference on human factors in computing systems. ACM, pp 1873–1882

Green P, Wei-Haas L (1985) The rapid development of user interfaces: experience with the wizard of Oz method. In: Proceedings of the human factors society annual meeting. Sage, Los Angeles, CA, pp 470–474

Gutman J (1982) A means-end chain model based on consumer categorization processes. J Mark 46:60–72

Harrison S, Sengers P, Tatar D (2011) Making epistemological trouble: third-paradigm HCI as successor science. Interact Comput 23:385–392

Hassani AZ, Van Dijk B, Ludden G et al (2011) Touch versus in-air hand gestures: evaluating the acceptance by seniors of human-robot interaction. In: International joint conference on ambient intelligence. Springer, pp 309–313

Hincapié-Ramos JD, Guo X, Moghadasian P et al (2014) Consumed endurance: a metric to quantify arm fatigue of mid-air interactions. In: Proceedings of the 32nd annual ACM conference on human factors in computing systems. ACM, pp 1063–1072

Hurtienne J, Blessing L (2007) Design for intuitive use-testing image schema theory for user interface design. In: 16th international conference on engineering design. Citeseer, Paris, France. 829–830

Hurtienne J, Stößel C, Sturm C et al (2010) Physical gestures for abstract concepts: Inclusive design with primary metaphors. Interact Comput 22:475–484. https://doi.org/10.1016/j.intcom.2010.08.009

Jayroe TJ, Wolfram D (2012) Internet searching, tablet technology and older adults. Proc Am Soc Inf Sci Technol 49:1–3

Keir PJ, Bach JM, Rempel DM (1998) Effects of finger posture on carpal tunnel pressure during wrist motion. J Hand Surg 23:1004–1009

Kortum P (2008) HCI beyond the GUI: design for haptic, speech, olfactory, and other nontraditional interfaces. Morgan Kaufmann, Burlington

Kurtz KH, Hovland CI (1953) The effect of verbalization during observation of stimulus objects upon accuracy of recognition and recall. J Exp Psychol 45:157

Maguire M (2001) Methods to support human-centred design. Int J Hum Comput Stud 55:587–634

Mana N, Mich O, Ferron M (2017) How to increase older adults' accessibility to mobile technology? The new ECOMODE camera. Paper presented at ForItAAL-Forum Italiano Ambient Assisted Living. Genoa, Italy.

Markussen A, Jakobsen MR, Hornb K (2014) Vulture: a mid-air word-gesture keyboard. Paper presented at the proceedings of the 32nd annual ACM conference on human factors in computing systems, Toronto, ON, Canada

Nacenta MA, Kamber Y, Qiang Y et al (2013) Memorability of pre-designed and user-defined gesture sets. Paper presented at the proceedings of the SIGCHI conference on human factors in computing systems, Paris, France

Ni T, Bowman DA, North C et al (2011) Design and evaluation of freehand menu selection interfaces using tilt and pinch gestures. Int J Hum Comput Stud 69:551–562

Nielsen M, Störring M, Moeslund TB et al (2004) A procedure for developing intuitive and ergonomic gesture interfaces for HCI. In: Camurri A, Volpe G (eds) Gesture-based communication in human-computer interaction. Springer, Heidelberg, pp 409–420

Pernice K, Nielsen J (2012) Web usability for senior citizens: design guidelines based on usability studies with people age 65 and older. Nielsen Norman Group

Reynolds TJ, Gutman J (1988) Laddering theory, method, analysis, and interpretation. J Advert Res 28:11–31

Rico J, Brewster S (2010) Usable gestures for mobile interfaces: evaluating social acceptability. In: Proceedings of the SIGCHI conference on human factors in computing systems. ACM, pp 887–896

Rogers Y, Marsden G (2013) Does he take sugar? Moving beyond the rhetoric of compassion. Interactions 20:48–57

Ruiz J, Li Y, Lank E (2011) User-defined motion gestures for mobile interaction. Paper presented at the proceedings of the SIGCHI conference on human factors in computing systems, Vancouver, BC, Canada

Ryan EB, Szechtman B, Bodkin J (1992) Attitudes toward younger and older adults learning to use computers. J Gerontol 47:P96–P101

Schiavo G, Mich O, Ferron M, Mana N (2017) Mobile multimodal interaction for older and younger users: exploring differences and similarities. In: Proceedings of the 16th international conference on mobile and ubiquitous multimedia. ACM, pp 407–414

Schiavo G, Ferron M, Mich O et al (2016) Wizard of Oz studies with older adults: a methodological note. Int Rep Socio-Inform 13:93–100

Vaidyanathan V, Rosenberg D (2014) "Will use it, because I want to look cool" a comparative study of simple computer interactions using touchscreen and in-air hand gestures. In: International conference on human-computer interaction. Springer, pp 170–181

Vanden Abeele V, Zaman B (2009) Laddering the user experience! In: User experience evaluation methods in product development (UXEM 2009)-workshop

Venkatesh V, Bala H (2008) Technology acceptance model 3 and a research agenda on interventions. Decis Sci 39:273–315

Vermeulen J, Luyten K, van den Hoven E, Coninx K (2013) Crossing the bridge over Norman's gulf of execution: revealing feedforward's true identity. In: Proceedings of the SIGCHI conference on human factors in computing systems. ACM, pp 1931–1940

Wigdor D, Wixon D (2011) Brave NUI world: designing natural user interfaces for touch and gesture. Elsevier, Amsterdam

Michela Ferron is a human-computer interaction and user experience researcher in the Intelligent Interfaces & Interaction research group at Fondazione Bruno Kessler. She holds a Ph.D. in Cognitive and Brain Sciences from the University of Trento and an MSc in Social and Communication Psychology from the University of Padua. Her research ranges across inclusive design for seniors, collaboration over digital networks, and the study of technologies for nudging behavioural change and improving quality of life.

Nadia Mana has been working at Fondazione Bruno Kessler since June 1996. In 1996 she graduated in Language Philosophy (University of Torino), and in 2006 she received her Ph.D. in Information and Communication Technologies (University of Trento). She has maturated a 20-year experience in data collection and processing, as well as in designing and conducting user studies and technology evaluations. Her research interests focus on the design and evaluation of multimodal and interactive technologies.

Ornella Mich received a degree in Electronic Engineering from the University of Padua and a Ph.D. in Computer Science from the Free University of Bozen. She has been senior researcher at Fondazione Bruno Kessler since 1989, and she taught Linguistic Interfaces Laboratory at the University of Trento. Her research interests focus on human-computer interaction, with much of her research focusing on interaction design, e-learning and accessibility-related issues, design and evaluation of intelligent interfaces for children.

Chapter 7
The Social Interaction Experiences of Older People in a 3D Virtual Environment

Panote Siriaraya and Chee Siang Ang

7.1 Introduction

Aging successfully does not only mean that one remains in good physical health in their later stages of life, but should also be well integrated in their social community and have adequate social relationships (Bowling and Paul 2005). Good interpersonal relationships contribute to active engagement with life which has a positive impact on health and well-being. However, due to factors such as declines in physical abilities and lifestyle changes (such as social networks becoming increasingly narrower in later life) which occur naturally with aging, it becomes more costly in terms of time and effort for older users to obtain meaningful social experience. As such, social isolation has become a major problem which can significantly influence the well-being of older adults.

In recent years, computer technology, in particular, ICT technology has shown much promise as a platform which could help alleviate loneliness for older adults (Khalaila and Vitman-Schorr 2018). A lot of these online communication tools have been shown to be beneficial to older people (Nimrod 2010), allowing older adults to keep in touch with family and friends and helping decrease feelings of isolation (Dunning 2009). 3D virtual world is one such technology which has great potential in supporting social interaction for older users. Much research has been carried out showing how such a platform could be used to support daily life activities such as shopping or keeping in touch with friends and families etc. However, most of these studies focus on "mainstream" computer users (Jung 2011 etc.) and research looking into the use of 3D virtual worlds for older people has been relatively limited. This

P. Siriaraya (✉)
Kyoto Sangyo University, Kyoto, Japan
e-mail: spanote@gmail.com

C. S. Ang
University of Kent, Canterbury, UK
e-mail: c.s.ang@kent.ac.uk

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_7

could lead to an unfortunate missed opportunity as such technology could potentially exclude a group of users who could truly benefit from them.

In this chapter, we discuss our work which has been carried out on the topic of older people and 3D virtual worlds. In particular, we discuss in detail an experiment study carried out to investigate how various aspects of the 3D virtual worlds (such as the avatars) influences the social interaction experience of older users.

7.2 Older People and 3D Virtual Worlds

As the computational and graphical processing abilities of computers continue to increase, the platforms which one could use for social interaction has also evolved substantially. One such platform is 3D virtual worlds. Social interaction in 3D virtual environments has many advantages when compared to other communication technology. Unlike video conferencing and text-based message tools, the embodiment of user interaction through avatars allows users to participate in social activities with other users (such as dancing) rather than just to communicate (Zhou et al. 2011). Thus, the social experience in virtual worlds goes beyond just providing an avenue for communication and can offer the opportunity for users to experience social activities with others in a more immersive manner. As such, 3D virtual worlds could offer much potential in supporting social interaction for older people. Through such platforms users are able to expand and maintain their social networks (i.e. meeting new friends etc.) (Zhou et al. 2011) and form online communities (Fetscherin and Lattemann 2008). Such activities could help enrich the social lives of older users. Despite this, there have been few studies which have explored the characteristics and interactions of older users in virtual worlds.

7.2.1 The Digital Lives of Older People in Virtual Worlds

To understand more about the characteristics of older people in virtual worlds, two exploratory studies (an interview study and user profile analysis study) were initially carried out which examined the activities, interests and experiences of older people in virtual worlds (Siriaraya et al. 2014), (Siriaraya and Ang 2012b). The results from both studies revealed several interesting aspects regarding the virtual interaction and experience of older users in virtual worlds. Overall, both studies indicated that social interaction seems to be main reason in which older people use virtual worlds. The majority of the participants in the interviews cited social purposes (socializing, keeping in touch with friends etc.) as their main motivation for using virtual worlds. What was particularly surprising was that such relationships did not only consist of weak ties (as tended to be the case with social capital obtained from social network services (Ellison et al. 2007)), but most participants reported developing strong interpersonal relationships in virtual worlds. Some of these friendships were reported to lasted for several years and some even transferred offline as well. Analysis of user behavior from the profiles also supported this notion. Even though other online technologies have been used in a similar role, it seems that the unique characteristics of virtual worlds (for instance, being able to carry out social interactions in an immersive 3D spatial context) helped enhance the process of relationship building. For instance, the diverse ways in which users could interact with each other in an immersive 3D environment (visit each other's virtual homes etc.) allowed online relationships to be developed and maintained more easily (Taylor 2002).

Another surprising finding was how older people use virtual worlds to pursue activities which they perceived to make useful contributions to others. A memorable example from the interviews was how a recent retiree nurse offered to teach classes about childbirth in virtual worlds (Siriaraya et al. 2014). Some even used virtual worlds to acquire skills and knowledge. The user profiles showed that older users even joined more groups related to learning or education (photography, history etc.) than younger users and during the interviews, they often reported participating in classes in the virtual world to learn more about programming. Overall, the results from these studies suggest that older people who use virtual worlds do so because they found this platform to be beneficial in augmenting a part of their physical lives (allowing them to again do activities which they were once able to do when they were younger), compared to the typical young user who participated in virtual worlds as a form of diversion or escapism from their daily lives into a novel fantasy world.

7.2.2 Factors Affecting 3D Social Interaction Experience

Despite the potential advantages of virtual worlds for social interaction, few studies have investigated how virtual worlds, as platform, could be designed to effectively enhance social experience for older people. Although we have identified a number of older adults who have benefited from social interaction in virtual worlds in our earlier studies, these users could be considered the minority (Pew Research Center 2010). A previous study of ours had identified various age-related differences between older and younger users in several aspects of their interaction with virtual worlds which could influence their social experience in this platform (Siriaraya and Ang 2012a). However, little is still known about the reasons why such factors effect social interaction experience and more importantly how they could be improved for older users. Therefore, a further experimental study was carried out to provide a more in-depth analysis on how and why factors related to older user's characteristics and the virtual world influence the quality of their social interaction.

Various measures have been proposed to evaluate the quality of the social interaction in a 3D virtual world. One such measure is social presence (or co-presence) which could be thought of roughly as the sense of being together with others (see Biocca et al. 2003). Other factors used to evaluate the quality of social interaction include the perceived quality of the communication process (i.e., how well users can understand each other) and the perceived satisfaction in the outcome of the task (i.e., how satisfied users are with their performance in carrying out the social interaction task) (Vilhjálmsson 2003).

For factors which could affect the quality of the social interaction experienced by older people in 3D virtual worlds, these could be divided into factors related to the characteristics of the users themselves (User factors), and factors related to the virtual world design (Platform factors). In regard to user characteristic, past experience with similar technologies is one factor which could play a role in how well older people are able to use 3D virtual worlds (Czaja and Lee 2007). Another often cited factor is computer anxiety (Jung et al. 2010) as studies have also shown how this factor acted as a psychological barrier to the acceptance of and use of technologies (Jung et al. 2010). Factors related to the 3D virtual world platform itself could also have an impact on the experience of older people. The ability to navigate in particular, could affect the social experience of older people in a 3D environment due to declines in their cognitive functions (spatial ability etc.) (Sjolinder et al. 2005). Physical presence or the sense in which a user perceives as being located in a place or environment (see IJsselsteijn et al. 2000) could affect how well users perform or enjoy their virtual world experience (see Lombard and Ditton 1997). Apart from this, the visual representation of the users in the virtual worlds or what is known as the "Avatars" could affect their social interactions in virtual worlds. Some studies have posited for example, that certain characteristics of the avatars (such as avatar realism and anthropomorphism etc.) could influence the quality of communication for users (Nowak and Biocca 2003).

7.3 Method

An experimental study was carried out to examine the various user and platform factors in relation to the social experience of older people in 3D virtual world. Overall, 38 older people were recruited to engage in a collaborative shopping activity in the 3D virtual world. We chose to focus on shopping activity because it was an activity older people are familiar with in their daily life (and as such they could more easily evaluate and reference their virtual world experience in comparison to their physical life experience). A non-3D virtual store (see Fig. 7.1) was also developed to allow participants to more easily compare and relate their 3D experiences (by providing a non-3D experience for reference). Each pair of participants would visit both 3D and non-3D virtual stores in the study. As identifying older people who were willing to use 3D technology was challenging, for practical reasons, participants were recruited by snowball sampling and participants were given a shopping voucher worth £10 for participating. The study was also reviewed and approved by the University's research ethics committee.

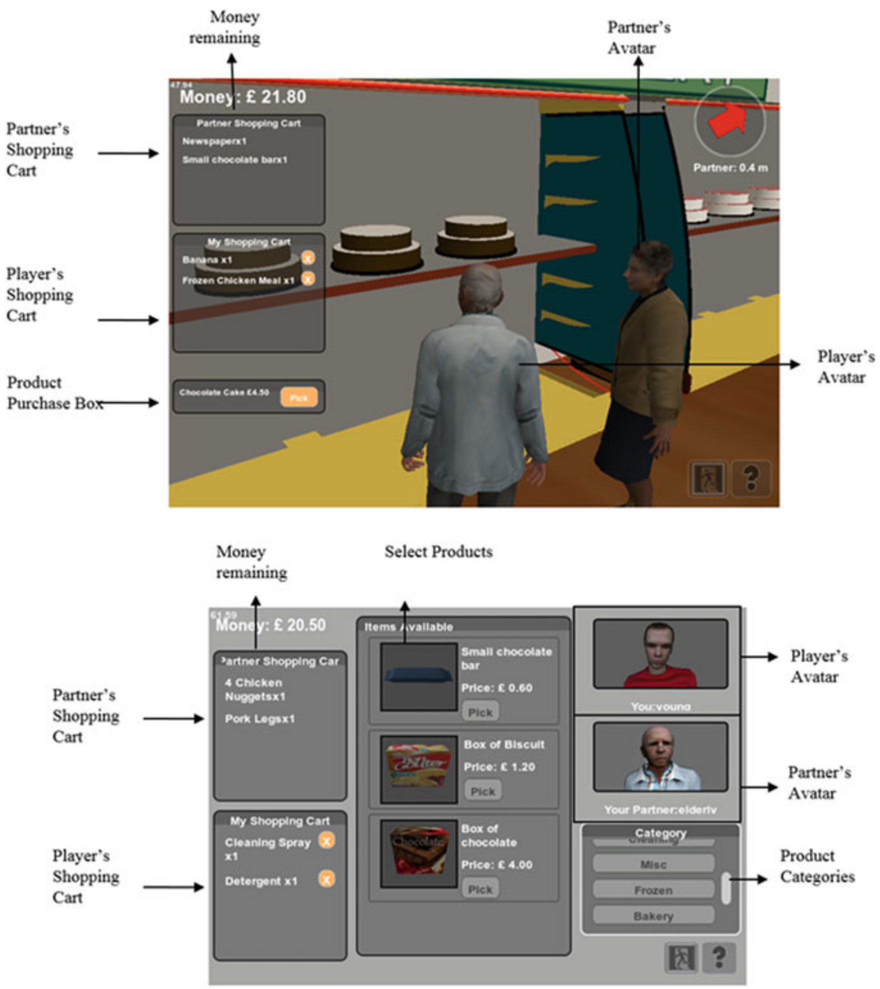

Fig. 7.1 Screenshots of the 3D (top) and non-3D store (bottom)

7.3.1 Virtual World System

The multi-user online virtual world systems (3D and non-3D) were developed using Unity3D. Users are able to choose between a non-human (a robot), older male, older female, younger male and younger female avatar to represent themselves in the study. For the 3D virtual store, users controlled their avatar by using the arrow keys on the keyboard. To make purchases, the user moves their avatar towards a shelf with the product they would like to purchase. When the avatar moved close enough to the shelf, a small "product purchase" window would appear on the user interface with the name of all the products available on that particular shelf (see Fig. 7.1).

In the non-3D store (as shown in Fig. 7.1), users make purchases by first selecting one of the categories from the "products category" menu. All the products in that category would be shown on the "select product" box and users would then click on the "pick" button next to the image of the product they would like to purchase. In both the 3D and non-3D store, participants communicated with each other by voice.

7.3.2 Study Procedure

A pair of older users participated in each experiment session, carrying out a collaborative activity in both the 3D and non-3D store. The session started with a brief explanation about the purpose of the study and the key concepts in the study (avatar, 3D virtual environment etc.) were explained. Then, participants accessed the virtual dressing room and selected an avatar to represent themselves. A brief tutorial session was then given, after which participants were asked to proceed to two separate rooms where they were unable to see or hear each other in the physical world. This was done to ensure that the social presence and interactions of the participants were limited to only inside the virtual environment during the study. In the virtual environments, participants were asked to carry out two tasks (one in 3D and another in non-3D store). Both involved a virtual shopping task which was purposely designed to involve collaboration. To complete these tasks, participants would need to communicate with each other in the virtual environment and reach an agreement on certain decisions. More specifically, in the first task, participants were asked to imagine that they and their partner needed to prepare a birthday and needed to collaborate with each other in the virtual store to choose the goods that they think would be best for their party (both were given a limited sum of money). In the second task, participants were asked to imagine that they and their partner were planning a picnic at the local park and were asked to cooperate with their partner in selecting the goods for the picnic. To compensate for order effect, 20 participants were asked to use the non-3D store for task 1 and the other 18 participants used the 3D store for task 1. After completing both tasks, participants filled in a questionnaire to evaluate their experience. Afterwards, semi-structured interviews were carried out individually with each participant. Overall, each session lasted approximately 2.5 h.

7.3.3 Data Collection and Analysis

A mixed method was used to collect data for this study. First, questionnaires were administered to examine the factors related to social interaction experience of the participants. Semi-structured interviews were later carried out to help provide context and illustration to the questionnaire findings. The questionnaires used were adapted from a previous study which we carried out (Siriaraya and Ang 2012a). A pre-study questionnaire was used to gather data about the demographics and characteristics of the participants and a post-questionnaire was used to examine their experience with the virtual worlds. Key measures used to evaluate the quality of social interaction experience (in the post-questionnaire) include social presence, perceive quality of communication, perceived efficiency of the medium in task performance and overall satisfaction with social experience. In addition, questions were also used to measure user factors (in the pre-questionnaire) such as skepticism of using technology to communicate, computer anxiety and perceived health as well as platform factors (in the post-questionnaire) such as physical presence, perceived value of the avatar and navigational ability. After data collection, reliability tests were carried out which showed good statistical reliability on all the multi-item measures variables (>0.8) except for the skepticism of using CMC technology which was removed from the statistical analysis.

Semi-structured interviews were then carried out to explore further how each of the factors (from questionnaires) affected the participants. First, open-ended questions were asked to encourage participants to discuss their experience of using the virtual stores, such as their overall experience in the virtual, their experience of communicating and collaborating with another user in a virtual environment (and also any factors which they felt facilitated or impeded the efficiency of the communication) and what they enjoyed/disliked about the two virtual stores. Afterwards, probing questions related to the specific factors of the platform and the user characteristics were asked (such the reason for choosing a particular avatar and the implications of it towards their experience). The interview structure and questions were adapted to suit the context of our participants who generally had little prior experience with technology and 3D virtual environments. For example, to help participants more easily frame their discussion, they were asked to discuss their experiences with the various aspects of the 3D virtual environment by comparing them to their experiences with the non-3D environment. Examples of questions include: "How did you feel about communicating and collaborating with the other person in the virtual store? In this aspect, which store do you think was better? How so?" and "Did the ability to see everything in 3D and move around in 3D have any effect on your social experience?"

To analyze the interview data, the audio recordings from all the interviews of the 36 participants were first transcribed (the data from one pair of participants was not available due to technical difficulties in recording). Altogether, there was approximately 19 h worth of data. The data was analyzed using thematic analysis (Braun and Clarke 2006). First the transcripts were re-read to help gain an overview of the key topics and then coding the data. Codes of similar nature were then grouped together into themes which were reviewed against the overall data and refined until saturation had been achieved.

7.4 Results

The key characteristics of the participants are shown in Table 7.1.

Table 7.1 Participant characteristics

Gender	Male	16
	Female	22
Age		Mean = 66.84 (SD = 6.55) (Min = 55, Max = 82)
Prior experience (out of 10)	Computer	Mean = 8.57 (SD = 2.4)
	Internet	Mean = 8.08 (SD = 2.27)
	E-mail	Mean = 8.24 (SD = 2.20)
	Skype	Mean = 3.43 (SD = 1.59)
	3D games	Mean = 2.54 (SD = 1.37)
Computer anxiety (out of 5)		Mean = 1.96 (SD = 1.00)
Perceived health (out of 5)		Mean = 2.00 (SD = 0.96)
Level of acquaintance with partner (out of 5)		Mean = 3.79 (SD = 1.6)

7.4.1 Avatars

As shown in Table 7.2, the most popular avatar selected by male participants was the older male avatar. However, for female participants the younger female character was the most popular.

When asked to describe the reason they chose their avatar in the interview, most male participants wanted to select avatars which best resembled their physical world appearances (n = 9). Female participants (n = 5) who selected the old female avatar also reported a similar reason. These participants did not want the avatars to misrepresent their real-world characteristics. There were also a number of older people selecting avatars which appeared younger than their actual age or were of opposite gender. What was particularly interesting was that the majority of the female participants selected the young female avatar. The reasons given for selecting these avatars were that they wanted the avatars to reflect their personality or outlook of still being young and perhaps female users tended to prefer avatars which had a similar appearance to their idealized selves (Ducheneaut et al. 2009).

Table 7.2 The types of avatars selected in the study

Avatar	Gender	
	Male	Female
Older male	12 (70.58%)	1 (4.76%)
Older female	0 (0%)	5 (23.8%)
Younger male	2 (11.76%)	2 (9.52%)
Younger female	1 (5.88%)	9 (42.85%)
Non-human	2 (11.76%)	4 (19.05%)

"*[I chose this avatar] because I feel I think of myself as young. I've got a young outlook to life*" (Participant 4, Female, 61, selected the young female avatar).

Other reasons given were that participants (n = 2) felt that these young avatars were the most realistic or best suited the context of the task (shopping) or to represent a family member or a shopping companion (n = 3). As for the non-human avatars, participants reported selecting them for their entertainment value. Three participants reported selecting the non-Human avatar either "for fun" or due to the perception of their experience in the virtual world as being unreal or similar to a video game.

"*I don't know, to me an avatar is an alien. I mean I don't think I've seen avatars…. I think it was the fact that I felt I was playing a game more than it was real life. So that's why it seemed right to chose something that looked like an alien or avatar in this context*" (Participant 34, 67, Female selected the non-human avatar).

7.4.2 Differences Between the 3D and Non-3D Store

T-tests were carried out to analyze the differences in the quality of social interaction and the various aspects of interaction within virtual worlds (e.g. physical presence, quality of communication etc.) between the 3D and non-3D platforms. Overall, we found no significant difference in all measures for the quality of social interaction between the 3D and non-3D store. The 3D virtual store did not provide a better quality of social interaction for older people. Not surprisingly, participants found it significantly easier to navigate in the non-3D store (mean = 4.09) than the 3D store (mean = 3.04), $t(74) = 4.54$, $p < 0.001$ and also felt that avatars played a more prominent role in the 3D store (mean = 3.07) than in the non-3D store (mean = 2.00), $t(74) = -4.10$, $p < 0.001$. There was a borderline significance in physical presence where older people in the 3D store (mean = 3.08) reported higher levels of physical presence than the non-3D store (mean = 2.51) ($t(74) = -1.98$, $p = 0.052$).

7.4.3 Factors Linked to the Quality of Social Interaction

Regression analysis was then carried out to investigate the degree to which certain factors influenced the quality of social interaction. Person's correlation tests showed that the variables Experience with computers and E-mail had an almost perfect correlation (all higher than 0.95) and were removed to prevent multi-collinearity. As the model building was exploratory, independent variables were entered using the stepwise method. The user factors entered into the model were experience with E-mail, Skype, 3D games, computer anxiety, level of acquaintance and health and were further divided into two groups when constructing the model. This was done to examine the effect of computer experience (E-mail, Skype, 3D games) and general characteristics (computer anxiety, level of acquaintance and health) on social interaction experience separately. The platform factors entered were perceived physical presence, navigation and avatar. Each of these three groups of independent variables was tested for regression for each dependent variable (i.e. social presence, quality of communication, performance, overall satisfaction in social experience and enjoyment). As such, a total of 12 regression models were calculated (6 for the 3D and 6 for the none 3D virtual store). Multi-collinearity within the variables was minimal (VIF < 10). A summary of the results of the regression analysis is shown in Table 7.3.

For social presence in the 3D store, multiple-regression showed only physical presence and experience with 3D games to be a significant predictor of social presence. For the quality of communication, physical presence is the only significant predictor for both 3D and non-3D store, and Navigation is the only significant predictor for the non-3D store. However, both models explained only a small portion of the overall variance (13% for the 3D store and 17% for the non-3D store). This could be expected as a majority of the communication between the participants in the non-3D store consists of searching for the products by navigating through a list of items. For performance, only navigation was a significant predictor for both stores. However, navigation was able to explain more of the overall variance of performance the 3D store than in the non-3D store (22% compared to 12%). Part of this could be expected as a major component of the task that was given required participants to move around in the 3D store (or navigate through the 2D store) to find the appropriate products. For the user factors, only experience with computer games was found to be a significant predictor of social presence in the 3D store.

Overall, the results show that physical presence was a key factor to many of the measures for the quality of social interaction in the 3D store, including social

Table 7.3 Summary of the regression analysis

		Adj R^2	Physical presence	Avatar	Ease of navigation	3D games experience
Social presence	Non-3D	0.24**	0.52**	–	–	–
	3D	0.45**	0.68**	–	–	–
		0.09*	–	–	–	0.34*
Quality of communication	Non-3D	0.17**	–	–	0.43*	–
	3D	0.13*	0.39*	–	–	–
Performance	Non-3D	0.12*	–	–	0.38*	–
	3D	0.22*	–	–	0.41*	–
Overall satisfaction with social experience	Non-3D	0.44**	0.50**	–	0.41*	–
	3D	0.63**	0.59**	–	0.28*	–
Enjoyment	Non-3D	0.19**	0.47*	–	–	–
	3D	0.42**	0.39*	–	0.34*	–

*Significance at 0.05 (2-tail)
**Significance at 0.01 (2-tail)

presence, quality of communication, overall satisfaction in social experience and enjoyment. For the 3D store, navigation was found to be a significant predictor of performance, overall satisfaction in social experience and enjoyment when other platform factors were controlled. The avatar however was not found to be a direct significant predictor of any of the measures. Part of this could be because both navigation and avatar indirectly influence the dependent variables through physical presence and the remaining variance not explained by physical presence was not a significant predictor of these measures. Indeed, for social presence, when not controlling for physical presence, single variable regression analysis also showed that Navigation (standardized beta = 0.535, $p < 0.01$), (Adjusted R2 = 0.27, $F(1,36) = 14.45$, $p < 0.001$) and Avatar (standardized beta = 0.47, $p < 0.01$), (Adjusted R2 = 0.20, $F(1,36) = 10.02$, $p < 0.01$) each significantly predicted social presence. In the non-3D store, both were not significant predictors of social presence.

7.4.4 Analysis of the Interview Data

The interview data was analyzed and the themes were categorized into three groups: (i) factors related to social interaction experience in the 3D virtual world; (ii) difficulties of older users in suspending disbelief and immersing themselves in the virtual environment; (iii) user barriers which effect interaction in 3D virtual worlds.

7.4.4.1 Social Interaction Experience

A large number of participants reported no difference in the quality of communication and collaboration between the non-3D and the 3D store (n = 14). For them, the 3D spatial environment did not influence their social experience. The main reason seems to be that participants (n = 15) felt that the audio and not the visual avatars were of more importance to their communication. The 3D spatial presentation of the store was helpful in other aspects however, such as helping provide a sense of realism in regards to the shopping experience and helping provide physical presence (n = 13). In particular, participants (n = 11) reported enjoying the experience of being able to move around in a 3D store.

"*The 3D store was much more fun (…) being able to walk around, navigating, going up to the counter and having the food identified by a little logo, very interesting, very useful…. and the fact that I could tell where my partner was and I could go and see her*" (Participant 22, Male, 65).

Two major factors were identified on why participants felt that the visualization of the avatar in a 3D spatial environment did not help improve their social interaction experience. First, participants reported a difficulty in associating the avatar with physical people. Second, participants cited a lack of non-verbal cue in communication as a reason which limited the perceived usefulness of a 3D avatar.

7.4.4.2 Difficulty in Associating a Virtual Avatar with Physical People

A commonly theme which was reported by older users was the difficulty in associating virtual avatars with real people. 16 participants reported some kind of difficulty in associating themselves or their partners with the avatars when communicating in the 3D virtual world. Part of this was due a perceived discrepancy between the visual avatars and the audio communication in virtual world. For these participants (n = 9), the social presences of their partners mainly came from their partner's voice which they felt was separate from the visual representation of the avatar. Therefore, this made it harder from them to associate the avatars with the partner they were communicating with.

"*She was hiding behind her avatar, I was hiding behind my avatar (…) those two avatars does not represent us as we are now… so it was a dual function if you like… we were communicating by phone[audio], our avatars were running around the store buying [products]*" (Participant 25, Female, 67).

In addition, seven of the participants felt that it was difficult to associate the avatars with their partners as the avatar's visual appearance did not match with the real appearance of their partner. A considerable number of older users also reported preferring avatars with appearances that match the actual characteristics of the people they represent.

7.4.4.3 Lack of Non-verbal Communication

Another limitation commonly mentioned in regard to avatar-mediated communication was the lack of non-verbal communication. 17 participants mentioned wanting to be able to display non-verbal communication cues while communicating with their partners in the virtual store. Overall, the inability of avatars to display facial expressions and other forms of body language had a significant impact to their social experience in this platform. In particular, one participant reported that the inability of avatars to display facial gestures made her feel they were emotionless and made her perceive the avatars as less human. Two participants even reported that their inability to display emotions and their awkward movements made them feel more like robots. Other participants felt that the lack of such cues limited the efficiency of their communication and made it more difficult to trust their partners as they felt that users could hide their emotions and body language during communication.

7.4.4.4 Difficulty in Suspending Disbelief

Participants also tended to report a sense of artificiality when engaging with the 3D store feeling that their experience was not real enough. Some participants felt that the inability of computers to transmit other senses such as touch and smell was one of the key factor which reduced their perceived sense of realism (n = 7). For example, one participant cited the inability to feel the paper cups in the stores, to see if they could bend it or if it was strong enough.

Part of this difficulty in suspending disbelief could also be due to their inherent perception of 3D virtual environments as being a "playful" or an "imaginary" game based on their past experience and perceptions with similar technology. Often, participants reported that their experience was more akin to that of a video game than a serious shopping experience (n = 14). For them, the perception of "moving around a character in a 3D virtual environment" reminded them of the games they had played when they were younger or the games they had seen their younger family members play. Participants tended to use words such as "play" and "having fun" to describe their virtual world experience (17 participants). Compared to the non-3D store which was more practical and task based, participants felt the 3D store was more play oriented. For instance, one participant described how her experience in the 3D virtual world was similar to playing in a dolls house. This perception of virtual worlds as being a "playful" and a "game" could be one reason which made them perceive their experience as less real and this perception of games being a fabricated construct could make participants less willing to immerse themselves inside the virtual world.

7.4.4.5 User Barriers

A number of barriers to the use of technology by older users were identified during the interviews. One key theme was in relation to the negative perception towards online technologies, in particularly CMC. Participants (n = 8) expressed concerns about the safety of such technologies, especially related to the use of false identity, privacy and the dangers of being deceived.

In addition, participants (n = 6) expressed doubt towards developing relationships online through a computer, as opposed to meeting face-to-face. The notion of communicating virtually made them feel uncomfortable and participants preferred to socialize in the physical world. One major concern with socializing in the virtual world was the possibility of avatars being used to give false representations or being used to deceive other users (n = 13).

"*Well there are some difficulties, because you don't quite know if the avatars that you're meeting is anything like the person they are representing, so you have got snakes there…. they might be trying to give me the impression of such and such. If they could… they could give a false image of themselves, they could use their avatar in that way and you would have to be careful*" (Participant 11, Male, 70).

In addition, the lack of transparency in avatar mediated communication (such as how the avatars can be used to give false impressions) made some participants (n = 7) reluctant to use virtual worlds to communicate with other users in a public social space. However, participants expressed more willingness to use virtual worlds to communicate with those who they already knew (such as family members or friends) and could confirm their identities. The other barriers reported were related to the cognitive ability. Cognitive load problems (Ang et al. 2007), i.e., difficulty in multi-tasking or the inability to give adequate concentration on a particular aspect of user interaction, were reported by the participants (n = 6).

7.5 Discussion and Conclusion

The results from this study showed that there was not a significant difference in the measures for the quality of social interaction experience between the non-3D and the 3D virtual stores. Of particular interest was how the results showed that older people found 3D avatars to be of limited use to their social interaction. Regression analysis shows how this factor was not a direct predictor of the measures for social interaction when the other factors (namely physical presence) were controlled. Overall, it appears that rather than perceiving the avatars as an extension of themselves in the virtual world (a "representation") (Bartle 2004), older users perceived the avatars as just being a representative, or a puppet which they only control but do not truly embody. While further controlled studies would need to be carried out to confirm why this is the case, the results from the interviews in this study led us to believe that this could be due to the inability of avatars to display non-verbal behavior and reflect facial expression through avatar-mediated-communication. This lack of such none verbal cues which could serve as indicators for deception not only made it difficult for users to trust their partners (Zuckerman et al. 1981), but also reduced their perceived level of realism. Such concerns about issues of deception and false identity are commonplace with older people in other CMC technologies (such as in social networking services (Lehtinen et al. 2009)). For virtual worlds however, the use of a 3D avatar seems to further compound this problem, as there was "an avatar representation" but not one which is realistic enough to display emotions or has a facial appearance which matches their partner. Part of this sense of uneasiness could also be due to the perceptual mismatch between the artificial features of the 3D avatars and the actual human feature perceived by users which could invoke a negative affinity towards the avatars (see Kätsyri et al. 2015).

A number of steps could be taken to improve avatar-mediated communication for older users. To address the issue of the lack of transparency, instead of relying on the 3D avatar to embody and convey the identity of the users, a separate 2D photographed avatar could be used to instead convey the identity of the user (with the 3D avatar being used mainly to convey a physical presence in the spatial realm). In addition, gesture-based sensors (such as the Microsoft Kinect) have the ability to directly map user motions and facial expressions towards their avatars which could provide a more accurate representation of body language (particularly those which are displayed unconsciously). While physical presence was found to be a significant predictor in most of the measures for the quality of social interaction which is in line with previous studies carried out with general users (Jung 2011) (Stanney et al. 1998), what was particularly interesting was how older people seem to hold a stereotype of virtual worlds as being a "game" (based on their past experience with similar looking technology) and associating it with mainly with "playfulness. Due to the sense of artificially associated with "games" and "play" as being an artifact outside real life, some users found it was difficult for them to suspend their disbelief and immerse themselves in the store. This perception could have negative implications for example if virtual worlds were to be used in more serious contexts. While it could be impossible to convey senses and project a high sense of realism through only a static computer screen, emerging technology such as Augmented reality or by simply using digital projectors, we would be able to project a virtual world dimension onto an existing plane of reality, therefore not necessitating us to recreate all aspects of the environment in a highly realistic manner.

Although some of these findings have been previously reported in past studies on 3D virtual world, very few of these past studies focused on older people. When older people were involved, most studies focused on only a specific aspect of the virtual world, for instance on the use of avatars as computer controlled interfaces to interact with older people (such as embodied virtual agents (Straßmann and Krämer 2017)) or the ability to navigate in a 3D space (Sjolinder et al. 2005). In this study, the avatars are evaluated as entities controlled by actual users and used in social interaction in a 3D spatial environment. The findings from this chapter generally supported the results from previous studies, for example, showing how some older adults selected avatars to represent their actual or idealized selves (Carrasco et al. 2017) or how older users were unable to relate and identified themselves with computer generated avatars (Cheong and Theng 2011).

There are several limitations in this study, the foremost being the relatively limited sample size. Although 38 samples are sufficient to detect a large effect size, our regression models might fail to detect results of low and medium effect sizes. In addition, as participants were recruited through convenient sampling (namely snowball sampling), most were quite acquainted with each other prior to the study. Whether the social experience of participants would be different had they never met face-to-face before would need to be further investigated. The interviews hinted that this might be the case as participants reported factors such as false identity and deception as being key points of concerns when using such technology.

Overall, the results from this chapter and from previously related studies which were carried out offers several interesting perspectives on how older people engage with 3D virtual world environments. When examining older people who engaged with virtual worlds, we found that despite the considerable difficulty in learning how to interact with virtual world, several were able to overcome these initial usability barriers and use virtual worlds to productively expand and maintain their social networks, learn new skills and knowledge and contribute back meaningfully to society (Siriaraya et al. 2014), (Siriaraya and Ang 2012a, b). A more in-depth study carried out in this chapter showed that it was not only the commonly assumed cognitive ability barriers such as difficulties of navigating in a 3D environment which impacted their social experience, but psychological barriers such as concerns about deception and false identity and prior expectations of 3D computer generated environments as being non-serious fictional spaces also contributed to their negative social experience as well. In particular, while the 3D environment seems to contribute to a borderline increase in physical presence, the environment did not contribute to an increase in social presence, with older people not perceiving avatars as being representations of actual human users and only as placeholders in the 3D environment. This shows to an interesting future research direction on how a more satisfactory embodiment in social interaction could be achieve for older users in a 3D environment.

References

Ang CS, Zaphiris P, Mahmood S (2007) A model of cognitive loads in massively multiplayer online role playing games. Interact Comput 19(2):167–179
Bartle RA (2004) Designing virtual worlds. New Riders, Indianapolis, IN
Biocca F, Harms C, Burgoon JK (2003) Towards a more robust theory and measure of social presence: review and suggested criteria. Presence 12(5):456–480
Bowling A, Paul D (2005) What is successful ageing and who should define it? BMJ V331:1548–1551
Braun V, Clarke V (2006) Using thematic analysis in psychology. Qual Res Psychol 3(2):77–101
Carrasco R, Baker S, Waycott J et al (2017) Negotiating stereotypes of older adults through avatars. In: Proceedings of the 29th Australian conference on computer–human interaction, Brisbane, Australia, pp 218–227
Cheong WL, Theng YL (2011) Avatar: a virtual face for the elderly. In: Proceedings of the 10th international conference on virtual reality continuum and its applications in industry, Hong Kong, China, pp 491–498
Czaja S, Lee CC (2007) Information technology and older adults. In: The human-computer interaction handbook: fundamentals, evolving technologies and emerging applications. Erlbaum, New York, pp 778–792
Ducheneaut N, Wen M-HD, Yee N et al (2009) Body and mind: a study of avatar personalization in three virtual worlds. ACM, NY, pp 1151–1160
Dunning T (2009) Online communities and aging. Adapt Aging 33(4):263–264
Ellison NB, Steinfield C, Lampe C (2007) The benefits of Facebook "friends:" social capital and college students' use of online social network sites. J Comput Mediat Commun 12(4):1143–1168
Fetscherin M, Lattemann C (2008) User acceptance of virtual worlds. J Electron Commer Res 9(3):231–242
IJsselsteijn WA, Ridder Hd, Freeman J et al (2000) Presence: concept, determinants and measurement. In: Proceedings of the SPIE, human vision and electronic imaging V, San Jose, California, January 24–27, pp 520–529
Jung Y, Peng W, Moran M et al (2010) Low-income minority seniors' enrollment in a cybercafé: psychological barriers to crossing the digital divide. Educ Gerontol 36:193–212
Jung Y (2011) Understanding the role of the sense of presence and perceived autonomy in user's continued use of social virtual worlds. J Comput Mediat Commun 16(4):492–510
Kätsyri J, Förger K, Mäkäräinen M et al (2015) A review of empirical evidence on different uncanny valley hypotheses: support for perceptual mismatch as one road to the valley of eeriness. Front Psychol 6:390
Khalaila R, Vitman-Schorr A (2018) Internet use, social networks, loneliness, and quality of life among adults aged 50 and older: mediating and moderating effects. Qual Life Res 27(2):1–11
Lehtinen V, Nasanen J, Sarvas R (2009) A little silly and empty-headed—older adults understanding of social networking sites. The British Computer Society, Cambridge, pp 45–54
Lombard M, Ditton T (1997) At the heart of it all: the concept of presence. J Comput Mediat Commun 3(2). http://jcmc.indiana.edu/vol3/issue2/lombard.html
Nimrod G (2010) The fun culture in seniors' online communities. The Gerontologist 51(2):226–237
Nowak KL, Biocca F (2003) The effect of the agency and anthropomorphism on users' sense of telepresence, copresence, and social presence in virtual environments. Presence Teleoperators Virtual Environ 12(5):481–494
Pew Research Center (2010) Generations 2010. http://pewinternet.org/Reports/2010/Generations-2010.aspx. Accessed 26 Aug 2011
Siriaraya P, Ang CS (2012a) Age differences in the perception of social presence in the use of 3D virtual world for social interaction. Special Issue on presence and interaction. Interact Comput 24:280–291
Siriaraya P, Ang CS (2012b) Characteristics and usage patterns of older people in a 3D online multi-user virtual environment. Comput Hum Behav 28(5):1873–1882

Siriaraya P, Ang CS, Bobrowicz A (2014) Exploring the potential of virtual worlds in engaging older people and supporting healthy aging. Behav Inf Technol 33(3):283–294

Sjolinder M, Hook K, Nilsson LG et al (2005) Age differences and the acquisition of spatial knowledge in a three-dimensional environment: evaluating the use of an overview map as a navigation aid. Int J Hum Comput Stud 63(6):537–564

Stanney KM, Mourant RR, Kennedy RS (1998) Human factors issues in virtual environments: a review of literature. Presence 7(4):327–350

Straßmann C, Krämer NC (2017) A categorization of virtual agent appearances and a qualitative study on age-related user preferences. In: International conference on intelligent virtual agents, Stockholm, Sweden, pp 413–422

Taylor TL (2002) The social life of avatars: presence and interaction in shared virtual environments. In: Living digitally: embodiment in virtual worlds. Springer-Verlag, London, pp 40–62

Vilhjálmsson H (2003) Avatar augmented online conversation. Ph.D. thesis, MIT Media Lab

Zhou Z, Jin XL, Vogel DR et al (2011) Individual motivations and demographic differences in social virtual world uses: an exploratory investigation in second life. Int J Inf Manage 31(3):261–271

Zuckerman M, DePaulo BM, Rosenthal R (1981) Verbal and nonverbal communication of deception. ADV experimental social psychology 14. Academic Press, New York, pp 2–60

Panote Siriaraya (Ph.D., Electronics, University of Kent) is currently working as a Post-Doctoral Researcher at Kyoto Sangyo University. Previously he worked as a Researcher at the Delft University of Technology from 2014 to 2017. His main research interest falls broadly in the field of Human-Computer Interaction and includes topics such as Virtual Environments, Gamification and Designing Technologies for the Aging population.

Chee Siang Ang (Ph.D., City University London) is a Senior Lecturer in Multimedia and Digital Systems in the School of Engineering and Digital Arts, University of Kent. Before joining Kent, he was a research fellow at the City University London. His main research interest lies in the general area of HCI (Human Computer Interaction) with an emphasis on digital health. Specific areas include (i) Games and virtual worlds and (ii) Sensing technologies.

Chapter 8
Web-Based Embodied Conversational Agents and Older People

Gerard Llorach, Javi Agenjo, Josep Blat and Sergio Sayago

8.1 Introduction

Embodied and voice-based interactions are increasingly important within Human-Computer Interaction. Speech is widely regarded as the most natural way for humans to communicate. Nowadays, it is possible to interact verbally with Intelligent Personal Assistants (IPAs), which provide assistance or companionship to a wide range of user groups, ranging from children (Druga et al. 2017) to people with disabilities (Pradhan et al. 2018). Examples of IPAs are Apple Siri, Microsoft Cortana, Google Assistant, Amazon Alexa, and social robots, such as Aldebaran Pepper. In the near future, it is expected that important elements of communication, such as emotions and nonverbal behaviors, and context, will be implemented, because "If these assistants communicate naturally with humans, then they essentially disappear as computers and instead appear as partners" (Ebling 2016).

Embodied Conversational Agents (ECAs) can be thought of as IPA variants, which have an anthropomorphic representation, typically a 2D/3D virtual humanoid. Their use has been growing in the last years, due to their potential benefits to society, and thanks to recent technology developments. Recent publications have examined the

G. Llorach (✉)
Hörzentrum Oldenburg GmbH & Medizinische Physik and Cluster of Excellence 'Hearing4all', Universität Oldenburg, Oldenburg, Germany
e-mail: gerard.llorach.to@uni-oldenburg.de

J. Agenjo · J. Blat
Universitat Pompeu Fabra, Barcelona, Spain
e-mail: javi.agenjo@gmail.com

J. Blat
e-mail: josep.blat@upf.edu

S. Sayago
Universitat de Barcelona, Barcelona, Spain
e-mail: ssayago81@gmail.com

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_8

effectiveness of ECAs as pedagogical agents for learning (Lewis and Lester 2016) and as agents for detecting and preventing suicidal behavior (Martínez-Miranda 2017). Other recent publications deal with them in the context of group-meeting (Shamekhi et al. 2018) or Clinical Psychology (Provoost et al 2017). With older people, previous research on ECAs concentrates mostly on virtual worlds (Carrasco 2017), gesture-based avatar game (self-)representations (Rice et al 2016), and geriatrics (Chi et al. 2017).

Recently, within the KRISTINA project (Wanner et al. 2017), we explored ECAs in two important and increasingly common health scenarios in Europe: (a) to provide health support to a migrant with very little knowledge of the local language when the physician or nurse do not speak the migrant's language and (b) to provide assistance and basic medical recommendations to older adults.

Building on this work, in this chapter we discuss our ongoing research on building the interactive 3D web graphics aspects of ECAs, showing that the goal of making embodiment available for IPAs, and turning them into online ECAs, is attainable, which makes them more accessible. ECAs are very complex systems integrating different components, and have been mostly developed and deployed in desktop platforms. Based on part of our work, we also present the results of research activities aimed to explore the design of ECAs by older people, using free online character editors, to answer the question of how an ECA should look like for this user group, as well as promoting their transition to content producers (Ferreira et al. 2017; Guo 2017) one step forward: from text, pictures, videos or programs, to 3D agents.

8.2 Creation and Design of 3D Virtual Characters

In the context of the increasing maturity of the 3D interactive web (Evans et al. 2014), this section focuses on the potentialities that a web approach could bring to the wider adoption of ECAs. ECAs as desktop applications present drawbacks for both developers and users: developers must create an ECA for each device and operating system while end-users must install additional software, limiting their widespread use. Llorach and Blat (2017) have demonstrated, through the integration of the *Web Speech* API, *Web Audio* API, *WebGL* and *Web Workers*, together with novel work in the creation and support of embodiment through *WebGLStudio* (Agenjo et al. 2013), the possibility of a simple fully functional web-based 3D ECA accessible from any modern device.

In the following subsections we review a number of open-source tools to create humanoid realistic virtual characters. We also describe the main requirements and modifications for the virtual characters to be ready for the interactive web.

8.2.1 Tools to Create 3D Virtual Characters

Designing virtual characters from scratch is a very time consuming task. There exist tools that allow us to create humanoid characters in less than an hour. We review open-source tools (*MakeHuman*, *Autodesk Character Generator*, *Adobe Fuse CC* with *Mixamo* and *Daz Studio*) that provide some high-level control and flexibility over the physical appearance and behavioral properties of the character—including its expressivity via interactive facial and full body animation. We compare them with respect to basic functionalities, such as geometry control and exporting options, and more advanced aspects for the believability of the characters, such as clothes and hairstyles (see Table 8.1 and Fig. 8.1).

Table 8.1 Comparative analysis of different tools to create virtual humans

	High-level geometry control	Detailed geometry control	Clothes, hairstyles	Textures	Facial blend shapes and skeleton	Realism
MakeHuman 1.1.0	++ Ethnicity, age, gender	+ Feature modification through sliders	− Small set	Diffuse, normal map	+ Facial bone rig	+ Medium
Autodesk Character Generator	+ Blending between two predefined geometries	− Blending of predefined geometries	+ Medium-to-large set of hairstyles and clothes	Diffuse, normal map, specular map	+ Facial bone rig or facial blend shapes	−− Low
Adobe Fuse CC 2017.1.0	− 3D scans of real humans	++ Feature modification through sliders or directly on the mesh	++ Highly customizable medium-to-large set of hairstyles and clothes	Diffuse, normal map, specular map, gloss map, opacity map	+ Facial blend shapes	++ Medium-to-high
Daz Studio 4.10 Pro	−− Predefined models	−− Feature modification through sliders	−− Very small set, but dependent on the predefined model	Diffuse, opacity map	+ Facial bone rig	++ High

Fig. 8.1 Pictures of characters created (with, from left to right, Makehuman, Autodesk Character Generator, Adobe Fuse CC and Daz Studio) and rendered on the web. The quality of the final rendering is only indicative, as it could be improved using custom shaders and additional textures when possible

MakeHuman (MakeHuman_Team 2016) is currently a free desktop program. Several general controls for visual features such as ethnicity, age and gender and several exporting options make it suitable for creating custom characters easily and quickly. The geometries of the body and face can be controlled in detail with sliders. There are several options for configuring the skeleton, including complex ones with facial rig, which are necessary to be able to properly animate a character. The resulting character can be exported in several formats. The *.mhx2* format offers more features (rigs, blend shapes) when opened with *Blender* (Roosendaal 1995), an open source 3D Computer Graphics (CG) tool, and its specific plugin. One limitation could be the insufficient variety of clothes and hairstyles, which are key aspects in making the character believable, although user community provided non-curated assets, scripts and plugins could help fix it.

Autodesk Character Generator (Autodesk 2014) is a web-based editor to create characters. This means that no software has to be downloaded and that characters can be accessed and modified online. A large set of clothes and hairstyles is available as well as different body textures to change their ethnicity. Their geometry is based on the mix of two predefined ones and fine grain control is not possible. The characters' clothes, body and hair are exported as one mesh with one material, great for simple applications, but not good enough for more realistic-looking characters, where different materials and shaders are required for hair, skin and clothes, for example. The textures include color, normal and specular maps for better quality rendering. The exporting options do not cater for as many formats as *MakeHuman* does, but one can choose the quality of the mesh, to include facial blend shapes or facial rig and two different skeleton models. This software is especially useful to create crowd characters or for users with little expertise (no installation required and few exporting options).

Adobe Fuse CC (Adobe 2018a) is a desktop application that starts from real human 3D scans to create a model. The geometries of the selected scan can be finely controlled by means of sliders or via the mouse pointer directly on the model, a quite natural geometry modification procedure. The assets provided are quite customizable: the colors and patterns of the clothes, eyes and hair can be changed, offering a wide range of choices. There are many textures for each mesh: (diffuse) color, gloss (roughness of the surface), normals, opacity and specularity, allowing users to customize and improve the quality of the final rendering. A newly created character is exported through *Mixamo* (Adobe 2018b), a web platform where animations from a database containing more than 2,000 can be applied to the characters and pre-visualized. The exporting options are quite simple but enough for web high-quality. Several facial blend shapes are included as well as different skeleton configurations.

Daz Studio (Daz Productions 2018) offers high quality and realistic virtual characters with a facial rig and detailed textures. Nevertheless, modifying specific visual and geometric features is not allowed, just editing some general features of a pre-defined character. Most assets and features to create and modify the characters are not free, and the tool becomes expensive if several characters are required. It focuses mainly on the realistic rendering of scenes with virtual characters.

Additionally, instead of modeling a character, a real person can be scanned (based on depth cameras, LIDARs or from simultaneous still images) and transformed into a virtual character. There are current tools, such as *SmartBody* (Feng et al. 2015), whose output includes automatic rigging and facial expressivity. Several issues strongly limit their use for quality interactive web applications, such as their inability to separate the geometries with different materials (such as eyes, hair, skin, clothes, etc.). At their present stage, using them takes more effort and time to achieve web-ready characters than the aforementioned tools.

8.2.2 Web Requirements

In non-real-time scenarios without time constraints, virtual characters can have highly detailed geometries and photorealistic effects: the rendering of a frame movie can take several hours, whereas real-time applications can afford just some milliseconds. Thus, interactive web characters have specific requirements, and we discus the most important ones next.

File Size. The size of a desktop-based ECA matters little as it is stored in a hard drive and quickly retrieved, while for the web, the character file must be transmitted to the browser client and decompressed there in little time (Evans et al. 2018). The size of the surface mesh[1] of the character is directly correlated to the file size, and a highly detailed mesh does not permit interactivity even after having been loaded.

Facial Expressions with Blend Shapes. Blend shapes are commonly used to deform the geometry of the mesh, in our case, the facial geometry to create expressions. Each blend shape has the same number of displacement vectors as vertices of its corresponding mesh, and increases the file size. Thus, web applications can only consider a limited number of blend shapes.

[1]Surface meshes are most usual representations in 3D graphics; alternatives are voxels, for medical and engineering applications, or unstructured point clouds coming from 3D scanners.

Facial Expressions with Facial Bone Rigs. Using bones to deform the face gives much more flexibility than using blend shapes. Each bone can be translated, rotated and scaled affecting its associated vertices with different weights. This flexibility results in more complexity when creating facial expressions. While a single blend shape value is enough to show a happy face, multiple bones with their translations, rotations and scales would need to be adjusted. Moreover, this is very application and character dependent. Blend shapes can be constructed as a combination of bone transformations, but we worked with tools that support directly blend shapes, limiting complexity in the web side. Our real-time web-based 3D engine currently supports only a 4 bones per vertex.

Skeleton and Animations. The skeleton or rig of a virtual character is used for animations. Body skeletons can be very varied in complexity. In practical terms, their most important feature is their compatibility with a (large) database of animations, as creating animations that look natural or recording them with motion capture techniques can be time consuming. From the several animations databases available, we started using the CMU Graphics Lab Motion Capture Database and retargeting the animations to *MakeHuman* characters using *Blender*. This required a bit of tweaking for each animation. At a later stage we switched to using *Mixamo*, as the animations can be previsualized and tweaked on the web application, which greatly speeds up the process.

8.2.3 Scene Editors and Renderers

Scene editors and renderers have become more usable and widespread over the last ten years, in connection to game development. *Unity* (Unity Technologies 2018) and *Unreal Engine* (Epic Games 2018), for instance, save users a lot of time, allowing them to rapidly create, visualize and export 3D scenes and games with little coding and compatibility issues. Exported scenes can be interactively played on the web. Although plugins and/or manual configuration are needed, the maturity of the tools makes them a solid alternative to create playable web content. However, these web scenes do not support key features required for ECAs, such as easy integration with off-the-shelf web APIs, to enable their speech, for instance.

The introduction of *WebGL*, "a cross-platform, royalty-free web standard for a low-level 3D graphics API based on OpenGL ES2.0, exposed through the HTML5 Canvas element as Document Object Model interfaces" (Kronos Group), has contributed to a widespread use of higher quality 3D graphics on the web, because the API addresses directly low-level graphics devices, and web-based 3D graphics applications can become ubiquitous within the web environment (Evans et al. 2014), in particular for ECAs.

In order to provide real-time rendering, scene setup and scripting, a 3D engine and scene editor is required. There are several libraries, such as *SceneJS* and *Three.js* to create 3D scenes on the web without having to struggle with the low-level layer, but demand a good knowledge of 3D graphics programming. Unlike them, *WebGLStudio* (Agenjo et al. 2013), a web based open-source 3D scene editor and rendering engine, requires less knowledge of low-level graphics programming, while following an approach similar to *Unity* and *Unreal Engine*. The scenes created can be accessed through a web browser, without installing plugins. *WebGLStudio* has tools and components to easily integrate virtual characters. It supports animations, blend shape transformation through the GPU, custom shaders, light baking and mesh compression, to mention a few features. *Clara.io* is another browser based scene editor and engine with similar features to *WebGLStudio*, but is more oriented towards 3D modeling (this is also the case of *Sketchfab*).

8.2.4 Virtual Character Integration and Control

With the virtual character imported in *WebGLStudio*, scripts and components can be added on top of it to control its behavior in a fairly straightforward way. ECAs researchers have made efforts to standardize control commands and our work is based on them, specifically, on the SAIBA framework established several years ago (Kopp et al. 2006). This framework "distinguishes three processes in the generation of multi-modal communicative actions: intention planning, behavior planning, and behavior realization" (Heylen et al. 2008), which are interconnected and receive feedback from each other. The communication languages between these processes were also established by this group of researchers: the *Functional Markup Language* (FML) leads from the first to the second process as it "is supposed to be concerned with specifying the intentions of an agent" (Heylen et al. 2008), while the *Behavior Markup Language* (BML) goes from the second to the third as it "is one kind of specification of the behaviour that results" (Heylen et al. 2008). We focus on the visual representation, and thus BML is the most relevant for us.

In our work, we have implemented the support of basic BML commands, thus providing a web-based BML Realizer, which relied on a very basic (behavior) planner. For the all-important facial expression, we developed several web-based systems: facial animation based on valence and arousal proposed by (Romeo 2016) for desktop; simple lip-syncing (Llorach et al. 2016); gaze and head nods, part of BML, which are acknowledged as basic communication gestures; and some basic animations to communicate some specific nonverbal messages. Gaze behaviors followed the directions of Ruhland et al. (2015). For more information, Huang and Pelachaud (2012) discuss different animation pipelines based on SAIBA; McTear et al. (2016) provide a more complete review on tools to create desktop ECAs and behavior control standards in their book on conversational interfaces.

8.3 Our Pipeline in More Detail

In Sect. 8.3.1, we summarise our pipeline for designing, rendering, and controlling web-based ECAs. In Sects. 8.3.2–8.3.6, we focus on specific and key aspects of our pipeline, such as gaze and gestures. In Sect. 8.3.7 we offer an example of implementation of the pipeline.

8.3.1 Overall Process

Virtual Character Creation

1. Among the alternatives discussed in Sect. 8.2.1 we regard *Adobe Fuse CC* as the best current option because of its realism, customization of clothes, small file size, number of textures for the materials, number of facial blend shapes and direct connection to the animation database *Mixamo*. Nevertheless we also discuss the issues and steps required with the other virtual character creation tools.

Blender: Improving the Model

2. Once the character is created with one of the virtual character creation tools (*Makehuman, Adobe Fuse CC, Autodesk Character Generator or Daz Studio)*, our next step is to import it into *Blender*. With *MakeHuman* we use the *Blender Exchange* format (*.mhx2*) together with the *MakeHuman* plugin for *Blender*; with the rest of the tools we import the virtual character as an *FBX* file.
3. In Blender we separate the head from the body (which appears as a single mesh in most cases) and remove blend shapes from body parts that are actually not deformed. A 60% size reduction results, and 20% more if merging symmetric blend shapes (e.g., for eyes) and removing unused blend shapes.
4. We create other necessary blend shapes by mixing existing blend shapes/facial bones or manually. In our facial expression system and lip-sync, only 9 blend shapes are used, four for the upper part of the face and five for the lips and mouth: eyebrows up, eyebrows down, inner eyebrows up and eyelids down; lips funneled, smile, lip corners down, lips pressed, mouth open. In terms of the Facial Action Coding System (FACS) (Ekman and Rosenberg 1997): AU2, AU4, AU1, AU43; AU22, AU12, AU15, AU24, AU27 respectively.
5. Usually small corrections are needed to fix errors of the model or to improve the character. Adding a bit of weight to the skin surrounding each eye adds a lot of realism: when the character looks away from the center, the eyelids and skin around the eyes will follow slightly. Some fixes depend on the software: in *MakeHuman* adding bone weights for the tongue and shoes and adjusting the teeth position; in *Autodesk Character Generator* unpacking the textures from the *.FBX* format to separate files; in *Adobe Fuse CC* renaming the objects and skeleton.

6. Further file size reduction for better loading process performance can be achieved by lowering the resolution of the textures, simplifying or deleting geometries that are not going to be seen or do not take part in the final scene.

Mixamo/Blender with Makehuman Plugin for Animations

7. We perform the preprocessing of the animations in *Blender* and/or in *Mixamo*. With *Mixamo* the character can be uploaded on the platform and the animations previsualized and adjusted in a very user-friendly way (e.g., via sliders that can even control motion style). *Blender* permits finer control (e.g., modifying weight bones), but loading, visualizing and modifying animations is slower. As an example of adjustment needed, if a character has very small hips and torso, it is likely that an animation from a standard database will place the arms too separated from the thin body. Within *Mixamo* the animations are automatically adapted to the character's size, whereas *Blender* animations would need to be adapted manually to each character. In our pipeline, animations can be imported later on *WebGLStudio*, so new animations can be continuously added to the web-based characters.

WebGLStudio for Integration and Control

8. We import in *WebGLStudio*, which supports two 3D standard formats, *OBJ* and *COLLADA*. *OBJ* does not support animations, thus we use *COLLADA* to import the characters with animations, skeleton, blend shapes, materials, lights and cameras.
9. To create materials, textures can be dragged directly on the 3D object in the scene, but some configuration of each material is still required, such as adding reflections to the cornea and specifying which texture applies to what (diffuse, specular, opacity…).
10. We use *WebGLStudio* components and scripts to configure the scene with the set (cameras, lights, background scenario) and add the scripts and components to control the virtual character. The scripts and components will be described in detail in the following Sects.
11. As *WebGLStudio* works in the (browser) client, the character and scene needs to be either stored in a server (through a *WebGLStudio* account for example) or downloaded. *WebGLStudio* can download the whole scene in a custom format (.*WBIN*), as a folder ready to deploy in a HTML server, or to store a new character on a remote disk.

8.3.2 Behavior Scripting and Control

In an ECA application, the character is controlled via instructions generated by the system that replies to user input. There are several standards to control virtual characters (Gibet et al. 2016) and some have been proposed and used over the years specifically for ECAs, within the SAIBA framework mentioned above. We use BML, as it is currently the most widespread format; EMBR (Heloir and Kipp 2009) has been proposed as an alternative for finer animation control. As our character is web-based, it can be controlled by a third party application hosted remotely, which is indeed the case in the KRISTINA project.

Within BML standardized behaviors, we support time synchronization, face, gaze, gesture, head and speech. We found especially challenging the simultaneous combination of several behaviors as far as they affect the same parts of the body. For example, both the actions "look to the left" and "head nod" modify the rotation of the head in different ways. We combined the rotations of the two, so that the agent can look towards the left while nodding. Both facial expressions and lip syncing (speech behavior) also control the lower part of the face. In our implementation we opted to override the facial expression of the lower part of the mouth with the lip syncing while the agent is speaking, although there are alternatives to combine facial expressions and lip syncing (Karras et al. 2017).

8.3.3 Look at

Gaze is a very important feature in the communication process. It indicates where attention is directed, plays an important role in turn-taking and even thoughts and emotions can be inferred from it (Ruhland et al. 2015). In our pipeline, we implemented a script component to make the character look at a desired 3D point in the scene by rotating the bones of the eyes, head and neck with different intensities through inverse kinematics. We adjust the intensity of the component to achieve natural relationships between the eye movement and head rotations.

8.3.4 Lip-Syncing

Lip-syncing is still an active area of research, where knowledge and expertise in speech processing, computer graphics and human animation is required. Although many solutions provide real-time lip-sync, commonly their parameters are generated using pre-recorded speech and then lip-sync is reproduced in real-time. Few solutions generate lip-sync based on live input in real-time (Wei and Deng 2015) (Liu et al. 2011) and they have not been implemented in a web browser.

We developed a simple lip-syncing (Llorach et al. 2016) which only uses the web resources, but can analyze the audio signal and extract the lip parameters with live input in real-time. The algorithm computes the short-term power spectrum and extracts the energies of different frequency bands, which are then mapped to three blend shapes through a set of equations based on the formant location and other speech features of the spectrum. The blend shapes used for this lip-sync are lips

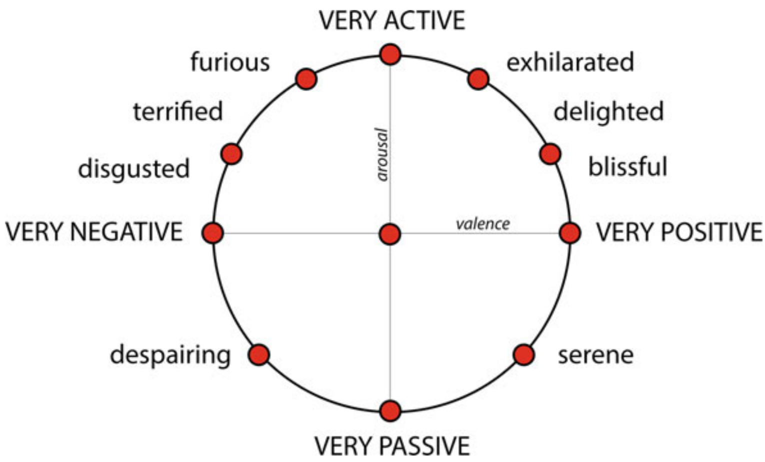

Fig. 8.2 Positioning of the predefined facial expressions in the valence (horizontal axis) and arousal (vertical axis) space

funneled, lips pressed, mouth open, which in terms of the FACS are AU22, AU24 and AU27 respectively.

8.3.5 Facial Expressions

It is essential that facial expressions are accurate in order to properly communicate, as shown by Beale and Creed (2009). Non-real-time applications can spend as long as needed to create facial expressions. On the contrary, the ECAs facial expression needs to be almost real-time without the possibility of small fixes. It can be controlled at different abstraction levels: high level labels such as happy, angry and displeasure; low-level instructions such as those provided in MPEG-4 (Tekalp and Ostermann 2000) or the FACS, each with its own advantages and limitations. High level labels limit the encoding capabilities to a set of predefined expressions, and low-level instructions need detailed specific control, which probably require another level of abstraction for its definition.

We have adapted to the web an intermediate approach proposed by Romeo (2016), where a 2D emotional space was used to generate facial expressions combining several facial actions from the FACS. The approach uses a valence-arousal (also known as activation—evaluation) space, which has been recently become more widespread in the literature. For instance, Hyde et al. (2014, 2015) use a valence-arousal based system to understand how to animate the faces of realistic characters to improve perceptions of emotions and naturalness with the goal of creating more compelling interactive applications. In Romeo's model there are eleven predefined facial expressions in different positions of the valence and arousal wheel (Fig. 8.2). The system interpolates between the nearest predefined facial expressions in the 2D space.

Fig. 8.3 Blend shapes used in our pipeline. From left to right and from top to bottom: eyebrows up (AU2), eyebrows down (AU4), inner eyebrows up (AU1), eyelids down (AU43); lips funneled (AU22), smile (AU12), lip corners down (AU15), lips pressed (AU24) and mouth open (AU27)

The eleven predefined facial expressions of the model can be created with only 9 blend shapes, four for the upper part of the face and five for the lips and mouth: eyebrows up, eyebrows down, inner eyebrows up and eyelids; lips funneled, smile, lip corners down, lips pressed, mouth open, which are FACS AU2, AU4, AU1, AU43; AU22, AU12, AU15, AU24, AU27 respectively (Fig. 8.3).

In our web-based implementation the facial expression of the virtual character can be controlled by either moving a pointer in the valence-arousal space or setting numerically the valence and arousal values. These different layers give a lot of flexibility to the model, as it can be controlled at very high levels (valence-arousal and emotional tags) or with more detail (blend shapes/facial action units).

8.3.6 Gestures

Gestures can convey a lot of non-verbal information. They can also modify the meaning of the verbal message. The BML standard divides body motions into head gestures, upper body gestures (arms/hands) and body posture. As discussed earlier, conflicts can appear when several BML instructions control the same parts of the body. How to solve these conflicts is not standardized, and different BML realizers can produce characters that behave differently for the same BML instructions. We implemented different postures, so that changes of mind or state can be shown.

8.3.7 An Example of a Fully Web-Based ECA

To demonstrate the possibilities of web browser based ECAs and test our BML Realizer, we developed a complete ECA that can interact verbally in real time (Llorach and Blat 2017) with a user. The ECA uses the aforementioned BML Realizer, interfaces with the speech recognition and synthesis of the Web Audio and Speech APIs and a basic artificial conversational entity, ELIZA. Additionally, the face of the user was tracked by means of jsfeat (integrated through Web Workers) and the gaze character followed it. The whole application works in the client but for the speech recognition and synthesis services, which use Google ones by default.

8.4 ECAs and Older People

Much research on ECAs with older people focuses on health-related issues. One of the first significant works on ECAs with older adults (Bickmore et al. 2005) concentrated on a relational agent that plays the role of an exercise advisor. More recently, in (McTear et al. 2016), one of the future directions of (embodied) conversational interfaces is health and ageing. The same future direction—namely, the Healthcare Personal Agent—is suggested in a relatively recent review of open challenges in modelling, analysing and synthesising human behaviour in human-machine interactions (Vinciarelli et al. 2015).

While health is a very important topic, especially in light of a growing ageing population, and much HCI research with older people also concentrates on health (Rogers and Marsden 2013), we consider that ECAs could be of great benefit to older people in other facets of their everyday lives, ranging from learning and leisure to well-being and tourism. To this end, a fundamental question for us is the physical appearance (Ring et al. 2014), along with the emotional component and personality, of ECAs. For humans, it is almost inevitable to impute human qualities to animals, things, and objects which are not human, in order to understand and deal with them (Lakoff and Johnson 2003).

Working towards this end, we conducted a workshop (Maña et al. 2018) intended to explore how a group of older people (N = 14) interested in technologies think ECAs look like. We first talked to them about ECAs and showed them some examples in an MS PowerPoint presentation. We then asked them to create their own ECA for two scenarios, which we thought could be of interest to them: a travel guide, a technology expert/assistant. To create the ECAs, participants used *Adobe Fuse CC* and *Mixamo*. This activity also allowed us to test the usability of these editors for older people. The activity seemed to elicit fun for them and was positively perceived. Overall, the participants created mostly female characters, with white skin, and were clothed informally (Fig. 8.4). Participants were able to create their agents mostly on their own, with our support.

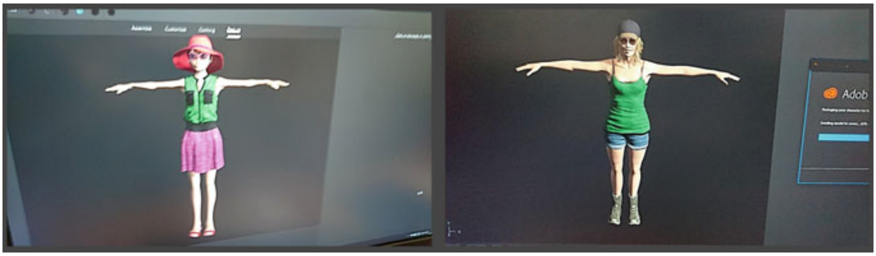

Fig. 8.4 Two of the female characters created by the older adults

While creating their preferred agents, we also had an opportunity to gather their opinions on this new type of user interface for them. There were diverse views: while some of them disliked the idea of talking with a cardboard, others pointed out that interacting with ECAs could help them skip a lot of steps while organizing a trip or buying a new computer online, for instance.

8.5 Conclusion

This chapter has presented an innovative way of building ECAs, in the context of future more widespread embodied conversational interfaces. The innovation lies in designing, controlling and deploying ECAs online. Web-based ECAs pose a few challenges, and this chapter has discussed a number of them, proposing and demonstrating solutions. This chapter has also presented results of research activities aimed to explore the design of ECAs by older people, using free online character editors. The aim of this exploration was to start to understand how an ECA should look like for this user group, and to identify the usability of online editors.

Unlike other chapters in this book, the perspective on HCI research with older people introduced in this chapter is mostly technical. The new perspective lies in a technological pipeline that allows for rapid or "quick-and-dirty" online experimentations, which are important to examine a wide range of aspects involved in the interaction between ECAs and older people. A large number of aspects (physical appearance, gestures, emotion, empathy…) remain to be understood with older people and ECAs. Exploring them online allows us to conduct a number of experiments relatively quickly. Also, older people can become "designers of assistants", using online free tools, taking one step forward the transition from passive users to active creators of digital content (and agents).

Acknowledgements This work was partly funded by the EU's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 675324 (ENRICH) and under the contract number H2020-645012-RIA (KRISTINA). We also acknowledge the support from the A-C-T network.

References

Adobe (2018a) Adobe Fuse CC (beta). https://www.adobe.com/products/fuse.html/. Accessed 15 Oct 2018

Adobe (2018b) Mixamo. https://www.mixamo.com/. Accessed 15 Oct 2018

Agenjo J, Evans A, and Blat J (2013) WebGLStudio: a pipeline for WebGL scene creation. In: Proceedings of the 18th international conference on 3D web technology. ACM, NY, USA, pp 79–82

Autodesk (2014) Autodesk Character Generator. https://charactergenerator.autodesk.com/. Accessed 15 Oct 2018

Beale R, Creed C (2009) Affective interaction: how emotional agents affect users. Int J Hum Comput Stud 67(9):755–776

Bickmore TW, Caruso L, Clough-gorr K et al (2005) 'It's just like you talk to a friend' relational agents for older adults. Interact Comput 17:711–735

Carrasco R (2017) Designing virtual avatars to empower social participation among older adults. In: Proceedings of the 2017 CHI conference extended abstracts on human factors in computing systems. ACM, NY, USA, pp 259–262

Chi N, Sparks O, Lin S-Y et al (2017) Pilot testing a digital pet avatar for older adults. Geriatr Nurs 38:542–547

Daz Productions (2018) Daz Studio. https://www.daz3d.com/daz_studio. Accessed 15 Oct 2018

Druga S, Breazeal C, Williams R et al (2017) Hey Google is it OK if I eat you? Initial explorations in child-agent interaction. In: IDC 2017 proceedings of the 2017 conference on interaction design and children. ACM, NY, USA, pp 595–600. https://doi.org/10.1145/3078072.3084330

Ebling MR (2016) Can cognitive assistants disappear? IEEE Pervasive Comput 15(3):4–6. https://doi.org/10.1109/MPRV.2016.41

Ekman P, Rosenberg EL (eds) (1997) What the face reveals: basic and applied studies of spontaneous expression using the facial action coding system (FACS). Oxford University Press, USA

Epic Games (2018) Unreal Engine 4. https://www.unrealengine.com/. Accessed 15 Oct 2018

Evans A, Agenjo J, Blat J (2018) A pipeline for the creation of progressively rendered web 3D scenes. Multimed Tools Appl 77:20355–20383

Evans A, Romeo M, Bahrehmand A et al (2014) 3D graphics on the web: a survey. Comput Graph 41:43–61

Feng A, Casas D, Shapiro A (2015) Avatar reshaping and automatic rigging using a deformable model. In: Proceedings of the 8th ACM SIGGRAPH conference on motion in games, ACM, NY, USA, pp 57–64

Ferreira SM, Sayago S, Blat J (2017) Older people's production and appropriation of digital videos: an ethnographic study. Behav Inf Technol 36(6):557–574. https://doi.org/10.1080/0144929X.2016.1265150

Gibet S, Carreno-Medrano P, Marteau PF (2016) Challenges for the animation of expressive virtual characters: the standpoint of sign language and theatrical gestures. In: Dance notations and robot motion. Springer, pp 169–186

Guo PJ (2017) Older adults learning computer programming: motivations, frustrations, and design opportunities. In: Proceedings of the 2017 CHI conference on human factors in computing systems. ACM, NY, USA, pp 7070–7083. https://doi.org/10.1145/3025453.3025945

Heloir A, Kipp M (2009) EMBR: a realtime animation engine for interactive embodied agents. In: 3rd international conference on affective computing and intelligent interaction and workshops, Amsterdam, pp 1–2. https://doi.org/10.1109/acii.2009.5349524

Heylen D, Kopp S, Marsella SC et al (2008) The next step towards a function Markup Language. In: Prendinger H, Lester J, Ishizuka M (eds) Intelligent virtual agents. IVA 2008. Lecture notes in computer science, vol 5208. Springer, Berlin, Heidelberg

Huang J, Pelachaud C (2012) September. Expressive body animation pipeline for virtual agent. In: International conference on intelligent virtual agents. Springer, Berlin, Heidelberg, pp 355–362

Hyde J, Carter EJ, Kiesler S et al (2014) Assessing naturalness and emotional intensity: a perceptual study of animated facial motion. In: Proceedings of the ACM symposium on applied perception. ACM, NY, USA, pp 15–22

Hyde J, Carter EJ, Kiesler S et al (2015) Using an interactive avatar's facial expressiveness to increase persuasiveness and socialness. In: Proceedings of the 33rd annual ACM conference on human factors in computing systems. ACM, NY, USA, pp 1719–1728

Karras T, Aila T, Laine S et al (2017) Audio-driven facial animation by joint end-to-end learning of pose and emotion. ACM Trans Graph 36(4):94

Kopp S, Krenn B, Marsella SC et al (2006) Towards a common framework for multi-modal generation: the behavior Markup Language. In: Gratch J, Young M, Aylett RS et al (eds) IVA 2006. LNCS (LNAI), vol 4133. Springer, Heidelberg, pp 205–217

Lakoff G, Johnson M (2003) Metaphors we live by. The University of Chicago Press, London

Lewis W, Lester C (2016) Face-to-face interaction with pedagogical agents, twenty years later. Int J Artif Intell Educ 26:25–36

Liu J, You M, Chen C et al (2011) Real-time speech-driven animation of expressive talking faces. Int J Gen Syst 40(04):439–455

Llorach G, Blat J (2017) Say Hi to Eliza. In: International conference on intelligent virtual agents. Springer, pp 255–258

Llorach G, Evans A, Blat J et al (2016) Web-based live speech-driven lip-sync. In: Games and virtual worlds for serious applications (VS-Games), 2016 8th international conference on. IEEE, pp 1–4

MakeHuman_Team (2016) MakeHuman. http://www.makehuman.org/. Accessed 15 Oct 2018

Maña F, Toro I, Sayago S et al (2018). Older people's interactive experiences through a citizen science lens: a research report. Funded by ACT (Ageing-Communication-Technologies)

Martínez-Miranda J (2017) Embodied conversational agents for the detection and prevention of suicidal behaviour: current applications and open challenges. J Med Syst 41:135

McTear M, Callejas Z, Griol D (2016) The conversational interface: talking to smart devices. Springer

Pradhan A, Mehta K and Findlater L (2018) Accessibility came by accident: use of voice-controlled intelligent personal assistants by people with disabilities. In: Proceedings of the 2018 CHI conference on human factors in computing systems. ACM, NY, USA, p 459

Provoost S, Ming H, Reward J et al (2017) Embodied conversational agents in clinical psychology: a scoping review. J Med Internet Res 19(5):1–17

Rice M, Koh RYI, Ng J (2016) Investigating gesture-based avatar game representations in teenagers, younger and older adults. Entertain Comput 12:40–50

Ring L, Utami D and Bickmore T (2014) The right agent for the job? In: International conference on intelligent virtual agents. Springer, Cham, pp 374–384

Rogers Y, Marsden G (2013) Does he take sugar? Moving beyond the rhetoric of compassion. Interactions 20(4):48–57

Romeo M (2016) Automated processes and intelligent tools in CG media production. PhD dissertation. http://hdl.handle.net/10803/373915

Roosendaal T (1995) Blender. https://www.blender.org/. Accessed 15 Oct 2018

Ruhland K, Peters CE, Andrist S, et al (2015) A review of eye gaze in virtual agents, social robotics and hci: behaviour generation, user interaction and perception. In: Computer graphics forum, vol 34, no 6, pp 299–326

Shamekhi, A, Liao, Q, Wang, D et al (2018) Face value? Exploring the effects of embodiment for a group facilitation agent. CHI 2018, Canada, Paper 391

Tekalp AM, Ostermann J (2000) Face and 2-D mesh animation in MPEG-4. Signal Process Image Commun 15(4–5):387–421

Unity Technologies (2018) UNITY. https://unity3d.com/. Accessed 15 Oct 2018

Vinciarelli A, Esposito A, André E et al (2015) Open challenges in modelling, analysis and synthesis of human behaviour in human-human and human-machine interactions. Cogn Comput 7:397–413

Wanner L et al (2017) KRISTINA: a knowledge-based virtual conversation agent. In: Demazeau Y, Davidsson P, Bajo J et al (eds) Advances in practical applications of cyber-physical multi-agent systems: the PAAMS collection. PAAMS 2017. Lecture notes in computer science, vol 10349. Springer, Cham, https://doi.org/10.1007/978-3-319-59930-4_23

Wei L, Deng Z (2015) A practical model for live speech-driven lip-sync. IEEE Comput Graph Appl 35(2):70–78

Gerard Llorach (BSc, Audiovisual Engineering, Universitat Pompeu Fabra, Barcelona) started working as a research assistant in the Technologies Interactive Group (GTI) at Universitat Pompeu Fabra in 2013, focusing on virtual reality and motion sickness, computer graphics and embodied conversational agents. He is currently undertaking a Ph.D. at CvO Universität Oldenburg. His research looks into visual cues and virtual characters in the hearing research context.

Javi Agenjo (BSc, Software Engineering, Universitat Pompeu Fabra, Barcelona) is an expert at WebGL and Computer Graphics. He is the developer of WebGLStudio and lecturer at Universitat Pompeu Fabra. His work at UPF revolves around European projects focused on tools for digital cinema and character animation.

Josep Blat (Ph.D., Mathematics, Heriot-Watt University, Edinburgh) is Professor of Computer Science at Universitat Pompeu Fabra, Barcelona and director of the GTI research group (https://www.upf.edu/web/gti). His current research includes advanced 3-D graphics (human modeling, animation and rendering, games), human-computer interaction (older people, ethnography, geolocation, wearables). Previously, he worked in applied nonlinear analysis, mathematical analysis of images and technology-enhanced learning.

Sergio Sayago (Ph.D., Human-Computer Interaction/Computer Science, Universitat Pompeu Fabra, Barcelona) has been conducting HCI research with older people since 2004. He has conducted long-term ethnographic, participant observation and co-design studies of real-life web accessibility (WCAG) and technology use, mostly communication and digital games, in different cultural settings. His current research focuses on long-term empowerment and democratization, addressing making, programming, and (embodied) conversational interfaces, with older and adult people with low levels of formal education.

Part IV
Technology Use

Chapter 9
Online Leisure and Wellbeing in Later Life

Vera Gallistl and Galit Nimrod

9.1 Introduction

Over the past 20 years, most human-computer interaction (HCI) research on older people and digital technologies has focused on design-related matters, while scholars in other disciplines (gerontology, sociology, psychology, social work, nursing, etc.) explored the association between Internet use and subjective wellbeing (SWB) in later life. Overall, their findings provided considerable evidence demonstrating a positive association between these two variables.

Many of the studies on Internet use and SWB were cross-sectional, although some applied a longitudinal approach or experimental design and pointed to causality. For example, a study with a quasi-experimental design conducted by Shapira et al. (2007) showed that learning computer and Internet skills contributed significantly to seniors' SWB and sense of empowerment. Similarly, a longitudinal study performed by Cotten et al. (2014) demonstrated that Internet use significantly reduced the probability of depression. Based on such findings, scholars argued that Internet use may play a central role in successful aging.

Existing research, however, also includes conflicting findings that reveal negative associations (or none whatsoever) between Internet use and SWB in later life. Berner et al. (2012), for example, found no significant associations between Internet use and life satisfaction, and Slegers et al. (2008) discovered that learning to use the Internet neither positively nor negatively influenced elders' wellbeing and mood. Moreover, Choi and DiNitto (2013a) indicated that older Internet users had higher levels of depression and anxiety than non-users, and Matthews and Nazroo (2015) concluded

V. Gallistl (✉)
University of Vienna, Vienna, Austria
e-mail: vera.maria.gallistl@univie.ac.at

G. Nimrod
Ben-Gurion University of the Negev, Beer-Sheva, Israel
e-mail: gnimrod@bgu.ac.il

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_9

that frequent Internet use was associated with more intense feelings of loneliness in later life.

One potential explanation for the inconsistencies in previous research may relate to differences in approach to Internet use measurement. Many studies considered Internet use a single activity, adopting a macro level view that could give rise to misleading generalizations. Different activities may yield diverse benefits and/or negatively affect participants. The macro approach conceals such distinctions, thereby limiting our understanding of the particular ways in which Internet use affects SWB. Other scholars limited their research to specific online activities (e.g., games, online communities and the like), applying a micro level outlook that ensures a deeper understanding of the benefits of such activities to older Internet users but precludes generalization.

To achieve a better understanding of the Internet's role in supporting wellbeing in later life, Lifshitz et al. (2016) suggested a functional approach, calling for simultaneous but separate examination of each of the principal online functions common among older adults (interpersonal communication, information, task performance and leisure). Using data collected online from Internet users aged 50 years and over, they revealed that all four online functions were positively correlated with life satisfaction and that task performance and leisure were negatively correlated with depression. After controlling for socio-demographic variables, however, only leisure associated significantly with the wellbeing measures. This finding suggests that previous studies on Internet use and SWB yielded contradicting findings because they overlooked use functions as perceived by users.

The online leisure function's significance to SWB is consistent with an extensive corpus of literature on the importance of leisure in later life. Numerous studies have shown that involvement in leisure activities exerts a major influence on older adults' physical, psychological, social and spiritual wellbeing and improves their self-image, sense of control and quality of life (for reviews, see Dupuis and Alzheimer 2008; Gibson and Singleton 2012). When adults retire from their jobs and their children leave home and start their own families, leisure may become more central as a life domain in which they find meaning. At some points, leisure may even constitute a highly significant factor in shaping older adults' sense of identity (Frazier et al. 2002) and its contribution to SWB may be greater than that of background factors such as poor health, low income or absence of spouse (Fernández-Ballesteros et al. 2001; Nimrod 2007). A recent study (Nimrod and Shrira 2014) showed that the significance of leisure to wellbeing increases throughout the later life course, suggesting that leisure may even constitute a resource for resilience in old age. At the same time, however, this study pointed out a paradoxical situation in which "the older seniors, who may benefit from leisure involvement more than their younger peers, are precisely the ones who face the greater number of constraints to beneficial use of leisure" (p. 106).

The Internet offers numerous leisure activities that can be performed indoors and require no physical effort, rendering them highly suitable for elderly persons who are physically constrained, lack mobility or feel anxious about leaving home. Moreover, most online activities are offered gratis (except for the initial costs of purchasing an Internet-compatible device and acquiring Internet access). They are thus relatively affordable and may complement existing offline leisure activities, possibly compensating somewhat for activities older adults are no longer able to perform. These qualities, combined with the observation that leisure is the only online function associated with SWB among older Internet users (Lifshitz et al. 2016), call for further investigation of the contribution of online leisure to SWB in later life.

9.2 Three Pathways Towards Better Understanding

In an attempt to suggest new directions for HCI research among older people, this chapter posits three pathways towards a better understanding of the roles online leisure can play in older adults' SWB:

- **Simultaneous exploration of various online leisure activities**: Studying the online leisure repertoire of older Internet users may help differentiate among the activities in terms of contribution to SWB. Furthermore, it may enable exploration of associations among various activities, revealing the structure of individuals' repertoires, factors promoting or limiting participation and conditions predicting beneficial involvement. This path combines the functional approach suggested by Lifshitz et al. (2016) with the micro level approach, maintaining the advantages of both while allowing for some level of generalization.
- **Concurrent examination of online and offline leisure activities**: As older users of new media typically still use traditional media (e.g., TV, radio, print newspapers) and continue to be involved in offline leisure activities, studying their online activities alone reveals only part of their complete leisure repertoire, namely, activities one considers potentially usable during his daily leisure (Iso-Ahola 1980). Exploring associations between online and offline activities may clarify the extent to which online leisure displaces (or complements) the offline variety. This path challenges the traditional online-offline divide and suggests that online leisure activities may spill over to and/or display the effects of one's activities in the offline environment.
- **Differentiation among subsegments of older Internet users**: Older Internet users should not be studied as a homogeneous group, as physical, sociological and psychological variance increases with age (Yang and Lee 2009). Examination of various subsegments within the older audience may reveal which seniors are more likely to take part in online leisure activities, who is more likely to benefit from online leisure and the extent of overlap among these groups. In addition, such examination may reveal inequalities between older Internet users in terms of access, knowledge and skills, as well as disparities in terms of preferences and actual participation.

Adopting each of these paths or optimally applying them all in future research of online leisure and SWB in older adulthood may enhance our knowledge of the theoretical aspects of technology use and successful aging, while guiding future interventions, policies and technology development and design.

9.3 Applying the Three Paths

To demonstrate the efficacy of the three suggested paths, we used data collected in Israel during the first wave of the Ageing + Communication + Technology (ACT) cross-national study. Although data were gathered in seven countries, we decided to use information originating in one country only, avoiding analyses and interpretations irrelevant to the paths suggested in this chapter.

In this study, online leisure is understood as leisure activity that is performed online (Nimrod and Adoni 2012). Literature offers manifold definitions of leisure, and most scholars have emphasized its role in play, relaxation, entertainment, social connectedness and sensory stimulation (Stebbins 1997). The present study therefore only considers activities as leisure if they include recreational or entertainment aspects. Because they might be part of work-related activities, we excluded activities associated with communication (e.g. making phone calls, emails) or productivity (e.g. online errands, shopping). Even though these activities might be associated with leisure, we do not classify them as leisure activities in the context of this study.

9.3.1 Data Collection and Sample

The study was based on an online survey of 814 Israeli Internet users aged 60 years and over. A commercial firm that operates an online panel of 50,000 Internet users collected the data between November 2016 and January 2017. Study participants were sampled randomly from their age group and contacted by the firm via email with a link to the survey. Quotas were instituted to ensure that the sample is representative of the country's older online population (Israel Central Bureau of Statistics 2014). The first page of the online survey included a description of the research aims, as well as detailed instructions that participants were asked to read before filling in an online survey questionnaire, typically taking up 10–15 min of their time. To prevent repeat participation, each candidate was assigned a one-time personal survey entry code.

Participants' ages ranged from 60 to 87, with a mean of 66.93 years (sd = 5.55); 50.2% were male, 72.2% married and 87.8% had some post-secondary education. Forty-two percent reported having a higher than average income and 24.7% lower than average; 52.8% percent were retirees and 22.5% worked full-time. All participants were community-dwelling individuals: 61.1% lived in big cities or their suburbs, 23.9% in medium-sized or small cities and the remainder in rural areas (n = 814).

9.3.2 Measurements

The investigation was based on a specific part of the data that explored the participants' media use the day before they responded to the survey. Participants were asked to think about the previous day and report how much time they spent using various media. This part of the questionnaire was split into two sections: The first related to traditional mass media (e.g., TV, radio, newspapers) and differentiated between old media and digital/Internet-based use (via computer and cell phone), while the second considered various Internet-based activities (e.g., using social networking services [SNSs], reading and writing entries in forums and chatrooms and playing online games). Only activities clearly associated with leisure were selected and all others (e.g., emails, online errands) ignored. The following questions were used during data analysis:

- *Please think of yesterday: How much time did you spend on the following media?* Watched television on a tv set (flatscreen etc.), watched television on a computer (PC, laptop, tablet, etc.), watched television on a mobile phone (iPhone, Nokia, HTC, etc.), listened to radio on a radio set (FM, FAB, etc.), listened to radio on a computer (PC, laptop, tablet, etc.), listened to radio on a mobile phone (iPhone, Nokia, HTC, etc.), read newspaper and magazines in the print version (on paper), read newspapers and magazines on the internet (at websites or designated application), read books in the print version (on paper), read book in an electronic version (on a digital reader (Kindle etc.) pc, laptop, tablet, mobile phone, etc.), listened to audio books
- *How much time did you spend watching videos, DVDs, TV box, or hard disk recordings (approximately)?*
- *Please think of yesterday—and any use you made of the Internet yesterday. How much time did you spend on the following things?* Getting news (e.g. national newspaper), downloading music, films, or podcasts, playing computer games online, using chat programs (e.g., Skype, WhatsApp), reading entries at debate sites, blogs etc., using websites concerning my interests or hobbies, using social network sites (e.g., Facebook, LinkedIn), writing entries at debate sites, blogs, etc. (including your own)

The analysis also addressed responses to background questions exploring sex, age, marital status, place of residence, education, work status, monthly income, as well as participants' evaluations of their satisfaction of life and their health status on a ten-point Likert scale ranging from 1 ("not satisfied at all") to 10 ("very satisfied").

9.3.3 Data Analysis

Data analysis was conducted in four steps, the first being a factor analysis of the data describing time spent on online and offline activities the day before responding to the survey. For that analysis, we used principal components extraction and Varimax rotation with Kaiser normalization. The accepted factors had an eigenvalue of at least 1.0 and reported factor loadings were at least 0.4. The six identified leisure factors were then subjected to cluster analysis, identifying groups of older Internet users with similar media-based leisure patterns. As most online and offline activities showed a high range with extreme values, the top five cases of each activity were set aside for the cluster analysis. The extreme-case filter was then applied in all subsequent data analyses.

In Step 3, we examined differences among the groups in life satisfaction and background characteristics, using cross-tabulations and chi-square tests, as well as one-way Analysis of Variance (ANOVA) and Bonferroni post hoc tests. In the fourth and final step, we conducted a multiple linear regression to explore leisure factors and background variables explaining life satisfaction in the current sample. Only background variables that reflected significant differences among clusters in Step 3 were included in the multiple linear regression model. Data were analyzed using SPSS V. 22 software; a confidence interval of 95% was maintained in all tests.

9.4 Results

9.4.1 Online and Offline Media-Based Leisure Activities

A total of 18 offline and online media-based leisure activities were included in the analysis (Table 9.1). Of the seven offline activities, watching TV on a conventional TV set was the most common activity, with 90.4% of the sample reporting participation in this activity the day before the survey. Watching TV was also the activity that occupied most of the participants' leisure time: On average, 3.3 h were spent doing so the day before the survey. Other offline activities commonly undertaken among sample participants were reading newspapers (77.5%, mean = 1.3 h) and listening to the radio on a conventional radio set (68.7%, mean = 2.4 h). Furthermore, almost half of the sample (46.2%) reported having read conventional printed books the day before the survey for an average of 1.7 h. Less common offline activities were watching videos or DVDs, as well as reading books in electronic versions and listening to audiobooks.

Obtaining news online (66.8%), using chat programs such as Skype and WhatsApp (65.7%), using SNSs such as Facebook (63.4%) and reading the online versions of newspapers that also exist in print (59.8%) were the most common online leisure activities among study participants. These activities were nearly as prevalent as certain offline activities, although participants engaged in them for shorter periods of time (0.9 h on average for obtaining news, using chat programs and reading online newspapers and 1.2 h on average for SNSs). Other activities involved significantly lower percentages of participants but extended over longer time periods, especially those associated with using digital devices to consume traditional mass

Table 9.1 Offline and online activities

	Activity	% of users	Mean usage time (St.D) in h	Range in h
Offline	1. Watching TV	90.4	3.3 (2.0)	0–20.5
	2. Reading newspapers	77.5	1.3 (1.2)	0–15.5
	3. Listening to the radio	68.7	2.4 (2.8)	0–24
	4. Reading printed books	46.2	1.7 (1.8)	0–20
	5. Watching videos and DVDs	20.1	1.9 (1.8)	0–18
	6. Reading books in electronic version	6.4	1.2 (1.1)	0–5
	7. Listening to audio books	1.7	1.0 (0.9)	0–3
Online	1. Getting the news	66.8	0.9 (1.5)	0–20
	2. Using chat programs	65.7	0.9 (1.4)	0–20
	3. Using social networking services	63.4	1.2 (1.7)	0–15
	4. Reading online newspapers	59.8	0.9 (0.8)	0–7
	5. Visiting websites concerning hobbies	44.5	1.1 (1.5)	0–18
	6. Watching TV	32.4	2.2 (2.8)	0–30
	7. Listening to the radio	26.6	2.4 (2.9)	0–20
	8. Playing games	26.2	1.3 (1.2)	0–9
	9. Reading entries in forums, blogs, etc.	26.2	0.7 (0.6)	0–3
	10. Writing entries in forums, blogs, etc.	11.2	0.9 (1.9)	0–17
	11. Downloading music, films, etc.	8.4	1.0 (0.9)	0–5

Note: N=814. For Watching TV online and listening to the radio online two variables were combined indicating the time dedicated to these activities using a computer and/or a mobile phone

media. The mean reported time for watching TV online, for example, was 2.2 h and for online radio listening 2.4 h (same as offline radio).

Reported participation in the various activities adds up to an average of 6.95 h for offline activities and 5.12 h online. In the concurrent examination, online and offline leisure activities were significantly correlated (Pearson's $r = 0.401$, $p < 0.01$), suggesting that online and offline leisure activities are not sharply differentiated from one another among older Internet users but rather complement each other.

9.4.2 The Structure of Online and Offline Activities

To enable joint analysis of older adults' offline and online leisure activities, a factor analysis of all 18 offline and online leisure activities was conducted, yielding six leisure activity factors. The percentage of variance explained jointly by these factors was 53.7. Cronbach's alpha for all those factors together was 0.536. The factors' internal consistency (Cronbach's alpha) and the activities included in each factor are indicated in Table 9.2 factor labels were discussed and resulted from the authors' interpretation of common characteristics of activities in each factor, especially those with the highest loading.

Each of the factors showed, regarding their highest loadings, a tendency to be either offline or online. Three of the observed factors were interpreted as online leisure factors: Active online leisure, online updates and online content. Applying the functional approach (Lifshitz et al. 2016) to the functions of Internet use for older adults revealed that the factors serve different purposes in older users' leisure repertoires. Active online leisure contained activities that were relatively expressive and/or closely related to entertainment, including posting to debate sites and blogs, using hobbyist websites and playing online games. Online updates involved activities demanding considerable investment of time in social connectedness (using chat programs and SNSs) as well as obtaining news and watching TV online. These activities share the quality of "being on top of things" by staying connected with friends, family and current affairs. Online content consumption consisted of reading online

Table 9.2 Factors and factor loadings of online and offline media-based leisure activities

Factor (Eigenvalue) (alpha)	Activities included in the factor	Factor loading	Variance explained by factor
Active online leisure (3.093) (0.475)	Writing entries at forums, blogs, etc. (online)	0.776	17.2%
	Using websites concerning hobbies (online)	0.748	
	Playing games (online)	0.537	
	Watching TV (offline)	0.498	
Online updates (1.693) (0.673)	Using chat programs (online)	0.799	9.4%
	Getting news (online)	0.784	
	Watching TV (online)	0.649	
	Using social networking services (online)	0.563	
Offline content (1.524) (0.332)	Reading printed books (offline)	0.697	8.5%
	Watching videos or DVDs (offline)	0.680	
	Reading newspapers (offline)	0.596	
	Listening to the radio (online)	0.550	
Online content (1.254) (0.201)	Reading newspapers (online)	0.695	7.0%
	Downloading music, films etc. (online)	0.692	
Offline radio (1.086)	Listening to the radio (offline)	0.637	6.0%
Alternative books (1.008) (0.081)	Listening to audio books (offline)	0.703	5.6%
	Reading books in electronic version (offline)	0.585	

Note: N=814, Principal component extraction and Varimax rotation with Kaiser normalization. Factors included based on eigenvalue of at least 1. Only loadings of at least .4 are presented. The six factors explained 53,7% of variance. KMO=0,7 newspapers or downloading music, films, podcasts, etc. Un-like the two previous factors, this one entailed a more passive style of engagement.

Three offline activity factors were also indicated in the factor analysis, among which offline content explained the highest percentage of variance. Traditional media use, such as reading printed books and newspapers or watching videos or DVDs, were most dominant in this factor. Listening to offline radio was indicated as the second factor of offline leisure activities, and the third was a factor labeled alternative books, indicating reading/hearing books in new formats (e.g., ebooks, audiobooks)

Two of the six factors analyzed revealed a combination of offline and online activities: Watching TV was included in the active online leisure factor and listening to online radio in offline content. This finding may signify simultaneous involvement of older Internet users in both online and offline leisure activities and suggest that their online participation does not displace but rather complements their offline pastimes. Alternatively, it may be explained by high TV and radio use rates in both online and offline formats.

9.4.3 Clusters of Older Internet Users

The cluster analysis of the six factors of leisure activities produced an optimal solution of three clusters of older Internet users (see Table 9.3 for the standardized means of each leisure factor and the average overall time spent on online and offline activities in each cluster). The first cluster, Onliners, showed the highest involvement in online activities, including active online leisure as well as online updates and consumption of online content. Onliners were thus most active in all indicated online activity factors. This cluster described a group of relatively frequent users of the Internet for leisure, whose participation in offline activities was lower than the sample's average.

The second cluster consisted of older Offliners. Unlike the Onliners, they are highly involved in offline leisure factors, reporting an above (sample) average standardized score for offline content consumption and radio use. The third group—and least active in most leisure activity factors and in spending time on online and offline activities—was called Lighter Users. Alternative book reading/listening was the sole factor for which there were no significant differences among the groups.

The three clusters were not equally distributed across the sample. Lighter Users were by far the most prevalent group, accounting for 43.5% of participants. This does not imply, however, that a majority of the sample reported low levels of engagement in leisure activities as a whole, as even Lighter Users indicated that they used media for an average of 6.17 h the day before the survey. It is possible, however, that the role media (especially new media) use plays in their leisure is different and that they tend to engage in activities not covered by this study. Onliners constituted the second largest group in the sample, with 31.5% of participants, while Offliners—older adults primarily pursuing traditional media-related leisure activities—accounted for 25%.

Table 9.3 The three clusters of Internet users

Activities factor	Internet user cluster		
	Onliners	Offliners	Lighter users
	z-standardized means		
1. Active online leisure*	0.591[a]	0.085[b]	−0.476[c]
2. Online updates*	0.629[a]	0.076[b]	−0.499[c]
3. Offline content*	−0.161[b]	1.293[a]	−0.627[c]
4. Online content*	0.242[a]	0.070[a]	−0.215[b]
5. Offline radio*	−0.165[b]	1.105[a]	−0.516[c]
6. Alternative books	0.070	−0.013 means (h)	−0.043
Offline activities	6.966[b]	10.613[a]	3.975[c]
Online activities	6.795[a]	4.870[b]	2.199[c]
N	235	187	325
%	31.5	25.0	43.5

Note: Total N = 747, z-standardized means (total sample) for each factor, significant differences (*$p < 0.001$) were tested using one-way ANOVA, (a) (b) (c) mark significant ($p < 0.001$) differences between groups which were tested with Bonferroni Post Hoc tests. Offline and online activities were calculated by summing the time spent on seven offline and 11 online activities (see Table 9.1)

9.4.4 Background Characteristics of Older Internet User Clusters

Five background characteristics were significantly associated with the clusters of older Internet users: Place of residence, work position, family status, sex and satisfaction with health (Table 9.4). Onliners were characterized by being retired, unemployed or in an unpaid position (66.7%), however, most were retired (59.4%), at the time of the survey. They were also more likely to be single, divorced or widowed, live in a town or small village and report significantly lower satisfaction with health than members of the other two clusters. Although numerous studies display significant gender differences regarding media use among older adults, indicating that men have a greater tendency to use new technologies (Seifert and Schelling 2016), the Onliners in this study were mostly women. This may be the result of a work-related effect, as more females in the sample were not working (63.9% of women were retired, un-employed or in unpaid positions vs. 53.3% of the men, $p < 0.05$).

The Offliners' characteristics were similar of those of the sample as a whole and were only salient in the percentage of group members living in big cities or their suburbs. Lighter Users were characterized by a relatively high involvement in the workforce; they were more likely to be married, male and reside in rural villages than persons in the other clusters. They also reported the highest satisfaction with health.

Table 9.4 Background characteristics of Internet user clusters

Attribute	Category	Onliners	Offliners	Lighter users	All
Place of residence	Big city incl. suburbs	56.8%	64.3%	60.4%	60.2%
	Town or small city	32.1%	21.1%	22.0%	24.9%
	Country village	11.1%	14.6%	17.6%	14.8%
Work position	Full- or part-time work	33.3%	42.8%	43.9%	40.4%
	Retired, unemployed or in unpaid position	66.7%	57.2%	56.1%	59.7%
Family Status	Single, divorced or widowed	35.3%	28.3%	21.8%	27.7%
	Married	64.7%	71.7%	78.2%	72.3%
Sex	Female	56.6%	48.1%	44.6%	50.7%
	Male	43.4%	51.9%	55.4%	49.3%
Health	Mean	6.6	6.8	7.0	6.8

$N = 747$, Chi-squared statistics were significant ($p < 0.05$) for all attribute category cross-tabulations. Health was tested using one-way ANOVA and was approaching significance ($p < 0.1$)

Contrary to studies pointing to high associations among Internet use, education and income (e.g., Choi and DiNitto 2013b), the present study found no significant correlations between cluster type and income or level of formal education. Two explanations may be advanced: First, the present study focused on differences among older Internet users, not a comparison between users and non-users. While income and education differences in older adults might affect older adults' access to and competence in Internet use, differences among users would not. Second, as the older Internet users in this study participated in an online survey, the sample itself was probably biased towards the more tech-savvy users and thus may be perceived as selective regarding income and education.

9.4.5 Life Satisfaction Differences

We conducted a one-way ANOVA to determine the connection between older Internet users' offline and online leisure involvement, analyzing differences in life satisfaction among the various clusters. No significant differences were found among the three groups despite their differential involvement in offline and online leisure activities. Analysis of background characteristics in the three clusters, however, might point to a balancing mechanism wherein high involvement in beneficial leisure activities could

Table 9.5 Linear regression analysis of respondents' background and online and offline activity factors with life satisfaction

Variable	Unstandardized coefficient	Standard error	Standardized coefficient
	B		β
Constant	3.464	0.364	
Active online leisure	−0.018	0.023	−0.025
Online updates	0.045	0.022	0.069*
Offline content	0.082	0.028	0.148**
Online content	−0.019	0.070	−0.009
Offline radio	−0.078	0.039	−0.101*
Alternative books	0.264	0.171	0.048
Place of residencea			
- Town or small city	0.178	0.123	0.046
- Country village	0.147	0.150	0.031
Work Status (Retired)	0.034	0.054	0.020
Family Status (Married)	0.515	0.119	0.138***
Sex (Female)	−0.205	0.108	−0.061
Health	0.461	0.025	0.565***

[a]Reference: City or Suburbs. R2 = 0.370; N = 692; F = 33.277. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

compensate for factors that affect SWB negatively, thereby engendering similar life satisfaction levels across clusters.

To test these possible balancing effects, a multiple linear regression analysis was conducted to simultaneously explore associations between involvement in offline and online leisure activities, as well as participants' background and life satisfaction (Table 9.5). Three media-based leisure activity factors significantly associated with SWB: Two (online updates, offline content) associated positively with life satisfaction and one (offline radio) negatively. Of the three factors, offline content showed the strongest correlation with life satisfaction. Two of the socioeconomic background variables analyzed associated significantly and positively with subjective life satisfaction: Being married and reporting greater satisfaction with one's health. The latter variable was the most dominant factor in the regression model, with an effect size larger than for family status and all leisure factors.

Overall, the analysis confirmed the suggested balancing effect, indicating that the Onliners' involvement in online updates compensates somewhat for their lack of a partner and lower satisfaction with health. Furthermore, the negative effects of the Offliners use of offline radio are balanced by the positive effect of their consumption of offline content. Lighter Users' low involvement in beneficial leisure activities, in turn, is balanced by their spousal relationships and good health.

9.5 Discussion

Although the study presented in this chapter was inevitably limited to reported participation in media-based leisure activities in a specific cultural context, its findings ably demonstrate the value of the three proposed pathways in achieving a deeper understanding of the association between online leisure and SWB in later life, calling for reconsideration of the contribution of technology use to older adults' SWB.

The findings resulting from simultaneous exploration of various online leisure activities show that while some types of online leisure activities significantly associate with users' wellbeing, other activity types do not. This finding is consistent with Lifshitz et al.'s (2016) claim that not all online activities contribute to wellbeing in later life. Moreover, the observation that online updates are the only online activity factor associated positively with life satisfaction suggests that online activities that help maintain social connectedness have a greater impact on older adults' SWB than expressive activities, entertainment and enrichment. This finding is congruent with previous evidence of the beneficial effects of social involvement and essentiality in later life (Gibson and Singleton 2012; Nimrod 2007), leading to the conclusion that the impact of media-based leisure activities on SWB does not depend on medium type (offline or online) but rather on the purpose they serve.

This conclusion is further supported by concurrent examination of online and offline leisure activities: After controlling for background variables, only two activity factors, online updates and offline content, associated positively with life satisfaction. This observation confirms the well-established positive association between leisure and wellbeing in later life (Dupuis and Alzheimer 2008; Gibson and Singleton 2012), although three other factors did not associate with life satisfaction, indicating that not all online and/or offline activity types are beneficial. One factor, offline radio, even correlated negatively with life satisfaction. This might be explained by the specific radio programming in Israel includes frequent news reports that can be disturbing. Further exploration of this phenomenon is required, however, as other types of news consumption examined in the current study did not reflect such negative correlation with SWB.

The concurrent examination also demonstrates that offline and online leisure activities are not disparate segments of older adults' media-based leisure repertoires but are significantly correlated with one another. Furthermore, although the six activity factors were generally divided between offline and online activities, some included both types, demonstrating that users' online activities are embedded and influenced by their involvement in offline activity. These findings support research (Nimrod and Adoni 2012) that conceptualizes online leisure as an extension of the offline variety, challenging the traditional online-offline divide. Older adults now live in increasingly mediated environments that are shaped by both offline and online content. Consequently, their SWB is not determined by involvement in one specific activity or the other, but rather by simultaneous involvement in several offline and online activities.

Differentiation among subsegments of older Internet users supports previous arguments regarding the heterogeneity of the older population (Yang and Lee 2009) and emphasizes the importance of older adults' social circumstances for technology use in later life (Righi et al. 2017). Results point to three types of older Internet users: Onliners who participate predominantly in online leisure activities, Offliners who display greater involvement in offline activities and Lighter Users who are less involved in media-related leisure activities but may engage in other leisure and work-related pastimes. As these groups of users differ considerably in background characteristics, including place of residence, work position, family status, sex and health, the findings—like those of numerous studies on offline leisure (Gibson and Singleton 2012)—suggest that seniors' backgrounds significantly shape the extent to which they are involved in online and offline leisure activities.

As demonstrated in previous research (Fernández-Ballesteros et al. 2001; Nimrod 2007), this study confirms that certain online and offline leisure activities may balance the impact of various distressing conditions in later life, supporting Nimrod and Shrira's (2014) perception of leisure as a resource for resilience in old age. The balancing mechanism is particularly noticeable among Onliners, whose marked involvement in online activity appears to compensate for the negative effects of lack of partner and poorer health. As both background variables may limit benefits derived from various offline activities, the results also demonstrate how online leisure may serve as a means for negotiating age-related constraints to offline leisure.

Overall, this study suggests that the association between Internet use and SWB in later life depends on the functions the Internet serves for older users, its role in their overall media and leisure repertoire and various background variables affecting access to and competence in media use. As online leisure clearly correlates with offline leisure routines and practices, it should be regarded as part of seniors' leisure repertoire—a behavioral construct that is shaped by an extensive variety of factors, including interpersonal characteristics (e.g., socio-demographic background, personality), interpersonal circumstances (e.g., social networks, opportunities for leisure activities in the community) and cultural contexts (Iso-Ahola 1980).

In conclusion, the present study offers a detailed analysis about the determinants of online leisure and its association with wellbeing in later life. Parts of these findings might be leading future studies on technology use of older adults, may it be in the context of digital making or technologies for ambient and assisted living. Future re-search in these fields should take these factors into consideration when applying the three pathways for better understanding of the roles online leisure plays in seniors' SWB, carefully examining the different functions, meanings, and potential benefit and harm resulting from new technology use among differentiated groups of older adults.

Acknowledgements This work was supported by Ageing + Communication + Technologies (ACT), a research project funded by the Social Sciences and Humanities Research Council of Canada and housed at Concordia University in Montreal, Canada, as well as by a Short Term Scientific Mission (STSM) grant to the first author from COST Action CA15122 "Reducing Old-Age Social Exclusion: Collaborations in Research and Policy (ROSEnet)."

References

Berner J, Rennemark M, Jogréus C et al (2012) Distribution of personality, individual characteristics and internet usage in Swedish older adults. Aging Ment Health 16:119–126

Choi NG, DiNitto DM (2013a) The digital divide among low-income homebound older adults: Internet use patterns, eHealth literacy, and attitudes toward computer/Internet use. J Med Internet Res 15

Choi NG, DiNitto DM (2013b) Internet use among older adults: association with health needs, psychological capital, and social capital. J Med Internet Res 15

Cotten SR, Ford G, Ford S et al (2014) Internet use and depression among retired older adults in the United States: a longitudinal analysis. J Gerontol Ser B Psychol Sci Soc Sci 69:763–771

Dupuis SL, Alzheimer M (2008) Leisure and ageing well. World Leis J 50:91–107

Fernández-Ballesteros R, Zamarrón MD, Ruiz MÁ (2001) The contribution of socio-demographic and psychosocial factors to life satisfaction. Ageing Soc 21:25–43

Frazier LD, Gonzalez GK, Kafka CL et al (2002) Psychosocial influences on possible selves: a comparison of three cohorts of older adults. Int J Behav Dev 26:308–317

Gibson HJ, Singleton JF (2012) Leisure and aging: theory and practice. Hum Kinet

Iso-Ahola SE (1980) The social psychology of leisure and recreation. William C Brown Pub

Israel's Central Bureau of Statistics (2014) Haseker Hahevrati [The social survey]. http://surveys.cbs.gov.il/survey/survey.htm. Accessed 1 May 2016

Lifshitz R, Nimrod G, Bachner YG (2016) Internet use and well-being in later life: a functional approach. Aging Ment Health:1–7

Matthews K, Nazroo J (2015) Understanding digital engagement in later life. University of Manchester. Accessed 29 May 2016

Nimrod G (2007) Retirees' leisure: activities, benefits, and their contribution to life satisfaction. Leis Stud 26:65–80

Nimrod G, Adoni H (2012) Conceptualizing e-leisure. Loisir et Société/Society and Leisure 35:31–56

Nimrod G, Shrira A (2014) The paradox of leisure in later life. J Gerontol Ser B Psychol Sci Soc Sci 71:106–111

Righi, V, Sayago, S, Blat J (2017) When we talk about older people in HCI, who are we talking about? Towards a 'turn to community' in the design of technologies for a growing ageing population. Int J Hum Comput Stud 108: 15–31

Seifert A, Schelling HR (2016) Old and offline? Findings on the use of the Internet by people aged 65 years and older in Switzerland. Z Gerontol Geriatr 49:619–625

Shapira N, Barak A, Gal I (2007) Promoting older adults' well-being through Internet training and use. Taylor & Francis

Slegers K, Van Boxtel MP, Jolles J (2008) Effects of computer training and Internet usage on the well-being and quality of life of older adults: a randomized, controlled study. J Gerontol Ser B Psychol Sci Soc Sci 63:P176–P184

Stebbins R (1997) Casual leisure: a conceptual statement. Leis Stud 16:17–25
Yang Y, Lee LC (2009) Dynamics and heterogeneity in the process of human frailty and aging: evidence from the US older adult population. J Gerontol Ser B Psychol Sci Soc Sci 65:246–255

Vera Gallistl MA is a research assistant and Ph.D. candidate at the Department of Sociology, University of Vienna. In her research, she explores social and cultural participation in later life using qualitative and quantitative research methods. Her research interests include cultural activities and learning in later life as well as digitalization of age and ageing and technology (non)-use and the multiple dimension of the age-related digital divide.

Galit Nimrod Ph.D., is professor at the Department of Communication Studies and a research fellow at the Center for Multidisciplinary Research in Aging at Ben-Gurion University of the Negev, Israel. Aiming to contribute to the understanding of well-being in later life, Dr. Nimrod studies psychological and sociological aspects of leisure, media and technology use among older adults.

Chapter 10
Designing for the Informatics Lifecourse and Ageing in Place

Noah Lenstra

10.1 Introduction

Since the 1980s, policy makers and researchers have framed "ageing in place" as a reachable, positive goal (Vasunilashorn et al. 2012). The U.S. Centres for Disease Control and Prevention (2017) define "ageing in place" as "the ability to live in one's own home and community safely, independently, and comfortably, regardless of age, income, or ability level" (n.p.). Research on this topic tends to focus more on the first part of this definition—living in "one's own home"—than on the second—living in "one's own … community." This chapter instead focuses on how community-based technology support plays an important—if under-acknowledged—role in enabling an individual to achieve the goal of ageing in one's own place safely, independently, and comfortably, for as long as one wishes to do so.

Over the last decade, a growing number of scholars have studied how to design technological infrastructures for and with ageing adults. This scholarship has considered how diverse ageing experiences lead to diverse patterns of technology adoption (Rogers and Mitzner 2017). Concluding a study of how older adults experiment with MaKey MaKey technologies, Rogers et al. (2014) write that "as we age, rather than becoming a more homogeneous category to be designed for, we grow more diverse rather than less, by virtue of our different life experiences" (p. 3921). An individual does not arrive at the stage of life known as "older adulthood" as a blank tabula rasa. Rather, one experiences older adulthood differently based on one's different life experiences. These different experiences in turn lead to different uses of technology. As a result, great care must be taken when designing technology for and with older adults.

A second trend in recent HCI literature centres on how groups of older adults interact with technologies within their communities. Righi et al. (2017) call this the "community-turn" in HCI research focusing on older adults. They argue we need to "rethink the subject of design. We should shift from designing 'for older people' to

N. Lenstra (✉)
University of North Carolina at Greensboro, Greensboro, NC, USA
e-mail: lenstra@uncg.edu

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_10

designing for 'situated communities' to which they belong and where technologies are shaped and appropriated" (p. 16). From a methodological perspective, the "community turn" involves the participation of researchers and de-signers working "in a community over an extended period of time" (ibid.). This immersion is necessary to understand how local norms shape technology appropriation in communities that include older adults.

This chapter integrates and builds on these two strands of recent HCI research. It does so by: (1) Examining how ageing members of a particular local community appropriate technology; and (2) Examining how the technology practices of these community members ageing in place evolve over time based on their diverse life experiences. This study found that understanding these two topics could be aided by a new concept developed through this research: the informatics lifecourse. This concept refers to how a person learns technology throughout the stages of his or her life as he or she ages in place (Lenstra 2016).

10.2 Background

10.2.1 Lifecourse Theories and ICTs

The lifecourse approach to the study of ageing posits that human life proceeds through a series of stages that are socially shaped and evolve over time (Cole 1992). As such, what it means to be old, and thus the boundaries of older adulthood, changes from historical moment to historical moment and from culture to culture. People become old in society—society shapes how and when one perceives oneself, and is perceived by others, to be old. As Settersten (2003) points out, scholars of the human lifecourse seek to understand "the cartography of human lives, at understanding its maps" (p. 1). Just as geographical maps visualize but do not convey every facet of the places they represent, so too maps of the human lifecourse visualize but do not convey every detail of the ageing experience, which, as Hooyman and Kiyak (2011) point out, is "unique to each individual" (p. 7).

Employing this theoretical framework requires asking "how historical time, social location, and culture affect the individual experience of each life stage" (Hutchison 2014, p. 11). In other words, the individual experience of moving through the stages of life is shaped or conditioned by heterogeneous factors. This chapter examines closely how ageing in a particular local community affects the lifecourse.

Scholars working in sociology have started to use the lifecourse approach to study how literacy at one stage of life relates to digital literacy at subsequent stages (Silvast 2015; Silver 2014). Furthermore, Vines et al. (2015) and Wildevuur et al. (2013) consider how transitions in life stages affect technology usage. Nonetheless, the focus in past work has been on the individual, and not on the individual in the community.

This chapter extends the lens outward to consider how individual experiences of moving through the stages of life are affected by the situated communities—the places—in which life is lived.

10.2.2 Designing Technology Support in Communities

The Pew Research Centre (Anderson and Perrin 2017) estimates that nearly 75% of Americans aged 65 and older need help from another person to learn to use new digital technologies. Past research demonstrates that technology support systems found in trusted institutions, such as senior centres and public libraries, provide crucial supplements to technology support older adults find within the more intimate networks of family and friends (e.g. Gardner et al. 2012; Hardill 2014; McKee and Blair 2006; Xie and Jaeger 2008). Summarizing findings from research conducted with 750 older adults throughout England and Scotland, Hardill (2014) writes that for older adults, "support from the community … organized formally by neighbourhood and community groups is providing a vital resource supporting older people sustain their use of digital technologies" (p. 280).

The available evidence suggests that for the foreseeable future ageing individuals will continue to seek technology support within their local communities. Rogers and Mitzner (2017) point out that older Americans frequently "choose to live near a religious or other social organization to maximize opportunities for social interactions" (p. 134), and they are predicted to continue to do so into the future. In addition, there is evidence that older adults seek technology support first within face-to-face networks before seeking it online. Peek et al. (2016) found in the Netherlands that older adults "tried out technology when they were visiting members of their social network, and that this contributed to them starting to use it themselves" (p. 233). These studies suggest that HCI researchers should consider how to design technology support systems within local communities that include older adults.

The importance of designing technology support for ageing in place comes into focus when one considers the risk of digital disengagement many older adults face. Wildevuur et al. (2013) highlight how transitions in life stages, such as leaving the workforce for retirement, are linked to disconnecting from digital technology. Wildevuur et al. (2013) invite HCI scholars to look at this transition as an opportunity to design systems that would better enable older adults to maintain digital literacy across such life stage transitions. Similarly, Rogers et al. (2014) find that "there is a concern … that after retiring, people's knowledge and use of technologies—especially new ones—will decline (as they are no longer exposed to them at work or get training)" (p. 3913). Theorizing on this phenomenon, Olphert and Damodaran (2013) call it digital disengagement. Digital disengagement refers to periods of life in which there is a partial or total cessation of learning and using technology, and it is especially common among older adults, who lack access to technology support systems younger individuals may find in schools or workplaces (Olphert and Damodaran 2013).

Community informatics scholars analyse how technology support interactions take place in specific geographical communities. In a study of technology support system located in the Chicago Public Library, Williams (2012) found that having supportive people in the library ready and willing to help with technology enhanced the digital literacy of those in the surrounding geographical space. This research suggests avenues by which HCI scholars can work with libraries, and other local organizations, to design technology support systems in communities.

10.2.3 Designing Community-Based Technology with Older Adults

In their review of the literature on why community-dwelling older adults use technology, Peek et al. (2016) conclude that "in situ research within the specific context of ageing in place is scarce" (p. 226). Some exceptions to this trend include Sayago and Blat (2010) and Botero and Hyysalo (2013). Based on their experience working to fill this gap, Righi et al. (2017) argue that HCI scholars should move from "designing for older people to designing for the community/communities they belong to" (p. 25). Designing for communities that include older adults requires attending closely to how older adulthood is actually lived and experienced. Righi et al. (2017) find these experiences extend beyond the family to include "civic contexts, such as neighbourhood and local community groups" (p. 24).

In the United States, two structures that shape how ageing in place is experienced are race and social class. These structures are under-studied in the HCI literature. Rogers and Mitzner (2017) find that research has not adequately "investigate[d] in depth the effect of other SES related variables … on technology adoption," and that "little research has investigated the degree to which ethnicity and culture will influence technology use and acceptance" (p. 134) among older adults. To grapple with these different structures, Righi et al. (2017) call for an intersectional approach to designing technology for and with older adults. This intersectional approach frames older adults as "ordinary members of (multiple) communities" (p. 16), which are shaped by, among other things, class, race, gender, age, physical location, and a host of other structures and contexts.

Past research suggests that designing technological systems for and with older adults requires grappling with the fact that older adulthood is a complex stage of life shaped by multiple contexts. Furthermore, past work suggests that this designing work should include the design of technology support systems that could support ageing individuals across transitions in life stages, so as to prevent episodes of digital disengagement.

10.3 Methods

To analyse how experiences of ageing in place affect how older adults use technology, the researcher utilized a case study approach to ethnography (Burawoy 1998). This approach was adopted to deeply understand how pre-existing technology support systems embedded in a specific geographical space operate in the communities of ageing individuals that live in that space. Since Suchman's (1987) canonical work on situated action, scholars have found that in-depth and up-close analyses of how people actually use technology in naturalistic social settings (that is, in settings not created by researchers) reveal indispensable information about how technology is incorporated into work and life in ways not achievable via other methods (Blomberg and Karasti 2013; Lenstra and Baker 2017). Following Dourish (2001), the researcher strived to go "where the action is" rather than create an artificial grouping of older adults to study. Such an approach has benefits and limitations, as does any approach. The results are obviously not generalizable to a large population. Instead, this approach seeks to generate methods and concepts that other researchers and designers could productively use to engage in design work in their own communities (Burawoy 1998).

During a one-year period (September 2014–August 2015), the researcher studied technology support systems utilized by older adults in three senior centres and three public libraries in a medium-sized urban area in the Midwestern United States. The specific methods used were participant observation (i.e. ethnographic fieldwork) in technology support sessions with older adults. The 209 older adults that participated in this study were individuals who in the course of their daily lives regularly engage in these spaces (Figs. 10.1 and 10.2). No recruitment or sampling took place. Instead, the researcher relied on the fact that these spaces—public libraries and senior centres—were already integral parts of these older adults' communities. In addition, to learn more about these technology support systems, and about the older adults who use them, the researcher conducted semi-structured interviews with 54 older adults who participated in fieldwork. The particular processes involved in data analysis included coding, reducing and sorting the data, and then using both induction (i.e. Charmaz 2012) and theoretically informed deduction (i.e. Burawoy 1998) to understand what this data had to say about how older adults use and learn to use digital technology as they age in place (for more information on methods, consult Lenstra 2016 and Lenstra 2017).

For most of the study, the researcher occupied the role of the participant observer. At its conclusion, however, the study's methods shifted to ethnography for design (Crabtree et al. 2000). In June 2016, representatives of the three public libraries and three senior centres, as well as older adults who participated in the study, gathered together to discuss findings and to engage in collaborative design exercises focused on designing more robust technology support systems (Fig. 10.1). These discussions led to increased collaboration across the six institutions (Lenstra 2016).

Fig. 10.1 Images from fieldwork. Top image—Participants gather together to discuss results and to engage in collaborative design of technology support systems. Bottom images—Typical technology support sessions at institutions studied. Volunteers from a local university work with regular participants in these spaces to learn to do things with their personal digital devices

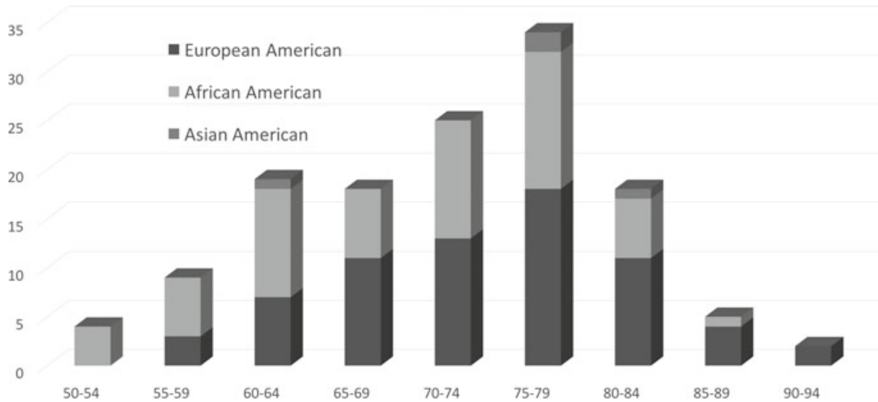

Fig. 10.2 Ages and ethnicities from convenience sample of study participants, n = 135

10.3.1 Limitations

The methods used in this study were chosen to document and to analyse the complex and diverse experiences of older adults learning technology within their communities as they age in place. The position of the researcher within these institutions impacted what data could be gathered. To gain entry into the institutions, the researcher joined and helped technology support services that started between 1997 and 2014, depending on the institution. The older adults who participated in this study thus perceived the researcher to be a service provider. As such, some of the older adults that participated may have adapted their actions because they sought services. It is possible that if the researcher occupied a different role within these institutions (such as a seeker of services, or a neutral third party), different data would have been collected. These limitations were in part circumvented by supplementing ethnographic fieldwork with interviews, in which participants were invited to reflect on their technology learning practices. Data reported by participants are also susceptible to recall bias, since interviewees were asked to recount events that in some cases occurred nearly 50 years in the past.

Furthermore, this study focused narrowly on a small subsection of older adults living in a particular geographical space. More research is needed to understand how the experiences of these particular older adults compare to experiences of other older adults, including those who do not participate in public libraries and senior centres. It is also important to note that these findings are affected by the beliefs, values, and assumptions of the researcher. Situationally is a core part of ethnography: It is an inescapable part of this type of qualitative research (Blomberg and Karasti 2013). However, congruent with the exploratory nature of this study, these limitations do not detract from its overall conceptual contributions.

10.4 Findings

The findings from this study orient around the concept of the informatics lifecourse, or how a person learns technology throughout the stages of life as they age in place. This concept was developed to encapsulate the experiences documented during fieldwork and interviews (Lenstra 2016). Key dimensions of the informatics lifecourse include: (a) how experiences of ageing in particular subcommunities affect technology help seeking patterns, (b) how technology support affects technology usage, and (c) how ageism and the transition from work to retirement affects technology usage. The chapter concludes with a discussion of the implications of this empirically derived concept for future HCI design and research with older adults.

10.4.1 How Ageing in Place Affects Technology Help Seeking Patterns

The one geographical space where this study took place hosted multiple subcommunities of older adults ageing in place. Racial boundaries formed in the past—a product of American racism—were discovered to be one of the primary determinants of community boundaries. These boundaries, in turn, shaped where and how technology support was sought among older adults ageing in this particular space.

The older adults who participated in this study turned to particular spaces for help with technology because those spaces were already perceived to be embedded within their local communities. This perception formed over lifetimes lived in this particular space. Among those who participated in interviews (n = 54), 67% reported living for more than 30 years in the local urban area. Among those, half had lived their entire lives in the regional area, and over a quarter had lived their entire lives in the urban area (28%). This is a group of older adults deeply rooted in this local space.

Public libraries and senior centres are institutions rooted in this space, and in the communities of these older adults. Older adults reported going to these public libraries throughout their lives. Many also reported lifelong connections to senior centres formed through networks of family and friends: Older members of their families had been active in the senior centres, so when they themselves grew old they saw membership in the local senior centre as a natural next step.

Even those older adults who had not lived extensive periods of time in the local area drew on positive associations with public libraries and senior centres as they turned to them for support with technology learning. An older couple new to the area turned to a library for help with technology because of a generally positive attitude toward public libraries. Similarly, some members of the senior centres were new to the area. They joined because they had participated in a senior centre in their former community and were looking for a similar environment in their new home.

Distinct subcommunities of older adults living in this one geographical space led to different patterns of participation in technology support. This discovery was made by tracking patterns of participation among the 209 individuals who participated in this study. One of the senior centres, and one of the public libraries, had participants who were over 90% African American, while none of the other four sites had more than 50% African American participation rates. The disproportionate participation of African Americans in two sites reveals the existence of an African American subcommunity that shapes how ageing African Americans living in this city use technology and access technology support over time. Older adults bring social divides formed in the past with them as they age in place, and they participate in socially stratified places based in part on the structures of race. Attending to these subtleties is part of studying diverse experiences of ageing in place.

10.4.2 How Technology Support Affects Technology Usage

Technology learning in old age builds upon past technology learning practices. This idea can be productively explored through the story of one woman's experiences learning technology in her senior centre, and in her community, over time. Hester (a pseudonym) is an 89-year-old African American who has lived her entire life in the local community. Hester started using digital technology in the 1960s, when she was employed as a stenographer in a courthouse. There she used a mainframe computer to input data on court cases. She received computer training from faculty at a local university.

In the 1980s, and in particular when she retired in 1986, Hester struggled to maintain her digital literacy skills. She said that in the 1960s she: "*Learned how to wire a mother board!…. But I lost track of [computers] when they switched from mainframes to PCs. I quit using all of that when I retired*." During the stage of her life in which she was working full-time, Hester relied on her employers to provide her with the training she needed to practice digital literacy. After Hester retired, she lost that technology support. As a result, Hester stopped using technology for more than a decade. This break in her digital practices relates to a break in her access to support services.

Hester started using technology again in the late 1990s, when she decided to purchase a digital camera so that she could take pictures at her granddaughter's wedding. She purchased the camera because a family member told her that she could take more pictures with the digital camera than she could on a conventional roll of film. She did not, however, find the support she felt she needed in order to learn how to use her digital camera within her family. Hester said that: "*I got it [the digital camera] just to take pictures and I wanted to take pictures of my granddaughter's wedding. But I could not figure out how to use it [laughs]: What to do with the pictures after I took them!*"

To address this learning need, Hester decided to seek support from her senior centre. Hester joined a senior centre shortly after she retired because the senior centre was rooted in her local community. Many of Hester's now retired friends participated in the senior centre. Furthermore, her mother was a leader in the senior centre in the 1970s. This space, which already had played an important role in her life, began to also play a role in her digital learning practices:

"*I got some help from some university students [who volunteered in a computer class] here at the senior centre. I figured out I better buy a computer so I had some place to put my pictures. [Laughs] I just didn't realize you needed a computer if you used a digital camera. [Laughs] They never tell you what all you need, and it seems like you always need something else. So, anyhow, I bought a desktop, with XP, in 2000, 2001, something like that. I can't remember exactly when. I still have that computer. It is at home. I still use it. But it is getting old*."

Although Hester found some support in her senior centre, it was not enough to enable her to do everything she wanted to do with technology. The volunteers Hester turned to for support were not always present at the senior centre, and as a result

Hester could not always find the support she wanted. After Hester started using her desktop computer (and later her laptop) to manage her digital photographs, she did not continue to learn how to do more things use these devices, despite desiring to do so. I asked Hester to 'tell me about what you have been doing with technology since' learning how to transfer the photos from her digital camera to her computer. She responded:

"*Not much. I was using my desktop a little bit, now and then, but less and less as time went on. The university students stopped coming to the senior centre, I can't remember when, but sometime. And then without them here to ask questions, I guess I just used the computer less and less. Oh, I got on it from time to time. And I take pictures now and then with my digital camera.... It always changes*."

Nevertheless, Hester is not a passive user of technology support services created for her. When computer classes were discontinued at the senior centre because of a lack of volunteers to staff them, Hester (and others at the senior centre) requested over and over again that someone help them with technology. This persistence prompted the staff of the senior centre to actively seek more volunteers for its computer classes.

Hester's story reveals multiple dimensions of the informatics lifecourse. As an individual ages, he or she draws upon available resources in his or her community to continue to use new technologies as they emerge over time. These resources include family, friends, and institutions like senior centres. These resources are not static, but are actively shaped by the agency of older adults. Hester's need for technology support, and her articulation of that need in her community, led to the development and continuance of technology support services in her senior centre.

10.4.3 How Transitions to Retirement and Ageism Affect Technology Usage

Hester's story reveals how technology learning does not always proceed uninterrupted. Some older adults experience periods of digital disengagement that make it difficult for them to appropriate new technology later in life. Fully 48% of the interviewees stated they had stopped using technology for some period of their lives. The factors causing digital disengagement are many, with two major ones discovered during this study being (a) the transition into retirement and (b) ageism.

Digital disengagement is less a product of the declining minds and bodies of older adults and more a product of our society. When they retired, many older adults had never used technology outside of a workplace, and as a result, leaving the workplace meant leaving technology. Sixty-two percent of those who disengaged from technology gave retirement as the primary reason they ceased technology usage for a while. When asked why he stopped using technology, a 73-year-old man stated that after retirement, he "*didn't want to be bothered with the computer anymore. I didn't want to be attached. I had been attached for 20 years. It was enough*."

Although not a reason explicitly offered by older adults to explain periods of digital disengagement in their lives, there is evidence that societal ageism contributed to disruptions in their digital learning. The belief that older adults are inherently behind with technology led some to stop learning technology, which in turn led to digital disengagement. Two regulars at one of the senior centres maintained a running joke in which they laughed about how ridiculous it would be for them to help each other with technology. Their joke, a variant of the "blind leading the blind," centres on the assumption that older adults do not, and never can be, good enough with technology to help each other. Nonetheless, both men are in fact quite proficient with a number of programs and procedures on their laptops and smartphones. The two could have shared their skills with each other, and with others, but the ageist idea that they would forever be backwards in their technology skills because of their age stood in the way.

One of the consequences of this ageist belief was that many older adults interpreted breakdowns that arise when they are using technology as emanating out of their supposedly declining minds. One of the challenges older adults face while learning technology is that when they see others doing something with technology they say that it "*seems like magic,*" *as one woman stated. Another woman remarked on* "*how easy it was to do something after you figure it out, but before you know how to do it, it is terrifying*." Family members add to these feelings by making technology seem mystifying and out of reach, and by acting in ways that shame older adults for their lack of understanding about contemporary digital technologies. When asked about people in his life who help him with technology, an older man in his late 70s stated that:

"*Sometimes I got my daughter or one of my grandkids who know what I'm doing … like my little granddaughter who is about 6 years old …. She said "Y'all don't know that? I know that!" And she's only 5 or 6 years old! So these younger kids know a whole lot of this stuff and what these apps mean. We don't*."

The man said that he does not spend much time learning technology in retirement because he feels it is a losing venture. He said he feels like he will always be behind, so he would rather use his retirement for other purposes.

On the other hand, other older adults demonstrated that they had found ways to weave digital technology into the rhythm of their daily lives in retirement. For some, the transition to retirement leads to digital disengagement. For others, retirement leads to new forms of engaging with and learning technology. Daily life of most retirees is shaped by the experience of not having formal commitments associated with work, raising families, or attending school. As a result, for some older adults digital learning practices unfold over years, since there was not a perceived external demand (such as one would find in a workplace) compelling a more rushed approach to learning. Cynthia had been working intermittently since 2012 to create video slide shows of her international travels to places like Senegal and South Africa. She knows that many of her friends in the Tubman Senior Centre cannot afford such international travel, so she started the project to share her travels with others in the community. She started the project with a staff member at the Tubman Senior Centre and has since been working with volunteers to create the videos in Windows Movie Maker on her laptop. After an intensive period of weekly support for two months in which she needed assistance getting started on the project, she now comes to the senior centre irregularly when she encounters a hurdle in her work. She said she works on the project whenever she has free time: "*sometimes I will spend all afternoon on it [laughs]. Other times, I may not touch it for a month. But I get into trouble then [laughs]. Oh, it takes a while to get back into it after taking that much time off. I try not to, but sometimes I get so busy. But I know I will always come back to it*." She completed DVDs for her trips to South Africa and Senegal in spring 2015 and donated the DVDs to the senior centre. She is now working on a DVD of her trip to New Zealand.

This story reveals two important things about the informatics lifecourse. First, the pacing of life in retirement leads older adults to extend digital projects over an extended, self-directed period of time. Second, retired individuals have rich, multifaceted lives. Although densely woven into her local community, Cynthia also values opportunities to travel and to explore new areas of the nation and world, which she was unable to do earlier in life. Cynthia's story illustrates, some older adults then share their travels in their communities, enabling others to vicariously participate in their explorations. Indeed, the point of learning to make videos was to share her travels within her local community, enabling those who had less financial resources to see what she had seen. These mobile older adults are not, however, any less connected to their local communities as a result of their mobility. Individuals like Cynthia show how new technology enables some older adults to share their travels with others in their local communities, bringing the world back to others ageing in place.

10.5 Conclusions and Implications for Design

By building upon ethnographic fieldwork conducted over a one-year period with older adults in senior centres and public libraries, this chapter puts forward the concept of *informatics lifecourse*. This concept refers to how a person learns technology throughout the stages of his or her life as he or she ages in place. The chapter presents key dimensions of this concept, as it emerged through a qualitative analysis of ethnographic field-data: experiences ageing in particular sub-communities, technology support, ageism, and the transition from work to retirement.

The concept of the informatics lifecourse can be put into practice in future HCI research and practice by:

(1) Forming multi-disciplinary partnerships with community organizations like libraries, and the scholars who study these institutions, to design culturally responsive, locally-based technology support systems. These partnerships could involve HCI researchers working with, for instance, scholars and practitioners in the fields of Library and Information Science, Urban Planning, Community Informatics, and Gerontology, to design systems that enable older adults to use technology with fluency as they age in place.

(2) Contributing to scholarship and policies that attempt to correct ageist stereotypes with empirical facts about how older adults use technology as they age in place (e.g. McKee and Blair 2006). Deeply ingrained ageist assumptions about who uses technology leads some older adults to stop using technology when they retire, out of a belief that technology is inherently the domain of younger individuals. The video produced by Rogers et al. (2014) of older adults experimenting with Makey Makey technologies represents the type of public artefact HCI scholars could produce more of in order to positively contribute to public discourse about ageing and technology.

(3) Focusing more attention on the community dimensions of aging in place. Experiences moving through the stages of life (e.g. from work to retirement) take place in particular places. Based on this fact, the field of HCI could better attend to those facets of aging in place not bound to one's domicile, community dimensions such as the availability and effectiveness of community-based technology support that was the subject of this study.

Although this study was limited to one geographical place, and to a small number of institutions and ageing individuals within it, it revealed important dimensions of the experiences of diverse older adults learning and using technology as they age in place. The concept of the informatics lifecourse adds to the toolkit HCI researchers and designers can use to support technology usage in ageing communities.

References

Anderson M, Perrin A (2017) Tech adoption climbs among older adults. Pew Research Centre. http://pewrsr.ch/2pWRh2J. Accessed 24 Feb 2018

Blomberg J, Karasti H (2013) Reflections on 25 years of ethnography in CSCW. Comput Support Coop Work (CSCW) 22(4–6):373–423

Botero A, Hyysalo S (2013) Ageing together: steps towards evolutionary co-design in everyday practices. CoDesign 9(1):37–54

Burawoy M (1998) The extended case method. Sociol Theory 16(1):4–33

Centres for Disease Control and Prevention (2017) Healthy Places Terminology Atlanta, CDC. https://www.cdc.gov/healthyplaces/terminology.htm. Accessed 24 Feb 2018

Charmaz K (2012) Constructing grounded theory. Sage, Thousand Oaks, California

Cole TR (1992) The journey of life: a cultural history of ageing in America. Cambridge University Press, New York

Crabtree A, Nichols DM, O'Brien J et al (2000) Ethnomethodologically informed ethnography and information system design. J Assoc Inf Sci Technol 51(7):666–682

Dourish P (2001) Where the action is. MIT Press, Cambridge

Gardner PJ, Kamber T, Netherland J (2012) "Getting Turned On": Using ICT training to promote active ageing in New York City. J Community Inform 8(1). http://www.ci-journal.net/index.php/ciej/article/view/809/907

Hardill I (2014) The intergenerational help desk: encouraging ICT use in older adults in England. In: Vanderbeck R, Worth N (eds) Intergenerational space. Routledge, Lon-don, pp 273–285

Hooyman NR, Kiyak HA (2011) Social gerontology: a multi-disciplinary perspective. 9th edn. Pearson Education, Boston

Hutchison ED (2014) Dimensions of human behaviour: the changing life course. 5th edn. Sage, Thousand Oaks, California

Lenstra N (2016) The community informatics of an ageing society: a comparative case study of senior centres and public libraries. Dissertation, University of Illinois at Urbana-Champaign

Lenstra N (2017) Agency and ageism in the community-based technology support services used by older adults. First Monday 22(8)

Lenstra N, Baker KS (2017) The intermediation of community and infrastructure. Libr Trends 65(4):473–490

McKee H, Blair K (2006) Older adults and community-based technological literacy programs: barriers and benefits to learning. Community Lit J 1(2):13–39

Olphert W, Damodaran L (2013) Older people and digital disengagement: a fourth digital divide? Gerontology 59(6):564–570

Peek ST, Luijkx KG, Rijnaard MD et al (2016) Older adults' reasons for using technology while ageing in place. Gerontology 62(2):226–237

Righi V, Sayago S, Blat J (2017) When we talk about older people in HCI, who are we talking about? Towards a 'turn to community' in the design of technologies for a growing ageing population. Int J Hum-Comput Stud 108:15–31

Rogers WA, Mitzner TL (2017) Envisioning the future for older adults: autonomy, health, well-being, and social connectedness with technology support. Futures 87:133–139

Rogers Y, Paay J, Brereton M et al (2014) Never too old: engaging retired people inventing the future with MaKey MaKey. In: Proceedings of the SIGCHI conference on human factors in computing systems. ACM, pp 3913–3922

Sayago S, Blat J (2010) Telling the story of older people e-mailing: an ethnographical study. Int J Hum-Comput Stud 68(1–2):105–120

Settersten RA (2003) Invitation to the life course: toward new understandings of later life. Baywood Publishing Company, Amityville, NY

Silvast A (2015) An oral history of programming practices: Gender and age dynamics and digital (dis)engagement among computer programmers in Finland. Hum Technol 11(1):4–29

Silver MP (2014) Socio-economic status over the lifecourse and internet use in older adulthood. Ageing Soc 34(6):1019–1034

Suchman LA (1987) Plans and situated actions: The problem of human-machine communication. Cambridge University Press, New York

Vasunilashorn S, Steinman BA, Liebig PS et al (2012) Ageing in place: evolution of a research topic whose time has come. J Ageing Res 2012:1–6

Vines J, Pritchard G, Wright P et al (2015) An age-old problem: examining the discourses of ageing in HCI and strategies for future research. ACM Trans Comput-Hum Interact (TOCHI) 22(1):2

Wildevuur S, van Dijk D, Hammer-Jakobsen T et al (eds) (2013) Connect: design for an empathic society. BIS Publishers, Amsterdam

Williams K (2012) Informatics moments. Libr Q 82(1):47–73

Xie B, Jaeger PT (2008) Computer training programs for older adults at the public library. Public Libr 47(5):42–49

Noah Lenstra is an Assistant Professor of Library & Information Studies at the University of North Carolina at Greensboro, where he also holds Affiliated Faculty status in the Gerontology Program. He teaches in the areas of community informatics and community engagement. He earned his Ph.D. in 2016 from the University of Illinois. Learn more about current work at noahlenstra.com.

Chapter 11
Older Adults as Internet Content Producers: Motivations for Blogging in Later Life

Montserrat Celdrán, Rodrigo Serrat and Feliciano Villar

11.1 Introduction

Many previous studies have examined how older adults use and benefit from the information and communication technologies (ICTs) (Selwyn et al. 2003; Wagner et al. 2010). Research has underlined the barriers that older adults may face in understanding and using ICTs. Accordingly, there is an increasing body of literature on how to design older adult-friendly ICT interfaces and promote their use through learning activities (Kuo et al. 2013; Robinson et al. 2009).

However, this barrier-centered approach is limited in at least two ways. Firstly, it could lead to viewing older adults as exclusively passive ICT users, overlooking the ways in which older adults use ICTs to enrich themselves and their communities. Secondly, it omits other factors that could also influence the adoption of ICTs, such as motivations. In this chapter, we will adopt a proactive participation approach regarding older adult interaction with ICTs by exploring the specific motivations that lead them to start and maintain a blog.

11.2 Body of the Chapter

Human-computer interaction (HCI) research has predominantly focused on compensating the negative consequences of aging (particularly cognitive ones) in order to help older adults embrace new technologies (Chu and Chu 2010; Gutman et al.

M. Celdrán (✉) · R. Serrat · F. Villar
Faculty of Psychology, University of Barcelona, Barcelona, Spain
e-mail: mceldran@ub.edu

R. Serrat
e-mail: rserrat@ub.edu

F. Villar
e-mail: fvillar@ub.edu

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_11

2017). However, this approach has been criticized for perpetuating the perception of older adults as passive recipients, reinforcing the traditional narrative of aging that emphasizes decline and vulnerability (for example, Righi et al. 2017). From this perspective, older adults' relationship with ICTs has been viewed as intrinsically problematic.

Older adults themselves are challenging this negative conceptualization of their relationship with ICTs. The current generation of older adults has a better educational and occupational level than previous cohorts, and therefore they are more likely to have had previous experiences with ICTs in their careers (Hong et al. 2017; Pew Research Center 2017). For instance, the percentage of people in Spain aged 55–64 years old with a tertiary education has grown from 15.9% in 2007 to 23.2% in 2016 (Eurostat 2017). There is also evidence of a growing interest among older people in using computers or the Internet (Pew Research Center 2017). For example, the percentage of Spanish older adults using a computer has increased from 7.5% in 2006 to 36.4% in 2017 (INE 2018). Rates are even higher for Internet use, rising from 5.1% in 2006 to 43.7% in 2017 (INE 2018).

Far from being a homogenous group in terms of their relationship with technology, the increasing number of older adults adopting ICTs in their daily lives has generated a variety of different user profiles, as illustrated by research specifically focusing on Internet use. Van Boekel et al. (2017) identified four different kinds of user: "minimizers" (those making low use of the Internet); "maximizers" (those using the Internet for a wide range of activities); "practical users" (those who search for information or use online banking), and "social users" (users of social media and web-based games).

However, van Boekel's profiles do not include a fifth type of user: older adults as producers, rather than mere consumers, of content. In fact, proactive users, those who use the Internet to create something new or disseminate their ideas through writing or videos, have rarely been studied (for an exception to this trend, see Ferreira et al. 2017). Writing a blog may be a paradigmatic example of this kind of productive role mediated by ICTs. Blogs generally consist of a series of posts or entries that appear in reverse chronological order, in which a person or group presents their writing, opinions, photographs, or videos, usually on one particular topic (Boulos et al. 2006).

11.2.1 Adoption of Blogging

Regardless of a person's age, creating a blog is not a frequent activity. For instance, the average percentage of active bloggers in the EU is only 6%, being highest in Denmark (10%) and Hungary (9%) (Eurostat 2017). Spanish data indicate an even lower participation rate, whether for the general population (6.9%) or among people aged 65–74 years old (1.5%) (INE 2015). In the same vein, research literature is scarce compared with other recent Internet activities, such as social media or instant messaging.

Previous research on blogging has analyzed either the content of blogs or the benefits that bloggers obtain from carrying out this activity. Regarding the first line of inquiry, Schler et al. (2005) found that sex and age influenced both the writing style and content of blogs, while Miller and Pole (2010) found that writing a health blog was associated with a range of socio-demographic characteristics, such as being female, employed in the health field, and highly educated. As regards the benefits of blogging, it has been found that this has a positive impact on a range of psychological and social aspects, such as self-esteem, emotional regulation, and social support (Baker and Moore 2011; Oostveen 2011; Chung and Kim 2008).

However, other issues, such as the motivations that prompt people to start and maintain a blog, have been much less studied. Those motivations could be particularly interesting given the higher level of resources and personal effort needed to undertake this activity in comparison with the adoption of other, more frequently researched ICTs. Blogging demands more resources than other productive activities such as writing on Twitter or Facebook, including the time, creativity, and writing skills required to produce each post, prior ICT skills in order to create a blog, and the self-confidence to expose oneself by expressing ideas, values, or feelings on a blog.

The few studies that have addressed blogging motivations have found that these can be classified as either self-focused or other-focused. The first type of motivation includes aspects such as using blogging to fulfill personal needs (e.g., contact and communication with family and friends), achieving ego-enhancing motivations (e.g., exhibitionism or the need to be seen and recognized by others), organizing thoughts and personal ideas, or fulfilling creative needs (e.g., sharing literary writing, paintings, or pictures) (Fullwood et al. 2015; Hollenbaugh 2011; Nardi et al. 2004).

Regarding other-focused motivations, it has been found that the idea of helping others or informing others on a specific topic or issue can spur people to write a blog. Hsu and Chuan-Chuan (2008) stressed that altruistic motivations such as sharing one's knowledge were positively related to attitudes toward blogging. In the same vein, Ekdale et al. (2010) found that other-focused motivations increased over time in political bloggers. Other-focused motivations could be an expression of generativity, defined by Erikson as "a concern for establishing and guiding the next generation" (Erikson 1963, p. 267). Although generativity has been mainly a characteristic of middle-aged adults, generative concerns and behaviors may still be present in older age (Villar 2012). Blogging could serve as a medium to fulfill these generative desires if posts are used to create or maintain bonds or to exert a positive impact on upcoming generations, especially young adults (Villar and Serrat 2014).

Either self-focused or other-focused motivations to start a blog could have a similar root that is, facing personal life transitions. So, personal life transitions may trigger blogging adoption as a way to facilitate (and share) reflections on certain vital circumstances and their consequences. Previous literature has studied examples of normative transitions, such as motherhood (Arias 2017) or adolescence (Boniel-Nissim and Barak 2013), and non-normative events, such as the death of a child (DeGroot and Carmack 2013) or overcoming a cancer (Donovan et al. 2017). Similarly, aging-related events such as retirement, widowhood or grandparenthood could also be turning points acting as an initial motivation to start writing a blog.

11.2.2 Older Adults as Bloggers

Of the range of variables that have been explored to understand ICT adoption, age has traditionally been the focus of studies on other ICTs such as smartphones (e.g., McGaughey et al. 2013) or social media such as Facebook (Braun 2013). Unfortunately, there are few studies on older adults as bloggers and even fewer that analyze their motivations.

Previous research on older bloggers has addressed either the benefits of writing a blog or the barriers to starting this activity. Regarding the first type of study, Brewer and Piper (2016) found that older adults seemed to benefit from blogging as a form of self-expression that fosters a sense of identity and provides a powerful form of social connection. Regarding the second type of study, Sayago et al. (2011) found that older adult non-bloggers did not seem to reject the idea of starting a blog, but appeared to be more interested in using computers as a way to communicate with family or friends rather than as a means to create something new of their own (Sayago et al. 2011). In addition, they expressed doubts regarding their capacity to create interesting content for a personal blog (Xie et al. 2012), and were also concerned about issues of privacy and security (Sayago et al. 2011).

To the best of our knowledge, no previous studies on motivations for starting a blog have focused solely on older adults, and few have compared their motivations with those of younger bloggers (Fullwood et al. 2015; Hollenbaugh 2011; Nardi et al. 2004). Hollenbaugh (2011) found that older participants usually maintained a blog in order to help and inform others, whereas younger adults generally viewed blogging as a pastime, while Fullwood et al. (2015) found that older participants were more motivated to maintain their blog as a way to fulfill their creativity needs. However, Hollenbaugh's measure of blogging motives was based on a previous study on undergraduate students and Fullwood's Blogging Motivations Questionnaire was based on previous blog literature that did not specifically address older adult bloggers, raising the question of whether older adults might have specific motivations that are different to those of younger cohorts and have not been explicitly stated in previous literature. Therefore, the aim of this study was to explore the motivations that lead older adults to write a blog.

11.3 Method

11.3.1 Participants

Sixteen Spanish older adults were interviewed. Study participants were required to be at least 60 years old and have an active blog at the time of the study (defined as having published a post at latest three months before the study). Table 11.1 presents descriptive characteristics of the sample. Blog topics were highly diverse, including politics, sports, traveling, and others.

Table 11.1 Description of the sample

No.	Sex	Age	Marital status	Educational level
1	Male	63	Married	University degree
2	Male	66	Married	–
3	Female	65	Married	University degree
4	Female	69	Widowed	University degree
5	Female	67	Married	University degree
6	Male	67	Married	University degree
7	Male	75	Married	University degree
8	Male	77	Married	Secondary
9	Female	65	Married	Primary
10	Male	69	Divorced	University degree
11	Male	67	Divorced	University degree
12	Male	68	Married	University degree
13	Male	74	Married	University degree
14	Male	65	Married	University degree
15	Male	65	Married	–
16	Male	83	Widowed	University degree

Participants were recruited using a purposive-snowball approach and a web search, and recruitment concluded when a variety of different thematic blogs had been selected and when new interview data reached saturation (Fusch and Ness 2015).

11.3.2 Data Collection

A semi-structured interview was designed to explore the process of blog creation and maintenance. To this end, questions were divided into three specific moments: (a) antecedents (how the blog started), (b) present moment, and (c) future perspectives. In this study, we analyzed participants' responses to the first set of questions.

Specifically, the present analysis focuses on an open question regarding how participants had started their blogs and their motivations.

11.3.3 Data Analysis

Verbatim transcripts of the responses were analyzed thematically to identify common features in the participants' answers (Vaismorari et al. 2013). Atlas.ti software was used to carry out these analyses. Thematic analysis is ideally suited to capture and organize descriptions of people's experiences (Gubrium and Sankar 1994). The data were carefully scrutinized in different phases. First, verbatim transcriptions were read by two researchers (authors 1 and 2) in order to begin isolating the units of meaning generated by the question on older adults' motivations to start a blog. Second, these units of meaning were condensed into categories using inductive thematic analysis, "a process of coding the data without trying to fit it into a preexisting coding frame, or the researcher's analytic preconceptions" (Braun and Clarke 2006, p. 83). The researchers compared their ideas in this second phase and reached a consensus when differences were found.

Finally, peer debriefing was performed, in which a third researcher (author 3) reviewed themes and subthemes and challenged the previous researchers' interpretations of the data (Creswell and Miller 2000). As part of this reflection on the data, regular group meetings were held to discuss issues related to the study (Meyrick 2006).

Each interviewee was given a code (e.g., blogger_14), which appears after each extract cited in the chapter. The code included a random number that was assigned to each transcription.

11.4 Results

Two main categories were identified in the thematic analysis: self-focused motivations and external motivations to start a blog. The former could be described as those motivations that fulfill a self-need, such as a desire to write and express ideas or an attempt to cope with a life transition, whereas the latter was related to the role of a third person (usually a relative) in encouraging participants to start a blog.

11.4.1 Blogging as Self-expression

Ten bloggers talked about their inner need to start a blog, which resembled the self-focused expression motivation described in the introduction. Six of them reported that love of writing was their main motivation to start a blog. Writing a blog seems to be a continuation of a previous meaningful activity. As can be seen in the following extract, blogging can be used to convert a participant's previous activity (e.g., notebooks, diaries) into a technological format, and can also provide the opportunity to reach a larger audience:

"*I liked reading books and discussing them in a book club, and I started to write an opinion essay on each book after every session that I would send* via *email to the book club members. Then I heard about blogs and I thought I could reach more people if I started a blog with my book essays, and that it is how I started my blog*". [blogger_14]

Writing a blog endowed participants with at least two new advantages. Especially for those used to writing in notebooks or emailing their texts to friends or acquaintances, being a blogger enabled them to reach more people.

"*At the time, I thought that blogging opened new opportunities to communicate with everyone, that a variety of people and members of the public were beginning to use these new technologies. […] In a way, my blog served as a loudspeaker for my political activity*". [blogger_1]

Participants were surprised by the opportunities to connect with people worldwide, something they had not expected when they started their blogs.

"*One advantage of blogging is that it connects you worldwide… It really surprised me that only few days after I had started my blog, I saw that someone from Mexico had reached my blog!*" [blogger_2]

The second advantage came from the freedom they felt that writing their own blogs gave them. That was particularly important for those participants who during their professional career had had direct or indirect contact with the media, working on a newspaper or collaborating sporadically on a magazine.

"*I have collaborated with different media for many years, but there's a kind of self-censorship in operation, everything has to be expressed in a politically correct manner, whereas on a blog you can express yourself with much more freedom*". [blogger_11]

Thus, blogging enabled participants to exert total control over each post produced, guaranteeing that their voice and ideas were conveyed as the author wished.

"*The great advantage of a blog is that you write and publish everything yourself, what you really feel you want to write, and no-one is going to change it*". [blogger_13]

Blogging could serve on those occasions as a means to compensate previous experiences of writing that were not satisfactory for the participants. On these occasions, their blog could help them fulfill a failed vocation as a writer, journalist, political activist, or chef.

"*My blog started in response to this curiosity about journalism that one has*". [blogger_8]

"*I studied sociology but I haven't worked much in this field, so… as I've always been interested in politics and I also like writing… having a blog enabled me to do both, that's all there is to it*". [blogger_6]

A second theme of self-motivation to start a blog concerned personal life transitions. Participants expressed their need to start writing their thoughts and concerns in order to cope with a difficult situation. These life transitions included work-related changes, usually around retirement time. Some felt the need to start a blog when they were facing the last years of their working life in order to clarify their ideas and cope better with retirement, as illustrated by the following extract:

"*I was facing my last year of teaching and it was hard, caught between the simultaneous desire to stop and to continue working. So I started another blog where I poured out all my feelings and contradictions… I also told stories about being a teacher… The blog was a kind of therapy for me. And then other teachers started to read it, which was really nice, and there were even moments when they cheered me up*". [blogger_3]

Others started their blogs soon after retirement, as a way to put their ideas in order.

"*When I was preparing for my retirement, I mean, for my retirement party, I made an effort to prepare an enjoyable event that would be unforgettable for those who went, and when I saw that people found the event interesting, I decided to write about it, to capture it in writing*". [blogger_2]

Retirement gave participants more free time, and blogging was seen as a good way to keep active and participate in different and meaningful activities.

"*Let me tell you something: Retired people have time, a lot of time, and you have to get involved in different activities, and blogging was a good activity to start with!*" [blogger_8]

This kind of participation seems to provide a good excuse to show interest in current problems and issues that occur and might be important for a participant's topic. This may be particularly important during retirement, as people may lose social contact or slowly lose interest in what is going on in their communities or in a particular issue.

"*For people my age, writing a blog forces you to make an effort to keep up-to-date with ideas and events*". [blogger_15]

For others, blogging was related to health and family changes, and a blog appeared to be a way to moderate the psychosocial adversities that accompanied an episode of illness.

"*I retired at 61. I thought that it would be the time to do what I really wanted, but I was going through a really difficult personal moment because of health and family reasons, so I didn't have enough energy to start anything. When things started getting back to normal, I began thinking about taking up a new activity and I asked myself what I really liked. Old photographs. And that's how I started my blog*". [blogger_9]

11.4.2 Others as Blogging Prompters

"Others as blogging prompters", as external motivations that explain older adults' adoption of blogging, emerged as another theme in starting a blog among our participants. In this case, participants did not even know what a blog was and someone suggested this activity to them. Thus, some older bloggers reported that the idea of writing a blog came for their previous work.

"*In 2004, a Catalan newspaper started a new series of online products and one of them was the chance to have a blog in one of the newspaper sections. At that time, I was a literary critic for that newspaper and one of four who started this kind of blog there… nowadays, I think I've been the most prolific of those who started a blog that year*". [blogger_15]

Another example of this external suggestion came from a case in which another person created the participant's blog.

"*The idea of writing a blog came from the secretary of the advisory board for older adults, with the aim of creating blogs written by older adults to raise their profile on the Internet through blogging. She encouraged us to start the project and in fact she helps us with everything*". [blogger_16]

Children also seemed to play an important role in the adoption of blogging for some participants. Firstly, children could act information agents, motivating older parents to start using a new technological application that the parents might not even have known about until then.

"*I had taken early retirement and one day, my son asked me "Dad, why don't you start a blog?" and I said "What's a blog?" He told me about them and I started the next day. It was as simple as that*". [blogger_6]

Secondly, children helped their parents to create a blog and acted as consultants or technical advisers.

"*My daughter still helps me when I have no idea. She's good at marketing and I sometimes laugh at her because I don't understand her language. She says that sometimes, when she's giving an online marketing course, she tells her students "I'll explain this as if I was talking to my mum!"*" [blogger_5]

When asked why their children had suggested this kind of activity to them, older adults mentioned good writing skills or the belief that they had interesting ideas to share.

"*I started because my daughter told me to, and she created the blog for me. I liked to write things in my notebooks, so she said to me "Mum, I'll start a blog for you" and I asked her "What's a blog?" and we started working on it*". [blogger_4]

11.5 Discussion

The aim of this chapter was to explore older adults' motivations to blog. Our results suggest that some motivations are similar to those found in previous studies, but also that there are others that may be specific to the older population.

Previous research on motivations for blogging has classified them as self-focused and other-focused. At least when it comes to their reasons for starting their blogs, the older adults in our sample seemed to be more driven by self-focused than by other-focused motivations. Our results are thus in line with previous studies which have highlighted organizing thoughts and personal ideas, and fulfilling creative needs as potential motivations to start a blog (Fullwood et al. 2015; Hollenbaugh 2011; Nardi et al. 2004).

Nevertheless, we also found new motivations to start a blog in our sample, which could be interpreted from a life course perspective. First, transition to retirement seems to play a key role in explaining participants' adoption of blogging. Although blogging could be conceptualized as a new activity for older adults because of its relatively short history, the motivations underlying its adoption seem to fit better with theories such as continuity theory, in which retirement adjustment, i.e., the process of psychosocial adaptation following retirement (Wang and Shi 2014), reflects people's need to maintain consistency in life patterns over time (Atchley 1999). In other words, blogging allows older adults to continue with a previous interest, motivation, or hobby, but leveraging the benefits that publishing online can offer. This argument suggests that older adults do not start blogging randomly or spontaneously, but rather as the result of a previous trajectory or interest. Thus, blogging could serve to compensate for the restrictions that retirement can impose on one's life, and as far as our participants were concerned, this compensation could take two forms: (1) developing their professional interest through blogging, or (2) regaining a past motivation for a hobby or project.

The higher frequency of self-focused motivations could lead to a conception of blog writing as a kind of self-expression activity in which the blog itself, the ideas conveyed in posts, the graphical content, and even the title are a reflection of the author. However, our data gave no indication that exhibitionism was a motivation, although previous studies have described blogging as a way to gain attention and even fame (Hollenbaugh 2011). The following extract illustrates this lack of exhibitionism:

"*My daughter told me "Mum, you could have more readers if you had a good niche for your blog" [laughter], and I said "Look, I'll have a niche… in the future…." "But the most successful blogs are those with a specific topic such as diet, beauty, romantic novels, or whatever". But because I write on my blog about anything and everything that comes into my head, I told her "I don't want to be successful, I just want to write!"*" [blogger_5]

Besides self-focused motivations, another kind of motivation appeared in our analysis that has not been specifically mentioned in previous research. We called it "external motivations", and it encompasses all the ideas in which a family member, a friend, or someone close to the person encouraged him or her to start writing a blog. This key element of social support is of particular importance in activities in which older adults are not especially engaged and therefore social support facilitates or hinders the initial interest an older adult could have in a given activity. In the case of blogging, it seems to be important for the older adult to perceive society or their close social network as approving their interest in blogging and publishing personal ideas or thoughts worldwide.

Our results also suggest that older bloggers still needed to overcome several barriers to participation in specific ICT activities such as blogging. Even older adults with a good educational background or career did not see themselves as producers of content on the Internet. Self-deprecating beliefs, such as assuming that blogging is only for younger adults, or feeling that no-one would be interested in reading their posts, can act as self-imposed barriers to starting this activity, self-barriers that has been described previously in older adult's technology non-users (Knowles and Hanson 2018). Children could serve on these occasions as generational gatekeepers, enabling their parents to see themselves as potential users of blogging, cheering them up, and helping them in the initial stages of blog creation. Hence, although the digital generation gap is decreasing in the use of some programs or devices, there is still room for improvement in the potential uses and benefits of ICTs for older adults.

Lastly, our data indicated a lack of other-focused motivations such as helping others who read the posts or the generativity desire to leave content for future generations. This result can be partly explained by our research focus on initial motivations to start a blog, rather than on the changes that may occur while maintaining a blog. One could hypothesize that once someone realizes the impact that a post can have on readers, he or she may start changing the topics discussed or even the writing style. Further studies are needed in order to determine whether this is the case among older adults and if there is a higher presence of generativity concerns, especially when their blogs are read by younger adults.

This study has certain limitations that should be taken into account when interpreting the results. Due to the qualitative, retrospective, and descriptive nature of our study, the data cannot be interpreted as being a representative result for older adults who blog. It also focused on one particular moment, the initial motivations to start this activity, which although essential to understand blogging activity, do not encompass the complexity of this behavior. Further studies on the changeable nature of blogging motivations, such as comparing initial motivation with motivation to maintain a blog over time, could shed light on other kinds of motivation that are more related to other-focused motivations. In fact, some of our study participants were quite surprised to see that anyone worldwide could read a post on their blog, and this may affect how they write and their motivation to continue doing so in the future.

11.6 Conclusion

This chapter broadens our knowledge of older adults' participation through ICTs by examining older adults not just as Internet consumers but also as content producers. This idea of proactive participation through ICTs could expand the diversity of older adults considered in previous research and could also have an impact on how educational programs are designed in order to promote this kind of activity. Such specific training may be challenging, as it should have the two-fold goal of providing older adults with the ICT skills necessary to create and maintain a blog while also empowering them so that they feel their ideas and creativity are sufficiently interesting to be shared worldwide.

This profile of content-producer older adults is likely to be more typical in the next cohort of older people, as they become more digitally skilled, and have a richer experience using content creation tools, such as traditional blogs, wikis, videoblogging or microblogging. Future studies may explore how aging-related life events and transitions might inspire new technologically savvy older generations to create and express digital content in ways probably different to the ones used at present. In turn, such content could also transform the way such life events and transitions are experienced both by the content producers and by their audience, an aspect that has not been studied so far.

Acknowledgements This study was funded by the Spanish Ministry of Economy, Industry, and Competitiveness, with grant ref. PSI2016-77864-R. Rodrigo Serrat was supported by a Postdoctoral Fellowship from the University of Barcelona, in collaboration with the Caixa Bank Foundation.

References

Arias BS (2017) The importance of online peer relationships during the transition to motherhood: do they decrease stress, alleviate depression and increase parenting competence? Dissertation abstracts international section A: humanities and social sciences 77(10-A(E))

Atchley RC (1999) Continuity theory, self, and social structure. In: Ryff CD, Marshall VW (eds) Families and retirement. Sage, Newbury Park, pp 145–158

Baker JR, Moore SM (2011) An opportunistic validation of studies on the psychosocial benefits of blogging. Cyberpsychol Behav Soc Netw 14(6):387–390

Boniel-Nissim M, Barak A (2013) The therapeutic value of adolescents' blogging about social-emotional difficulties. Psychol Serv 10(3):333–341

Boulos MN, Maramba I, Wheeler S (2006) Wikis, blogs and podcasts: a new generation of web-based tools for virtual collaborative clinical practice and education. BMC Med Educ 15(6):41

Braun MT (2013) Obstacles to social networking website use among older adults. Comput Human Behav 29:673–680

Braun V, Clarke V (2006) Using thematic analysis in psychology. Qual Res Psychol 3(2):77–101

Brewer R, Piper AM (2016) "Tell it like it really is": a case of online content creation and sharing among older adult bloggers. In: Proceeding of the 2016 CHI conference on human factors in computing systems. https://dl.acm.org/citation.cfm?id=2858036.2858379. Accessed 10 Feb 2018

Chu RJ, Chu AZ (2010) Multi-level analysis of peer support, internet self-efficacy and e-learning outcomes—the contextual effects of collectivism and group potency. Comput Educ 55(1):145–154

Chung DS, Kim S (2008) Blogging activity among cancer patients and their companions: uses, gratifications, and predictors of outcomes. J Am Soc Inf Sci Technol. http://doi.org/10.1002/asi.v59:2
Creswell J, Miller D (2000) Determining validity in qualitative inquiry. Theory Pract 39(3):124–130
DeGroot JM, Carmack HJ (2013) "It may not be pretty, but it's honest": examining parental grief on the Callapitter blog. Death Stud 37(5):448–470
Donovan EE, Nelson EC, Scheinfeld E (2017) Cyberframing cancer: an exploratory investigation of valenced cybercoping on cancer blogs. Health Commun 32(1):1–10
Ekdale B, Namkoong K, Fung T et al (2010) Why blog? (then and now): exploring the motivations for blogging by popular American political bloggers. New Media Soc 12(2):217–234
Erikson EH (1963) Childhood and society. Norton, New York
Eurostat (2017) Culture statistics—use of ICT for cultural purposes. http://ec.europa.eu/eurostat/statistics-explained/index.php/Culture_statistics_-_use_of_ICT_for_cultural_purposes. Accessed 12 Feb 2018
Ferreira SM, Sayago S, Blat J (2017) Older people's production and appropriation of digital videos: an ethnographic study. Behav Inf Technol 36(6):557–574
Fullwood C, Nicholls W, Makichi R (2015) We've got something for everyone: how individual differences predict different blogging motivations. New Media Soc. https://doi.org/10.1177/1461444814530248
Fusch PI, Ness LR (2015) Are we there yet? Data saturation in qualitative research. Qual Rep 20(9):1408–1416
Gubrium JF, Sankar A (1994) Qualitative methods in aging research. Sage, Thousand Oaks
Gutman GM, Kwon S, Güttler JF et al (2017) Smart home technologies supporting aging in place. In: Kwon S (ed) Gerontechnology: research, practice, and principles in the field of technology and aging. Springer, New York, pp 223–249
Hollenbaugh EE (2011) Motives for maintaining personal journal blogs. Cyberpsychol Behav Soc Netw 14(1–2):13–20
Hong YA, Zhou Z, Fang Y et al (2017) the digital divide and health disparities in China: evidence from a national survey and policy implications. J Med Internet Res 19(9):e317. https://doi.org/10.2196/jmir.7786
Hsu C-L, Lin C-C (2008) Acceptance of blog usage: the roles of technology acceptance, social influence and knowledge sharing motivation. Inf Manag 45:65–74
Instituto Nacional de Estadsticia (2015) Encuesta sobre equipamiento y uso de tecnologías de la información y comunicación en los hogares 2014. http://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736176741&menu=publi&idp=1254735976608. Accessed 12 Feb 2018
Instituto Nacional de Estadística (2018) Encuesta sobre Equipamiento y Uso de Tecnologías de Información y Comunicación en los hogares 2017. http://www.ine.es/dynt3/inebase/es/index.htm?padre=3931&capsel=3933. Accessed 12 Feb 2018
Knowles B, Hanson VL (2018) The wisdom of older technology (non)users. Commun ACM 61(3):72–77. https://doi.org/10.1145/3179995
Kuo F, Tseng F, Lin C et al (2013) Critical success factors for motivating and sustaining women's ICT learning. Comput Educ 67:208–218
McGaughey RE, Zeltmann SM, McMurtrey ME (2013) Motivations and obstacles to smartphone use by the elderly: developing a research framework. Int J Electron Financ 7(3/4):177–195
Meyrick J (2006) What is good qualitative research? A first step towards a comprehensive approach to judging rigour/quality. J Health Psychol 11:799–808
Miller EA, Pole A (2010) Diagnosis blog: checking up on health blogs in the blogosphere. Am J Public Health 100(8):1514–1519
Nardi BA, Schiano DJ, Gumbrecht M et al (2004) Why we blog. Commun ACM 47(12):41–46
Oostveen A (2011) The internet as an empowering technology for stigmatized groups: a case study of weight loss bloggers. In: Proceedings of the 25th BCS conference on human-computer interaction, pp 114–119. http://dl.acm.org/citation.cfm?id=2305316.2305337. Accessed 2 Feb 2018

Pew Research Center (2017) Technology use among seniors. http://www.pewinternet.org/2017/05/17/technology-use-among-seniors/. Accessed 12 Feb 2018

Righi V, Sayago S, Blat J (2017) When we talk about older people in HCI, who are we talking about? Towards a 'turn to community' in the design of technologies for a growing ageing population. Int J Hum Comput Stud 108:15–31

Robinson L, Brittain K, Lindsay S et al (2009) Keeping In Touch Everyday (KITE) project: developing assistive technologies with people with dementia and their carers to promote independence. Int Psychogeriatr 21(3):494–502

Sayago S, Sloan D, Blat J (2011) Everyday use of computer-mediated communication tools and its evolution over time: an ethnographical study with older people. Interact Comput 23(5):543–554

Schler J, Koppel M, Argamon S et al (2005) Effects of age and gender on blogging. https://www.semanticscholar.org/paper/Effects-of-Age-and-Gender-on-Blogging-Schler-Koppel/21c40eb92cfa0f4928f6a5c155e62af32f13fcff. Accessed 20 Feb 2018

Selwyn N, Gorard S, Furlong J et al (2003) Older adults' use of information and communications technology in everyday life. Ageing Soc 23(5):561–582

Vaismorari M, Turunen H, Bondas T (2013) Content analysis and thematic analysis: implications for conducting a qualitative descriptive study. Nurs Health Sci 15(3):398–405

van Boekel LC, Peek ST, Luijkx KG (2017) Diversity in older adults' use of the internet: identifying subgroups through latent class analysis. J Med Internet Res 19(5):e180. https://doi.org/10.2196/jmir.6853

Villar F (2012) Successful ageing and development: the contribution of generativity in older age. Ageing Soc 32:1087–1105

Villar F, Serrat R (2014) A field in search of concepts: the relevance of generativity to understanding intergenerational relationships. J Intergener Relatsh 12(4):341–397

Wagner N, Hassanein K, Head M (2010) Computer use by older adults: a multi-disciplinary review. Comput Human Behav 26:870–882

Wang M, Shi J (2014) Psychological research on retirement. Annu Rev Psychol 65:209–233

Xie B, Watkins I, Golbeck J et al (2012) Understanding and changing older adults' perceptions and learning of social media. Educ Gerontol 38(4):282–296

Montserrat Celdrán (Ph.D.) is an associate professor at the Department of Cognition, Development and Educational Psychology of the University of Barcelona, Spain. Her research interests are focused on active ageing and social participation, volunteerism, grandparenthood, and dementia.

Rodrigo Serrat (Ph.D.) is a postdoctoral researcher at the Department of Cognition, Development, and Educational Psychology of the University of Barcelona, Spain. His research focuses on civic participation in later life, with particular focus on issues of inclusion and diversity.

Feliciano Villar (Ph.D.) is tenured lecturer and researcher at the Department of Cognition, Development, and Educational Psychology of the University of Barcelona, Spain. His research interests are focused on generative concerns in the second half of life and the contributions of older people to their communities and families.

Chapter 12
Older People Positive, Active and Creative ICT Use: A Study in Three Countries

Susan M. Ferreira, Sergio Sayago and Josep Blat

12.1 Introduction

An ever-growing ageing population and the ubiquity of Information and Communication Technologies (ICTs) in our everyday lives have motivated Human-Computer Interaction (HCI) scholars to explore the relationship between older people (60+) and ICTs. Qualitative and quantitative studies of their attitudes towards, and use of, several ICTs, ranging from mobile phones (Leme et al. 2014) and Online Social Networks (OSN) (Gibson et al. 2010) to digital games (Mosberg Iversen 2014) and video-sharing sites (Harley and Fitzpatrick 2008; Sayago et al. 2012) have been carried out. Assistive technologies, apps, OSNs and other computer-based tools, such as e-mail systems, have been specifically designed to help older people to conduct (instrumental) activities of daily living, ranging from keeping in touch with their relatives (Rodríguez et al. 2009) to being able to remember when they have to take their (McGee-Lennon et al. 2011). Within this body of knowledge, older people have almost unambiguously been characterized as:

- a very heterogeneous segment of the population, because "with increasing age there is an increase in inter-individual differences in rate, onset and direction of change in most functions and processes. This means that older people vary considerably in their abilities, skills and experiences" (Czaja and Lee 2007, p. 344),

S. M. Ferreira (✉)
Télé-Université Du Québec, Québec, Canada
e-mail: susanferreira@gmail.com

S. Sayago
Universitat de Barcelona, Barcelona, Spain
e-mail: ssayago81@gmail.com

J. Blat
Universitat Pompeu Fabra, Barcelona, Spain
e-mail: josep.blat@upf.edu

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_12

- a user group "with a set of specific characteristics: they have a range of health concerns, they experience physical and cognitive decline, they are slow at performing with technology, and experience social isolation and a loss of independence" (Vines et al. 2015)
- consumers, rather than producers, of digital content, e.g. "(even) social technologies designed specifically for older adults often prioritize functions that allow users to easily access content produced by others, rather than to create and share their own digital media" (Waycott et al. 2013).

Within this characterization of older people, "technologies that can help compensate for people's frailties and the assumed needs that arise when getting older" (Rogers et al. 2014, p. 3913) is the most predominant design approach.

We do not claim that this portrayal of older people within HCI is inconsistent, although we consider that there might be reasons for thinking just the opposite: how can a heterogeneous user group be uniformly regarded as consumers of digital content with a set of specific characteristics? Ageing is a cultural, multifaceted process of gains and losses (Gilleard and Higgs 2000). Thus, it should come as no surprise to see older people running marathons or leading an active and social life-style while others are homebound, living in nursing homes and socially isolated. Yet, this heterogeneity does not prevent older people from exhibiting fairly similar interaction practices when they use ICTs to, for instance, look for information online or keep in touch with their friends and children. Age-related changes in functional abilities (especially in cognition, vision and mobility) hinder considerably older people's interactions with technologies. Have you ever heard of older people complaining about the small size of mobile phones, or struggling to use the mouse? Moreover, if they find it difficult to access digital resources, how (and why) would they want to engage in digital content creation activities? In light of the interaction issues they are faced with, which sometimes become impossible barriers to cross, it is reasonable to assume that their ICTs use is more limited and/or poorer than that of other user groups (think, for example, how teenagers use smartphones). Accommodating for declines in functional capabilities in user interface design is therefore of paramount importance to make ICTs more accessible to older people and enable them to make the most of these technologies.

In this chapter we present selected key aspects of the PhD dissertation conducted by one of us (Ferreira 2015). We argue that characterizing older people as a heterogeneous group of consumers of digital content with a set of weaknesses/limitations is not enough to understand their relationship with ICTs, since people with a profile similar to Maria's, a 73 year-old Spanish woman, have not received enough research attention. This chapter also claims that compensating for age-related changes in functional abilities is not sufficient to design ICTs that people like Maria would want to incorporate in their everyday lives. Who is Maria? She lives in a flat in Barcelona, visits her grandchildren during the weekends and keeps in touch with her children, who lead a hectic lifestyle and are living in towns nearby, via e-mail, Facebook and WhatsApp. Maria started to learn computers and the Internet around 8 years ago. Currently, she has experienced changes in her vision, sometimes forgets things, such as the name of a person she has recently met or where she has left her keys at home. Maria also acknowledges that learning a new computer program is becoming a more and more challenging task. Maria makes her own digital videos of her trips—not without difficulties, though. She still does not remember all the steps to take in order to transfer video files from her tablet to her desktop computer. How does Maria fit in the current views of older people within HCI? How can the 'downside of ageing' (Rogers et al. 2014) approach help us to design technologies that are not only accessible and usable, but also meaningful in her life?

This study draws heavily on an ethnographical study of ICTs use by approximately 220 older people conducted over a 5-year period in Barcelona (Spain). It also draws on two rapid ethnographical studies (Millen 2000), one conducted in Denmark and another in Brazil, over 4 and 2 months, respectively, with around 180 older people (90 in each study). The results shows how older adults with mild-to-moderate age-related changes in functional abilities can (and indeed, did) move from seeking online information, e-mailing and voicing similar attitudes towards a perceived lack of privacy in OSN, which are oft-reported tasks and interaction behaviours associated to older people in HCI, to engaging in not so widely reported activities, such as creating their own digital videos with contemporary technologies (i.e. not designed specifically for them, such as Windows Movie Maker) and exhibiting creativity while editing them. They used digital videos as a means of keeping in touch with trusted members of their social networks. They also showed remarkably similar interaction practices, such as a perceived need of taking control over 'who sees what' when they share digital media online, such as photos and videos, despite having different cultural backgrounds. By editing digital media with contemporary ICTs, and sharing it with those they care for, older people in Barcelona, Denmark and Brazil reported feeling more useful, socially and digitally included.

These results present an alternative view of ICTs use by older people that differs deeply from the one that emanates from how this user group is characterized within HCI. These results invite us to re-imagine HCI research with older people by reflecting upon, and questioning, for instance, the following issues:

- How older people are and should be conceptualised within HCI. While it is difficult to argue against the fact that they are a heterogeneous user group, this study claims that when their ICTs use as a group is examined from within, i.e. from ethnographical lenses and over prolonged periods of time, more similarities than differences as far as their concerns, attitudes and interaction practices are concerned can be found.
- The design space and approach. This study does not argue against the fact that some older people might need special tools. Yet, this study suggests that reframing the design space in terms of supporting and facilitating older people's creativity, which has mostly been overlooked, could potentially widen the design space, wherein compensating for the downside of aging will be just one (important) part of the task to design more usable, accessible and meaningful ICTs for (and with) this user group.

12.2 Related Work

Studies of digital content creation by older people are surprisingly rare. Surveys show that older people are "beginning to use social media more and more" (Hope et al. 2014) and increasingly adopt mobile phones (Ling 2008) and tablet PCs (Werner et al. 2012). Research studies suggest that recording and watching home videos might be a familiar activity for most older people (Chalfen 1988), and that "digital content production can provide important opportunities for older adults for social engagement and self-expression" (Waycott et al. 2013). Moreover, "news, public discussions and product marketing emphasize the possibility to have a video camera in settings and situations previously unlikely" (Lehmuskallio and Sarvas 2008), and "one only has to look at online repositories of video such as YouTube to begin to understand how growing access to digital video is widening participation in a new culture of video production, exchange and viewing" (Kirk et al. 2007).

However, previous studies that have examined (a) digital video practices by non-professionals (e.g., O'Connor and Fitzpatrick 2009; Lehmuskallio and Sarvas 2008), (b) emerging issues introduced by personal media (photos and videos) on the web, such as ownership and remix (e.g., Marshall and Shipman 2011, 2013), and (c) video-user generated content, such as popular videos and patterns of user participation (e.g., Cheng et al. 2013; Park et al. 2011), have not been conducted with, or have not considered, older people. An exception is an online survey in which 290 online Korean people aged 50+ participated, conducted by Ryu et al. (2009), who argued that the respondents reported being willing to adopt video creation services if some conditions, such as ease of participation, usefulness, and enjoyment were satisfied. Another exception are Harley and Fitzpatrick's studies (Harley and Fitzpatrick 2008, 2009), which analysed 8 videos generated and uploaded by an older person, Peter, also known as 'Geriatric1927' and the subsequent responses, arguing that intergenerational contact, reminiscence, reciprocal learning and co-creation of content, emerged from how the videos produced by Peter were used in YouTube.

Thus, there is room for claiming that little if anything is known about older people creation of digital content in their everyday lives. In this chapter, we aim to reduce this gap in knowledge by showing older people in Spain producing and appropriating of digital videos and participants in different settings engaging in digital content creation.

12.3 Methodology

We understand the way (older) people interact with ICTs as a socially constructed, dynamic and diverse cultural practice (Dourish 2004). Thus, we turned to ethnography (Fetterman 2010), as we consider that depth, natural settings, intensity, holism, non-judgmental orientations, and giving voice to people in their own local contexts, which are foundational elements of this way of looking, listening, thinking and writing about social phenomena, should (and could) help us reveal and explain older people's ICTs use.

The crux of this study is a 5-year (2010–2015) ethnographical study conducted in Àgora,[1] a 35-year old highly participatory adult learning community in Barcelona, Spain. Àgora provides free courses, which are mostly run by volunteers and adopts a dialogical learning approach (Aroca 1999), which empowers the students—using Àgora's terminology, participants—to decide what they want to learn. Over this period of time, the first author participated in 21 computer courses and 18 drop-in sessions, resulting in a total of 298 h of fieldwork with 217 older people (aged 60–85; women: 120; men: 97) with different levels of experience with ICTs. In these activities, older people interacted with several ICTs, such as desktop computers, tablets, mobile phones, e-mail, ONS and video editing platforms. Courses lasted up to 12 weeks and were run in weekly sessions of 2 h long. Workshops were usually run in a 2-h session. The first author either ran the sessions or helped the person in charge of them. Participants reported having been using computers and the Internet from three months up to eight years. Informal conversations revealed that they were born in different Spanish regions and had low levels of educational attainment (70% finished primary school).

Given that older people are often regarded as a very heterogeneous user group, we considered that doing fieldwork activities in countries with different levels of economic development could (and should) help us understand how similar or different their ICTs use is. This research was conducted in Casa do Idoso,[2] a centre where older Brazilian people take computer classes and carry out other social activities, such as handcraft courses or playing cards, and in three social centres[3] in Denmark in which computer sessions for older people are organized. In both studies, the first author conducted first-hand observations of, and conversations with, older people (78 in Brazil, and 79 in Denmark) while they were using computers and the Internet in the courses organized in the social centres. Most of the participants reported not holding a university degree. The first author took part in these activities by helping the person in charge of the courses. In both countries, she also carried out home-based interviews about older people's use of TV, mobile phones, tablets PCs, computers, Internet and opinions regarding iTV services. These interviews included 13 participants in each country and explored the opinions and ICTs use of older people that were not enrolled in computer classes in the social centres.

Fieldnotes were taken mostly immediately after the sessions in the courses, due to the active participation in most of them. Additionally, in the interviews the field-notes were taken in situ. The analysis followed the interpretation by Nigel Gilbert in

[1] Agora, Escola d'Adults de La Verneda-Sant Martí, Barcelona, Spain, http://www.edaverneda.org/.

[2] Casa do Idoso, São Jose dos Campos, Brazil, https://www.sjc.sp.gov.br/servicos/apoio-social-ao-cidadao/casa-do-idoso/.

[3] FoF, Aalborg, Denmark, http://www.fof.dk/AfdelingForside.aspx?enhed=1. Borger Datacenter (affiliated with Ældremobiliseringen), Jerslev, Denmark http://9740.dk/borgen.aspx.

Kastaniegården, Frejlev, http://aktivitetscentre.aalborg.dk/vest/kastaniegaarden.

Researching Social Life (Gilbert 2008) of Strauss and Corbin (Strauss and Corbin 1998) Grounded Theory's methodology.

After presenting the methodological approach and the environments where the fieldwork activities were conducted, we present the results next.

12.4 Results and Discussion

The results presented in this chapter center on the participants ICT use in their everyday lives. We focus on older people access, creation, and sharing of digital content, discussing their similarities and showing an active and positive use of technology. In the first section, we discuss the similarities on ICT use in the three settings. The second section show selected details on participants' video content creation practices in our main setting, Spain.

12.4.1 Their ICTs Use Is not so Heterogeneous as One Might Think

12.4.1.1 Similar Interests, Concerns and Interactive Practices

Despite the fact that our participants had different economic and cultural backgrounds, our results show similar interest and concerns in relation to their ICT use. The use of ICTs for communication, the concern with privacy and the interest for multimedia content stood out among the participants that use computers or mobile devices in the different settings.

Regardless of whether the participants were in a social or private environment, the results show them interacting with different devices to access and create digital information. In addition to using the desktop computers provided in the social centers, participants owned laptops, mobile phones, tablets, and digital cameras. The results show an increasing interest in mobile devices. Participants used different technologies according to their personal interests and/or situation (e.g., communication, access to information or digital media creation). Accessibility features of tablets and mobile devices, such as a simple learning curve and easily enlarging the fonts sizes, also facilitated the adoption and inclusion of new users. Next, we present more details on participants' interactions practices, interests, and concerns in the three settings.

12.4.1.2 Multimedia Content and Online Communication Channels

The use of ICT for communication and the use of multimedia was a key motivation for using ICT regardless if in a social environment or if learning independently. Creating and editing multimedia content was a frequent activity amongst all the Àgora participants, as well as a motivation for them to learn ICTs. Courses on MS Power Point, photo edition or calendar creation were part of the ICT activities organized in

Àgora. Most of the participants were also motivated to share the multimedia contents they created, as illustrated by this participant in an Introduction to ICT course, [72, M11][4]: (showing the researcher 4 calendars that he created with pictures) "*These two are very similar but the size of this file is smaller, which helps me to send the calendars by e-mail to the people that usually e-mail me*."

Online communication and working with multimedia content were also of great interest to the Casa do Idoso participants. From our observations and the inter-views with teachers, editing pictures was a source of motivation for them to keep learning about ICTs; namely, how to look for, edit and share online content with people they knew. The e-mail was the most popular Internet application amongst the least and more experienced Brazilian participants. Indeed, Facebook was the second most popular communication tool, especially among the participants with more experience with ICTs, who also used Skype for keeping in touch with family members living abroad. In the in situ interviews, 70% of the Internet users report-ed using the e-mail. Half of them reported using social network sites and Skype too.

Similarly, communication was key amongst Danish participants. Participants were highly motivated to use, and, indeed, often interacted with, online applications to keep in touch with close friends and relatives. All the participants reported using the e-mail in the in situ interviews. Halt of them (54%) also used Skype, and 38% claimed to use OSN. Editing personal photographs on the computer was a very popular activity too. This popularity manifested itself in the activities carried out in the center, such as photo edition and creation of MS Power Point presentations, and it was confirmed in our conversations with the instructors and participants. The main reasons for editing and creating multimedia content can be divided into three categories: (a) keeping a digital record of the family to be circulated amongst the younger generations, such as grandchildren, (b) keeping memories of trips and (c) digitizing paper-based materials related to their hobbies or interests. 61% of the participants pointed out during the interviews that they edited photographs at home as well.

12.4.1.3 Privacy

As one may expect, privacy concerns were highlighted and discussed in all studies. All Spanish participants reported feeling uncomfortable with OSN when they were unsure about who could read their posts. Privacy was also an important concern amongst Brazilian participants. They needed to feel in control of the technology to decide who could see what. The comment from one participant in the in situ interviews is representative of that: [71, MbII] "*I use Facebook but not very often. When I receive something I answer, but adding things is very difficult for me and I don't do it. I don't know how it works well, so I avoid doing stupid things. I prefer to just see other people's contents. If you make your own things public…that is dangerous*." They did not feel comfortable when sharing content online with people

[4]The code for participants' identification consists of: (a) their age, (b) their sex (F. fe-male, M. male) and the ID that the fieldworker assigned to them.

they did not know—close groups were preferred (e.g., friends on Skype, Facebook or sending an e-mail to a group of people).

Similar issues were identified in the two centers in Denmark. All the instructors pointed out that privacy was an important concern amongst the Danish participants. They disliked the idea of not having control over what people could get to see and know about them online. They refused point-blank to publish content in OSN. They preferred private strategies of communication. As one of the participants put it in a semi-structured interview, [70, Fd15]: "*I don't use Facebook. It's dangerous. I tell my son to never ever put a picture of me on that. People should not put their personal things there, like if you are going to travel for example*."

We agree on the fact that age-related physically changes are different for each individual (Durick et al. 2013), and that different aspects should be considered when characterizing an older person besides her age, such as abilities, experiences and attitudes (Redish and Chisnell 2004). However, this study shows that older people with different cultural backgrounds and previous experience of using ICTs presented remarkably similar interaction practices, concerns, interests and needs in their use of ICTs. The participants appropriated popular contemporary ICTs to enrich aspects of their lives, such as OSN to keep in touch with family members and friends. Communication serves critical functions as we grow older (Nussbaum et al. 2000), and reducing social isolation and being closer to those one care for is important for (many) older people. Participants also expressed fairly similar concerns with respect to trust and the need of privacy online. Their life experiences are likely to play an important role in this finding, since the lessons learned over a person's lifetime determine to a great extent his or her current behavior. Yet, we found differences too (Ferreira et al. 2014). For instance, the high digitalization of public and private services in Denmark raised the urgent need of older people to access e-shopping or e-government digital applications. In the moment this re-search was conducted this issues was not so evident in Brazil, possible as a reflection on the different levels of digital technological development.

12.4.2 An Alternative View of ICT Use: Creative, Active and Positive Relationship with ICTs

In addition to their interest in accessing information online, our results show older people as active digital content creators. The results of the study in Spain portray older people as both consumers of digital content and active, creative makers of digital videos with contemporary video capturing, editing and sharing technologies. During the ethnographical study in Spain, we registered 320 videos produced by the participants (Ferreira et al. 2016). In keeping with their motivations and interests, 57.8% of them were about special events, such as birthday parties or trips, documenting memories of their relatives or their hobbies; 42.2% were about other events meaningful for them, such as neighborhood parties (Fig. 12.1) or AG activities; 38.7%

Fig. 12.1 Participant recording her partner in neighborhood event

of the videos were created with still images using a video-editing suite; 61.3% were recorded using camera phones, tablets or digital cameras. Next we present details on participants' motivation to create digital content, creativity and sharing practices.

12.4.2.1 Motivations and Creativity

By creating digital videos, our participants perceived that they could:

- Share with their relatives and friends key moments of special occasions, such as a trip around the Mediterranean: "*I want to create a video with the photos I took with my digital camera during my trip with my friends and partner in Tunisia. We had such a great time. I want to burn the video into a DVD and give it to them*" [75, M3].
- Keep alive memories of their relatives, especially those who were deceased, and share these memories with other family members: "*I've created a video about my family. I've got many pictures of my family, old ones, from people that are already dead, and more recent ones, from the new generation. One day I came up with the idea of creating a video representing my family tree and passing it on to the youngest members of my family*" [75, M27].
- Take forward their journey towards ICTs proficiency: "*The good thing about creating videos is that there are many effects and cool things (…) there is always something new to learn*" [68, M28].

- Feel more socially included, "*Nowadays, it's important to know how to use computers in order not to be excluded from society*" [63, F13].

The first important results that our ethnographic study helps us to identify are the importance of an event, documenting family history, and achieving personal objectives that made digital videos relevant for our participants and encouraged them to engage in digital video production. Keeping and sharing memories have motivated older people with different cultural backgrounds to engage with user-generated content (Karahasanović et al. 2009; Harley and Fitzpatrick 2008). Recording events also motivated adult people in families to find value in digital videos (Kirk et al. 2007). By contrast, attaining personal objectives, such as learning more about ICTs, and feeling more socially included, seem to be more specific motives of our participants. Their videos going viral was not among our participants' motivations for producing them. However, "35% of (American) adults who post videos online have posted a video with the hope it will be seen by many people or going viral" (Purcell 2013). These differences in aspirations might be due to the setting where we conducted our study and the profile of our participants.

All participants, regardless of being more or less familiar with ICTs, showed a high level of creativity while editing videos. Participants with more video editing experience tended to explore the editing tools (e.g., advanced options), while those with less experience used the most basic functions. Yet, participants' creativity showed up in the selection of tools, topics, animations, colors, fonts and music.

12.4.2.2 Controlled and Meaningful Sharing

There is room for thinking that privacy concerns could have hindered or prevented the social appropriation of digital videos from happening. Yet, participants adopted three different strategies for sharing videos in a controlled and meaningful way.

Co-located One-to-One and One-to-Few. The content of the video was personal and shared with people participants knew well. For example, participants put videos on USB drives or DVDs and passed them on to relatives: "*This weekend I'll visit my son, he has a modern TV. I'll bring the pen drive to show him the videos I made in the course on his TV*." [75, M41]

Online One-to-One and One-to-Few. An alternative sharing strategy was observed when participants created a video and wanted their friends and family members to watch it. The most common way of sharing the video was to send the file via e-mail, either as an attachment or a link using file transfer tools (e.g., WeTransfer). The more experienced participants shared videos via WhatsApp too: "*Look, this is the video I recorded from the lunch last weekend (showing the video in a WhatsApp conversation). I sent it to my partner's son, who was also there. He told me that he liked it a lot*." [75, M3]

One-to-Many in SNS. Only those participants who had more practical knowledge of ICTs shared videos on SNS, especially through Facebook. They did so by uploading videos in their profile pages or on their friends' walls. The videos shared were mostly related to artistic presentations, such as a typical Spanish dance. Participants pointed out that sharing these videos on SNS allowed them to reach people that could be interested in them in a non-intrusive way. E-mails were not considered appropriate for doing so: "*I give the name of my YouTube channel to people, so if they want, they can go and watch the videos. This way, I don't have to e-mail them every time I create and upload a video. If their friends are also interested in the videos, they can also watch it, I don't mind. These videos aren't private*." [74, M2]

Thus, participants came up with their own solutions to share digital videos in a controlled and meaningful way. These different sharing strategies reinforce the creativity found in digital video production and had a positive impact on their perceived wellbeing.

Whilst "current research concerning design technologies specifically for older adults often focuses on providing access to digital resources, rather than creating and sharing their own content" (Waycott et al. 2013), this study portrays older people as both consumers of digital content and active, creative makers of digital videos with contemporary video capturing, editing and sharing technologies. This study shows a social appropriation of digital videos in which these artefacts become meaningful objects within inter- and intra-generational communication, and where privacy, controlled and meaningful sharing strategies play a key role in the acts of appropriation. These results show an alternative, more positive and active view of ICTs use by older people, and prompt us to suggest that there is room for re-framing the relationship between them and ICTs in a different way. In addition to accommodating for age-related changes in functional abilities and helping them to access to digital resources, tapping into older people's creativity and seeing them as (potentially) digital content creators can (and should) inform the design of (usable and accessible) ICTs that enrich their everyday lives.

Central to the contributions this research is the fact the relationship between the participants and ICTs can be regarded as positive. They are interested in incorporating ICTs into their everyday lives, sign up for courses on computers and the Internet and even agree to take part in research activities aimed to understand their ICTs use. On the one hand, this positive view differs greatly from the negative one that dominates HCI. On the other hand, however, it reinforces an emerging strand of research aimed to capitalize on the strengths of older people and positive aspects of ageing. Noteworthy examples of this research strand are (Rogers and Marsden 2013), who draw attention to the need of moving beyond the "rhetoric of compassion", in which the focus is on providing for a lack of something, to an approach that promotes empowerment through technology, and (Carroll et al. 2011), who regard ageing as a resource, and argue that "Technology can improve the quality of life for elderly persons by supporting and facilitating the unique leader-ship roles that elderly play in groups, communities, and other organizations."

12.5 Conclusions

From the results of these studies we observed that older people ICTs use is not so heterogeneous as one might think. The results show that older people with different cultural backgrounds and previous experience of using ICTs presented remarkably similar interaction practices, concerns, interests and needs in their use of ICTs. Participants appropriated popular contemporary ICTs to enrich aspects of their lives, such as OSN to keep in touch with family members and friends. Communication serves critical functions as we grow older, and reducing social isolation and being closer to those one care for is important for (many) older people. Participants also expressed fairly similar concerns with respect to trust and the need of privacy online.

Furthermore, in this chapter we show an alternative view of older people ICT use: creative, active and positive relationship with ICTs. Our results portray older people as both consumers of digital content and active, creative digital content creators. Participants in the three countries used contemporary technologies to capture, edit and share content such as photographs, videos, digital cards or text messages.

Contrary to the most predominant approach—focused on compensating for age-related changes in functional abilities—within HCI, the results presented have portrayed older people with mild-to-moderate age-related changes in functional abilities as active, creative, and social ICTs users. This alternative view reinforces and extends previous works, which proposed a change in the paradigm in HCI research with older people, moving from compensating from diminishing abilities to understanding their real-life use of ICTs, promoting empowerment through technology and seeing ageing as a resource. This study contributes to this research strand by (i) detailing the digital content production (namely, videos) of older people, (ii) showing more similarities than differences in their interaction practices, and (iii) revealing their appropriation of digital videos.

Acknowledgements We thank all the participants, volunteers and members of the staff of Àgora, Caso do Idoso, Borger and FoF for their participation in our research

References

Aroca MS (1999) La Verneda-Sant Martí: a school where people dare to dream. Harv Educ Rev 69(3):320–335

Carroll JM, Convertino G, Farooq U et al (2011) The firekeepers: aging considered as a resource. Univ Access Inf Soc 11(1):7–15. https://doi.org/10.1007/s10209-011-0229-9

Chalfen R (1988) Home video versions of life—anything new? Soc Vis Anthropol Newsl 4(1):1–5. https://doi.org/10.1525/var.1988.4.1.1

Cheng X, Liu J, Dale C (2013) Understanding the characteristics of internet short video sharing: a YouTube-based measurement study. IEEE Trans Multimed 15(5):1184–1194. https://doi.org/10.1109/TMM.2013.2265531

Czaja SJ, Lee CC (2007) The impact of aging on access to technology. Univ Access Inf Soc 5(4):341–349. https://doi.org/10.1007/s10209-006-0060-x

Dourish P (2004) Where the action is: the foundations of embodied interaction. MIT Press, Cambridge

Durick J, Robertson T, Brereton M et al (2013) Dispelling ageing myths in technology design. In: Proceedings of the 25th Australian computer-human interaction conference on augmentation, application, innovation, collaboration—OzCHI 2013. ACM Press, pp 467–476. https://doi.org/10.1145/2541016.2541040

Ferreira SM (2015) An alternative view of ICTs use by older people in human-computer interaction. Similarities, digital content creation and perceived well-being. PhD Dissertation. Universitat Pompeu Fabra

Ferreira SM, Sayago S, Blat J (2014) Towards iTV services for older people: exploring their interactions with online video portals in different cultural backgrounds. Technol Disabil 26(4):199–209. https://doi.org/10.3233/TAD-140419

Ferreira SM, Sayago S, Blat J (2016) Older people's production and appropriation of digital videos: an ethnographic study. Behav Inf Technol 36(6):557–574. https://doi.org/10.1080/0144929X.2016.1265150

Fetterman, D (2010) Ethnography: step-by-step. Sage, Thousand Oaks

Gibson, L, Moncur, W, Forbes, P et al (2010) Designing social networking sites for older adults. In: Proceedings of the 24th BCS interaction specialist group conference. Br Comput Soc, pp 186–194

Gilbert, N (2008) Researching social life. Sage, London

Gilleard, CJ, Higgs, P (2000) Cultures of ageing: self, citizen, and the body. Prentice Hall, New York

Harley D, Fitzpatrick G (2008) YouTube and intergenerational communication: the case of Geriatric 1927. Univ Access Inf Soc 8(1):5–20. https://doi.org/10.1007/s10209-008-0127-y

Harley D, Fitzpatrick G (2009) Creating a conversational context through video blogging: a case study of Geriatric 1927. Comput Hum Behav 25(3):679–689. https://doi.org/10.1016/j.chb.2008.08.011

Hope, A, Schwaba, T, Piper, A M (2014) Understanding digital and material social communications for older adults. In: Proceedings of the 32nd annual ACM conference on human factors in computing systems—CHI 2014. ACM Press, pp 3903–3912. https://doi.org/10.1145/2556288.2557133

Karahasanović A, Brandtzæg PB, Heim J et al (2009) Co-creation and user-generated content–elderly people's user requirements. Comput Hum Behav 25(3):655–678. https://doi.org/10.1016/j.chb.2008.08.012

Kirk, D, Sellen, A, Harper, R et al (2007) Understanding videowork. In: Proceedings of the SIGCHI conference on human factors in computing systems—CHI 2007. ACM Press, p 61. https://doi.org/10.1145/1240624.1240634

Lehmuskallio, A, Sarvas, R (2008) Snapshot video: everyday photographers taking short videoclips. In: Proceedings of the 5th Nordic conference on human-computer interaction building bridges—NordiCHI 2008. ACM Press, p 257. https://doi.org/10.1145/1463160.1463188

Leme RR, Zaina LAM, Casadei V (2014) Interaction with mobile devices by elderly people: the Brazilian scenario. In: ACHI 2014, The seventh international conference on advances in computer-human interactions, pp 21–26

Ling R (2008) Should we be concerned that the elderly don't text? Inf Soc 24(5):334–341. https://doi.org/10.1080/01972240802356125

Marshall CC, Shipman FM (2011) The ownership and reuse of visual media. In: Proceeding of the 11th annual international ACM/IEEE joint conference on digital libraries—JCDL 2011. ACM Press, p 157. https://doi.org/10.1145/1998076.1998108

Marshall CC, Shipman FM (2013) Saving, reusing, and remixing web video: using attitudes and practices to reveal social norms. In: Proceedings of the 22nd international conference on World Wide Web. ACM Press, Rio de Janeiro, pp 885–896

McGee-Lennon MR, Wolters MK, Brewster S (2011) User-centred multimodal reminders for assistive living. In: Proceedings of the 2011 annual conference on Human factors in computing systems - CHI '11. ACM Press, p 2105. https://doi.org/10.1145/1978942.1979248

Millen DR (2000) Rapid ethnography: time deepening strategies for HCI field research. In: Proceedings of the conference on designing interactive systems processes, practices, methods, and techniques—DIS 2000. ACM Press, pp 280–286. https://doi.org/10.1145/347642.347763

Mosberg Iversen S (2014) Play and productivity: the constitution of ageing adults in research on digital games. Games Cult 11(1–2):7–27. https://doi.org/10.1177/1555412014557541

Nussbaum, JF, Pecchioni, LL, Robinson, JD et al (2000) Communication and aging. Routledge, New York

O'Connor C, Fitzpatrick G (2009) Making video mundane: intellectual disability and the use of camcorders. Pers Ubiquit Comput 14(3):197–208. https://doi.org/10.1007/s00779-009-0258-z

Park N, Jung Y, Lee KM (2011) Intention to upload video content on the internet: the role of social norms and ego-involvement. Comput Hum Behav 27(5):1996–2004. https://doi.org/10.1016/j.chb.2011.05.006

Purcell, K (2013) Online Video 2013. Pew Research Center, Washington, DC. http://www.pewinternet.org/2013/10/10/online-video-2013/. Accessed 14 Nov 14 2018

Redish JG, Chisnell D (2004) Designing web sites for older adults: a review of recent literature, Prepared for AARP December 2004. http://assets.aarp.org/www.aarp.org_/articles/research/oww/AARP-LitReview2004.pdf. Accessed 14 Nov 2018

Rodríguez MD, Gonzalez VM, Favela J et al (2009) Home-based communication system for older adults and their remote family. Comput Hum Behav 25(3):609–618. https://doi.org/10.1016/j.chb.2008.08.017

Rogers, Y, Marsden, G (2013) Does he take sugar? Moving beyond the rhetoric of compassion. Interactions 20(4):48. https://doi.org/10.1145/2486227.2486238

Rogers Y, Paay J, Brereton M et al (2014) Never too old: engaging retired people inventing the future with MaKey. In: Proceedings of the 32nd annual ACM conference on human factors in computing systems—CHI 2014. ACM Press, pp 3913–3922. https://doi.org/10.1145/2556288.2557184

Ryu MH, Kim S, Lee E (2009) Understanding the factors affecting online elderly user's participation in video UCC services. Comput Hum Behav 25(3):619–632. https://doi.org/10.1016/j.chb.2008.08.013

Sayago S, Forbes P, Blat J (2012) Older people's social sharing practices in YouTube through an ethnographical lens. In: Proceedings of the 26th annual BCS interaction specialist group conference on people and computers. British Computer Society, pp 185–194

Strauss A, Corbin J (1998) Basics of qualitative research: techniques and theories for developing grounded theory. Sage, Thousand Oaks

Vines J, Pritchard G, Wright P et al (2015) An age-old problem: examining the discourses of ageing in HCI and strategies for future research. ACM Trans Comput Hum Interact 22(1):1–27. https://doi.org/10.1145/2696867

Waycott J, Vetere F, Pedell S et al (2013) Older adults as digital content producers. In: Proceedings of the SIGCHI conference on human factors in computing systems. ACM (CHI 2013), pp 39–48. https://doi.org/10.1145/2470654.2470662

Werner F, Werner K, Oberzaucher J (2012) Tablets for seniors–an evaluation of a current model (Ipad). In: Wichert R, Eberhardt B (eds) Ambient assisted living. Springer, Berlin Heidelberg, pp 177–184

Susan M. Ferreira conducted ethnographical research with older people for 5 years in different cultural settings, such as Spain, Brazil, and Denmark, while doing her PhD. She holds a PhD Cum Laude in Computer Science and Digital Communication by Universitat Pompeu Fabra (2015). Susan was a Post Doctoral Fellow at the LICEF Research Center (Laboratory of Cognitive

Computing and Learning Environments) at Télé-Université of Quebec, Canada (2015–2017). Her current research interests are HCI and user experience in digital products.

Sergio Sayago (Ph.D., Human-Computer Interaction/Computer Science, Universitat Pompeu Fabra, Barcelona) has been conducting HCI research with older people since 2004. He has conducted long-term ethnographic, participant observation and co-design studies of real-life web accessibility (WCAG) and technology use, mostly communication and digital games, in different cultural settings. His current research focuses on long-term empowerment and democratization, addressing making, programming, and (embodied) conversational interfaces, with older and adult people with low levels of formal education.

Josep Blat (Ph.D., Mathematics, Heriot-Watt University, Edinburgh) is Professor of Computer Science at Universitat Pompeu Fabra, Barcelona and director of the GTI research group (https://www.upf.edu/web/gti). His current research includes advanced 3-D graphics (human modeling, animation and rendering, games), human-computer interaction (older people, ethnography, geolocation, wearables). Previously, he worked in applied nonlinear analysis, mathematical analysis of images and technology-enhanced learning.

Chapter 13
Designing Computer-Supported Technology to Mediate Intergenerational Social Interaction: A Cultural Perspective

Francisco J. Gutierrez, Sergio F. Ochoa, Raymundo Cornejo and Julita Vassileva

13.1 Introduction

Recent studies show that the penetration of social media has changed the way in which people interact with each other. It has also inadvertently increased the risk of social isolation among older adults, given that most of them are not able to adopt such a technology (Hope et al. 2014). This situation has weakened their links with the rest of their social network, which is mainly composed by their family members (Dickinson and Hill 2007).

The design of ad hoc technology that facilitates the social inclusion of older adults appears as a potential solution to mitigate the negative effects of isolation (Chen and Schulz 2016). However, and despite the increasing number of advances in this field, it is still not evident how to design effective computer-based technology that supports intergenerational social interaction from and to older adults.

The main limitations to conceive effective designs are the diversity of interaction contexts to be addressed and the lack of contextualized design knowledge to be reused. Although recent literature reports several design guidelines to support

F. J. Gutierrez (✉) · S. F. Ochoa
Department of Computer Science, University of Chile, Santiago, Chile
e-mail: frgutier@dcc.uchile.cl

S. F. Ochoa
e-mail: sochoa@dcc.uchile.cl

R. Cornejo
Faculty of Engineering, Autonomous University of Chihuahua, Chihuahua, Mexico
e-mail: rcornejo82@gmail.com

J. Vassileva
Department of Computer Science, University of Saskatchewan, Saskatoon, SK, Canada
e-mail: jiv@cs.usask.ca

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_13

interaction with older adults, most of them do not indicate the context in which they are effective. Guidelines focused on the design of user interface elements that address the effects of age-related changes in functional abilities of older adults are typically reusable. However, the design knowledge to support interaction among human beings tends to be less reusable, since people behave differently in particular socio-cultural scenarios. Recognizing the diversity of intergenerational social interaction scenarios, culture appears as a design dimension that should be considered when conceiving new technology and when envisioning the reuse of existing HCI knowledge. The relevance of this design dimension is recognized in contemporary HCI research, as computers are being used by people with different cultural profiles.

This chapter shows the main challenges involved in the design of computer-supported technology to mediate intergenerational social interaction. It also shows the relevance of considering culture as a key factor to conceive these solutions and reuse the design knowledge gained during the last two decades of HCI research with older people. In order to illustrate the impact of considering the cultural aspect in these designs, the relevance of requirements and design aspects reported in the literature are analyzed from a Latin American and Western countries perspective.

The next section presents a general description of the process to design and evolve interaction technology considering the cultural perspective. Section 13.3 then discusses the related work on the design of social interactive systems for older adults and the challenges to mediate intergenerational communication. Section 13.4 explores, from a cultural perspective, similitudes and differences in the intergenerational social interaction process, considering typical behavior of older adults living in Latin American and Western countries. Finally, Sect. 13.5 presents the conclusions.

13.2 Design and Evolution of Social Interaction Technology

The complexity of designing this kind of ad hoc technology lies in several factors related to direct and indirect users, where culture is one of them. For instance, in the case of Latin American countries, the social interaction of older adults is almost exclusively conducted with other family members and it involves formal and informal roles, activities, needs, and agreements among the participants (Gutierrez and Ochoa 2016). Such a process takes several formats and its components vary according to the context in which the social interaction should be supported (Bardis 1979). Consequently, the interaction process with older adults becomes diverse in terms of their goals and involves complex social structures that are also diverse and evolve over time. Therefore, technology conceived to assist such a process should not only consider the cultural traits, but also be context-aware (e.g., to consider the social network structure) to keep or increase its effectiveness over time.

The application context shapes particular social processes according to features of the participants (e.g., their culture, age, habits, practices, and socio-economic level) as well as the social structures in which they participate (e.g., if they are single, married, or if they have children or not). As depicted in Fig. 13.1, the contextualized social process and the application context are used to inform the design of the interaction

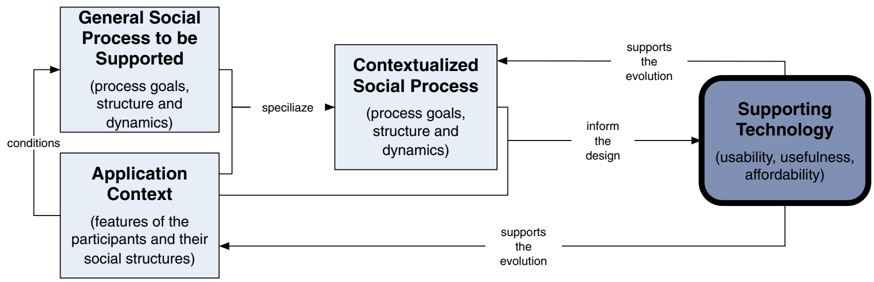

Fig. 13.1 Interaction technology design and evolution

technology that should be usable, useful, and affordable for direct and indirect users. In the case of mediating intergenerational communication, direct users are typically older adults, whereas the indirect users comprise the rest of their supporting social networks (e.g., children and grandchildren).

The features of the social interaction process and application context evolve over time due to several reasons, for instance, due to the natural decrease of the physical and cognitive capabilities of the older adults, or the learning and technology appropriation experienced by them. Therefore, interaction technology that was suitable for the users at a certain time period becomes unsuitable if it is not able to keep pace with the social process and context evolution. This aspect increases the complexity of designing interaction technology for this scenario.

Another factor that increases the complexity of modeling these ad hoc systems is the small amount of contextualized design knowledge (e.g., guidelines or design components) available for being reused; particularly, considering cultural aspects. Most knowledge in this design domain is focused on the reality of Western countries and framed in particular processes, like caregiving (Consolvo et al. 2004) or social interactions between grandchildren and grandparents (Forghani and Neustaedter 2014). Moreover, much HCI research in this domain does not explore the suitability of this design knowledge in other cultural scenarios, thus limiting its reusability. Understanding the cultural aspects involved in these designs and identifying similitudes and differences in users behavior among several cultures, could allow us to conceive the next generation of technology for this application domain.

13.3 Designing of Intergenerational Social Interactive Systems

The design of these interactive systems must respect the underlying social protocol and also the interests, expectations, and restrictions of the involved people. Furthermore, this design should focus on conceiving the application to be used by the older adults and allow the rest of family members to interact with them using regular interaction systems. Next sections discuss the related work on modeling of these systems for older adults and then explore the challenges on mediating intergenerational communication.

13.3.1 Modeling Interaction Systems for Older Adults

Considering older adults in the design of computing-based interaction systems is complex, since multiple human and cultural factors must be addressed and go beyond a mere characterization of their limitations caused by age or health conditions (Lindley et al. 2008). Indeed, older adults might be able to learn and overcome media literacy issues (Harley and Fitzpatrick 2009), thus effectively evading the negative effects derived from social isolation. Although older adults can become active users of digital technologies (Bell et al. 2013; Waycott et al. 2013), the design of these tools should be integrated into their particular sociocultural context, aiming to facilitate their acceptance and appropriation. For instance, the use of common online spaces allows family members to share their values and attitudes, as well as strengthening the ties across generations (Siibak and Tamme 2013).

After conducting a review of empirical research on technology acceptance by older adults, Chen and Chan (2011) conclude that TAM2—Technology Acceptance Model—(Venkatesh and Davis 2000) can help predict the acceptance level of a particular technology for older adults. Consequently, and assuming affordability of such a technology, its perceived usefulness and the perceived effort required to use it should be the main concerns of designers.

These general design concepts group a set of functional and quality requirements that should be addressed in different ways depending on each application domain; e.g., the process to be supported and the application context, including the characteristics of end users. This means that the design of this technology can follow some general rules, but it should consider the particularities of the application domain where it is going to be used. Supporting this claim, Schulz et al. (2013) state that the successful design of technology for older adults depends on considering "the interplay of three important factors: (a) characteristics, needs, and preferences of the end user; (b) features of the technology; and (c) societal factors including social, health care, and regulatory policies" (p. 364). Moreover, the authors indicate that this technology design needs to address transversal quality requirements, like usability, reliability, affordability, ease to learn, engagingness, and cost effectiveness, which also depend on the scenario in which such a technology is going to be used. Following the same line of reasoning, and after conducting a survey of related studies, Lee and Coughlin (2015) identify ten factors as the facilitators or determinants of older adults' adoption of technology: value, usability, affordability, accessibility, technical support, social support, emotion, independence, experience, and confidence. Once again, these pieces of research illustrate the complexity of designing ad hoc technology for this target population.

Furthermore, related literature also reports general and specific guidelines to design technology for older adults. Among the general guidelines are, for instance, the seven principles for designing for aging proposed by José Colucci (Lynch 2015): respect the individual, ease the transition, do not help more than what is required, promote empathy, encourage fresh thinking, and promote connection. There are also a number of guidelines to design of Web-based user interfaces for older adults, like those proposed by Kurniawan and Zaphiris (2005) and the World Wide Web Consortium (2008).

Although useful, these principles require being instantiated to each particular situation and culture in order to make them useful for informing the design of a particular system. Likewise, specific design guidelines are usually reported in conference and journal articles that provide suggestions for addressing specific processes in particular contexts. Although valuable, these guidelines are quite spread in several sources and the studies are poorly interconnected among them, which makes the reuse of the findings difficult. Moreover, such proposals count on few or short-term validation, and typically do not describe in detail the application context (particularly culture) for which they are proposed.

Given the uncertainty inherent to the design of these systems and the complexity of the process, it is not surprising the huge popularity that ethnography (Sayago et al. 2011, Ferreira et al. 2016, Gutierrez and Ochoa 2017) and participatory design (Cornejo et al. 2013, Muñoz et al. 2015) showcase for addressing this challenge. Particularly, participatory design involves the technical team and the stakeholders—mainly the end users—in an evolving design process based on the development of the system prototypes (Ehn and Kyng 1987; Leitch and Warren 2010). This design strategy covers the technical and socio-organizational aspects of the solution (Hirschheim et al. 1995). Although literature reports a long list of drawbacks related to the use of participatory design (Pekkola et al. 2006; Bratteteig and Wagner 2016), it seems to be the best option to address the design of these systems (de Angeli et al. 2014). This lack of alternatives to deal with this design challenge has focused the research efforts on understanding the target population, the processes to be supported, or the technology adoption and usage, hence informing the design of new or more effective interaction technology.

13.3.2 Challenges on Mediating Intergenerational Communication

The design of technology that mediates intergenerational communication requires not only understanding the older adults, but also considering the whole social ecosystem around them. As mentioned before, the behavior of this ecosystem depends, among other things, on the culture.

It is well known that older adults typically do not have broad access to modern technologies, or they find them difficult to use (Hope et al. 2014), and that situation generates loneliness and an increased longing to communicate or interact with family or friends (Forbes 1996; Newall et al. 2009). The proliferation of devices supporting ubiquitous access to communication technologies, and the prevalence of social media for connecting with family and friends challenge older adults when they intend interact with their younger relatives who use such technologies (Lindley et al. 2008, 2009; Moffat 2013). Consequently, they need support and guidance to face the new communication media in a pleasant way (Roupa et al. 2010), and in finding alternatives to allow them to be part of the intergenerational social space, where digital media play a key role.

When supporting intergenerational communication between older adults and their closer relatives, an asymmetrical pattern emerges. In fact, the grandparent-grandchild bond is an important emotional relationship in a human's life and very close to the parent-child bond. A strong relationship between grandparents and grandchildren benefits both parties, but the lack of technological support makes this relationship more difficult to build and maintain (Ballagas et al. 2009).

This asymmetry in the communication patterns is also expressed in terms of the media preference of both parties in the process. This preference can be explained by the technical abilities or merely comfort of the involved party in the communication (Forghani and Neustaedter 2014; Lindley et al. 2008).

Through observing and interviewing members in Chilean and Argentinian family networks, Gutierrez and Ochoa (2016) identified that informal communication asymmetries are mainly expressed in terms of: (1) the different media that family members are capable or prefer to use; (2) the available time periods for engaging into social communication with other parties; and (3) the perceived willingness to initiate a particular social interaction with another family member. In that respect, asymmetries need to be addressed when the social interaction space of one family member (e.g., who takes the initiative to interact) does not match the social interaction space of a fellow family member (i.e., the target people). For instance, different family members usually prefer different communication media to interact; e.g., telephone calls, email, social networking services, or other messaging tools. Respecting these preferences is part of what is required to design accurate and effective ICT-based solutions (Muñoz et al. 2015).

Although promoting social interaction among family members is a commendable objective, such interaction must not overwhelm people having little time for socializing. Therefore, effective mediation strategies should intelligently coordinate all the members in a family community based on specific criteria, such as location, time of the day, and available communication media to support the interaction. This necessarily implies that such mediation process should be adapted to both, the individual's interests and those shared among groups of his/her network. Supporting technology deployed in domestic settings should not be excessively intrusive as well. For instance, computer-based solutions based in habituated objects (Brereton 2013; Brereton et al. 2015) and extending design metaphors of common objects into the physical world (Cornejo et al. 2013; Garattini et al. 2012; Lindley 2012; Muñoz et al. 2015) have been proven effective for increasing technology adoption and appropriation by older adults. Similarly, using passive monitoring in lieu of instrumenting the older adults' house with sensors can be effective for dealing with technology reluctance.

Besides, the computer-mediated system should not be too proactive, since people will eventually refuse to react when there is no urgency. In fact, understanding the social, technological and cultural context of the involved people is fundamental to ensure the success of the mediation. Furthermore, this coordination process should be able to identify whenever family members need to be persuaded in order to engage in social interaction.

As stated before, the design of computer-mediated communication technology has not generally acknowledged the complexity and heterogeneity of the informal care provision to older adults (Procter et al. 2014). Fischer and Herrmann (2015) refer to this situation as a "Universe of One" problem, in which a solution for one person will rarely generalize to a broader population. Therefore, a plausible option to deal with this situation is to support meta-design, i.e., an approach where users act as designers in a scenario where technology gets embedded into the socio-technical environment to be deployed. Consequently, the latent needs of both older adults and the rest of their family network are addressed in the design process.

13.4 On the Influence of Culture in Mediating Intergenerational Communication

Recently, a lot of efforts reported in HCI literature have been devoted to exploring how family members interact using computer-mediated mechanisms. Particular topics of interest are: understanding the attitudes and needs of different generations around digital communication, and how to design ICT-based technology to support and integrate the elderly into the family rituals and routines. However, most of these research works are grounded in the reality of Western countries (i.e., North America and Western Europe), which do not necessarily transfer to the reality of other social groups, since people follow different behavior patterns or respect codes depending on their culture. Next, we briefly describe several aspects of the intergenerational family communication process in Western and Latin American countries, and then summarize and discuss similitudes and differences.

13.4.1 Intergenerational Family Communication in Western and Latin American Countries

With the proliferation of social media and ubiquitous technology for supporting communication with family and friends, it is likely that older adults face increasing challenges when interacting with their younger relatives, who typically use those kinds of supporting technology to socialize (Lindley et al. 2008). When looking deeper into family communication practices, some forms of interaction do not necessarily involve an explicit sharing of messages between older adults and their close family members, but rather an ongoing awareness of the other party's communication state (Riche and Mackay 2010). In other words, people actually use both personal and environmental cues to help the other communication party understand what is happening. As discussed in the previous sections, the design of supporting technology in this application scenario is highly dependent on the socio-cultural traits in which the intended technology will be deployed, as a way to actively support technology acceptance and appropriation. Next we present a list of features of this social process that influences the design of technology for both cultural scenarios.

Intra-family communication. Intra-family communication, particularly with older adults, is perceived as different in individualistic and collectivistic cultures. For instance, while grandparents in individualistic cultures do not typically have as much contact with their grandchildren as they would like (Harwood and Lin 2000), they may "view the exercise of familial obligation as an assault on their dignity and moral worth" (Lindley et al. 2008, p. 77). Older adults in Latin America, which is predominantly a collectivistic culture, still benefit from being considered by their family members as a fundamental pillar in the family structure. In this latter case, adult children are usually prompted to support their older parents following a personal commitment that is grounded in affection (Stuifbergen et al. 2008). Frequently older adults—particularly women—take care of their grandchildren or collaborate in the parenting activities which strengthen the affective bound among them (Redondo et al. 2015).

Autonomy and Independency of Family Members. According to Kennedy and Wellman (2007), in developed countries, such as urban Canada, family members have found different means to live their own lives while staying more connected. This way of living is partially attributed to the high penetration and adoption of ICTs and the tremendous mobility and reduced family size in Western countries that leads then to a reduced assumption of intergenerational social interaction commitment, when compared to what would be expected in a typical Latin American family. Conversely, in collectivistic societies (e.g., Asia and Latin America), where people are raised and continuously encouraged to support each other, the notion of family has a central role in society. Therefore, the need for autonomy and independence is lower, but it increases in younger family members.

Privacy. The literature reports this aspect as highly valuable in Western countries (Caine et al. 2006; Huber et al. 2013; Mynatt et al. 2004; Vines et al. 2013), not only for older adults but also for the rest of the family ecosystem. In the case of the Latino culture, such an aspect is much more relaxed and practically non-existent among older adults (Gutierrez et al. 2017). This can be explained by the close relationship that people usually keep with other family members. In the case of teenagers, they typically demand high privacy in both scenarios.

Interaction Preferences and Routines. Communication asymmetries are mainly grounded in the types of interaction paradigms preferred by the participants (e.g., face-to-face encounters, phone calls or asynchronous messaging) and also to the time periods liked to conduct synchronous interactions. These factors usually limit the interaction with older adults (Muñoz et al. 2015). However, the interaction routines also help reduce this problem, since they represent an informal agreement and trade-off between the preferences of the involved people. Adherence to interaction routines is important in both cultures (Lindley et al. 2008; Muñoz et al. 2015; Gutierrez and Ochoa 2016). However, in the Latino scenario it tends to be more required, particularly in interactions with the older adults, since the social process involves more communication. Concerning the respect for the people's interaction preferences, in Western countries it is more required and addressed than in Latin America. This could be explained because in individualistic cultures people are more aware of their own and the others' preferences, and also the interactions with the elderly tends to be peer-to-peer. In the Latino scenario, the assistance provided to the older adults frequently involves more than two people and several interactions among them (Gutierrez and Ochoa 2017), which sometimes jeopardizes the respect for their own and the others' preferences, given that they prioritize reaching the assistance goal.

Relevance of Regular Face-to-Face Encounters. While exceptions occur, Latin American families follow an interaction routine—grounded in tradition—that in most cases involves a weekly family reunion (Suárez 2004). These meetings take place in the home of a family member, usually the older adult or one of his/her adult children, uniting those who are available during the weekend. If these family meetings do not occur, or if their frequency is reduced, people miss them, particularly the elderly. By recognizing that this routine should be adjusted according to the intrinsic family evolution, most members value these opportunities to conduct face-to-face interactions (Gutierrez and Ochoa 2017). Likewise, current trends in intergenerational communication in Western countries shows several aspects that limit the possibility to perform regular face-to-face encounters, e.g., the high mobility of the people or the reduced time to interact with older adults. Consequently, technology-mediated interaction replaces partially or completely face-to-face encounters. The use of technology generates asymmetries in the preferences of the involved parties. For instance, according to Lindley et al. (2008), older adults prefer long synchronous exchanges (such as those supported by face-to-face encounters), while younger generations prefer short asynchronous exchanges (such as those mediated by instant messaging or social networking services).

Technology Adoption. As mentioned before, the adoption of interaction technology in Western countries is higher than in Latin America. It is not necessarily due to economic reasons, but instead caused by the need that they feel for taking advantage of it. Prior literature suggests that in developed Western countries this adoption is motivated by the interest of the elderly in staying in touch with other family members (Dickinson and Hill 2007; Lindley et al. 2008; Siibak and Tamme 2013), particularly with their younger relatives (Nef et al. 2013; Waycott et al. 2013) and grandchildren (Cornejo et al. 2013; Forghani and Neustaedter 2014; Lindley et al. 2008). Conversely, while older adults in Latin America show the same need (Barros et al. 2014), they do not perceive a benefit in adopting digital technology. The reason behind this attitude is that they manage their communication through mechanisms that are already assimilated by them (Gutierrez and Ochoa 2016). In fact, very few

Latin American older adults describe themselves as active users of social media or demonstrate comfort in using smartphones.

Stress and Burden of the Intergenerational Social Care Process. An important part of the social interaction with older adults is related to assist or socially care for these people. In both cultures, the literature reports that family members feel stress and burden when conducting these interactions (Gutierrez and Ochoa 2017; Papastavrou et al. 2007). In Latino culture, an important part of the process is usually conducted by family members through synchronous interactions (Barros et al. 2014; Redondo et al. 2015). The low technology adoption of the elderly conditions their adult children to use interaction means that are comfortable for the former, such as short visits and phone calls, hence restricting the available alternatives for the latter to deal with their filial obligation. This situation usually stresses and burdens those family members who are in charge of assuming and coordinating within the family network informal caregiving duties targeted to improve the wellbeing of their older adults. This situation is also present in Western countries (Papastavrou et al. 2007; Schorch et al. 2016) but probably in a lower frequency, since in individualist culture this process tends to be partially supported by external caregivers and the older adults are more autonomous.

In summary, although the findings obtained from studies in Western countries could help elucidate how family networks find their way to interact with their older adults in a broad sense, they are not necessarily representative of the Latino culture. The main reason that explains this contrast is the underlying attitude of adult children on fulfilling caregiving tasks in favor of their parents, which is perceived as stronger in collectivistic societies, and consequently the elderly frequently adopt a passive attitude, resting on the shoulders of their family networks. These differences imply that design guidelines of social interaction technology conceived for Western countries not only has to be tailored to Latino families, but also needs to acknowledge the potential involvement of a broader scope of family members.

13.4.2 Comparison of Both Scenarios

Table 13.1 summarizes the features of the intergenerational social communication shown in the previous section and compares these features for both scenarios in order to illustrate the relevance of culture in the design of these interaction systems. It is important to understand that the values assigned to each feature comes from behavioral patterns identified in Latin American or Western countries, but do not represent the reality of each social interaction scenario with older adults. In Table 13.1, the symbol ++ stands for very high, +: high, −: medium, and X: low. Using these symbols we characterize each aspect of the social interaction scenario to help understand the reusability level of the HCI design knowledge gained for each particular cultural domain.

Table 13.1 Features of the social interaction scenario under a cultural perspective

Features of the social interaction scenario	Latino scenario	Western countries
Feeling of filial obligation	++/+	−/X
Need of frequent interactions	++/+	−/X
Need of autonomy and independence	−/X	++/+
Need of privacy	−/X	++/+
Respect for interaction routines	++/+	+
Respect for interaction preferences	+/−	++
Relevance of the face-to-face encounters	++	+/−
Capability of technology adoption	+/−	+/−
Willingness to adopt technology	−/X	+/−
Stress and burden of the intergenerational social care process	++/+	+/−

The table shows a stronger requirement for intergenerational social interactions in the Latino culture, which probably emerges from collectivistic practices like the parenting style and the filial obligation (Barros et al. 2014). This requirement is lower in individualist cultures, since people appreciate their independence, autonomy, and privacy more, which reduces the need to conduct frequent interactions with older adults and vice versa. The size of the family networks in Western countries—usually smaller than in Latin America—is another reason that contributes to reduce the number of interactions with older adults.

The respect for the interaction preferences and routines of the people involved is important in both cultures. However, respecting routines seems to be more important in Latino culture and respecting interaction preferences seems to be more relevant in Western countries. The reasons also seem to be rooted in the implicit agreements and regular practices that are usually present in individualist and collectivistic culture.

Promoting or supporting face-to-face interactions is more relevant and feasible in Latin American families, since these practices are typically part of their routines. Moreover, family size and the low mobility of their members, both increase the feasibility of these encounters.

Concerning the capability to adopt technology, both cultural scenarios are similar. However, older adults in Western countries are more willing to use it than Latino elderlies, since the requirement to conduct remote interaction with other family members is stronger for them; therefore, they perceive a higher usefulness in using interaction technology.

In the case of the stress and burden generated by the intergenerational social care process, is important in both cultural scenarios. However, it is more demanding in the Latino scenario, since most interactions are synchronous and many of them are face-to-face.

13.5 Conclusions

Given the high penetration of computer-mediated technology to support social interactions at all levels, and the low adoption of these technologies among the elderly people, it becomes evident that there is a need to conceive ad hoc solutions to allow the participation of the elderly in this new social interaction scenario. This need is enhanced due the fact that the elderly population is growing quickly worldwide, particularly in non-Western countries (United Nations 2017).

On the other hand, most HCI research conducted in this domain has been focused on the reality of older adults living in Western countries, and therefore the findings are (a priori) reusable to conceive technology for the same cultural domain. Although the cross-cultural differences (and similarities) are important to conceive the next generation of interaction technology for older adults, we still know relatively little about that.

Therefore, we need to understand how we can reuse the design knowledge gained during the previous two decades of HCI research with older people in order to conceive the next wave of interaction systems for older adults considering their culture.

This chapter emphasizes the relevance of considering this cultural aspect not only to conceive ad hoc technology, but also to reuse the guidelines reported in the literature. Then, it discusses similitudes and differences between the intergenerational social interaction processes conducted in Western and Latin American countries, and also between the attitudes assumed by the people involved. Gaining this understanding is part of "knowing the user", which is key in contemporary HCI research.

Recognizing the heterogeneity of intergenerational social interaction scenarios, the suitability of the technology support given to older adults depends on the culture of the people involved, since the process to be addressed and the roles played by the older adults and the rest of the family network is shaped by these cultural traits. Consequently, our capability to obtain suitable designs will be influenced by the possibility to reuse culturally contextualized HCI knowledge. In that sense, this chapter makes a step forward helping to conceive the next generation of culturally-aware interaction technology for older adults.

Acknowledgements The work of Francisco J. Gutierrez has been supported by the PhD scholarship program of Conicyt Chile (CONICY-PCHA/Doctorado Nacional/2013-21130075). This research work has been partially supported by the grant Fondecyt Enlace 2018, VID, University of Chile.

References

Ballagas R, Kaye J, Ames M, et al (2009) Family communication: phone conversations with children. In: Proceedings of the international conference on interaction design and children (IDC 2009). ACM Press, pp 321–324. https://doi.org/10.1145/1551788.1551874

Bardis PD (1979) Social interaction and social processes. Soc Sci 54(3):147–167

Barros C, Fernández MB, Herrera MS (2014) Notions that people over 45 years old have about family and the internal interactions between family members [in Spanish]. Psicoperspectivas 13(1):121–130. https://doi.org/10.5027/psicoperspectivas-vol13-issue1-fulltext-264

Bell C, Fausset C, Farmer S et al (2013) Examining social media use among older adults. In: Proceedings of the ACM conference on hypertext and social media (HT 2013). ACM Press, pp 158–163. https://doi.org/10.1145/2481492.2481509

Bratteteig T, Wagner I (2016) Unpacking the notion of participation in participatory design. Comput Support Coop Work 25(6):425–475. https://doi.org/10.1007/s10606-016-9259-4

Brereton M (2013) Habituated objects: everyday tangibles that foster the independent living of an elderly woman. Interactions 20(4):20–24. https://doi.org/10.1145/2486227.2486233

Brereton M, Soro A, Vaisutis K et al (2015) The messaging kettle: prototyping connection over a distance between adult children and older parents. In: Proceedings of the ACM SIGCHI conference on human factors in computing systems (CHI 2015). ACM Press, pp 713–716. https://doi.org/10.1145/2702123.2702462

Caine KE, Fisk AD, Rogers WA (2006) Benefits and privacy concerns of a home equipped with a visual sensing system: a perspective from older adults. Proc Hum Factors Ergon Soc Annu Meet 50(2):180–184

Chen K, Chan AHS (2011) A review of technology acceptance by older adults. Gerontechnology 10(1):1–12. https://doi.org/10.4017/gt.2011.10.01.006.00

Chen YRR, Schulz PJ (2016) The effect of information communication technology interventions on reducing social isolation in the elderly: a systematic review. J Med Internet Res 18(1):18. https://doi.org/10.2196/jmir.4596

Consolvo S, Roessler P, Shelton BE et al (2004) Technology for care networks of elders. IEEE Pervasive Comput 3(2):22–29. https://doi.org/10.1109/MPRV.2004.1316814

Cornejo R, Tentori M, Favela J (2013) Enriching in-person encounters through social media: a study on family connectedness for the elderly. Int J Hum Comput Stud 71(9):889–899. https://doi.org/10.1016/j.ijhcs.2013.04.001

de Angeli A, Bordin S, Blanco MM (2014) Infrastructuring participatory development in information technology. In: Proceedings of the participatory design conference (PDC 2014). ACM Press, pp 11–20. https://doi.org/10.1145/2661435.2661448

Dickinson A, Hill RL (2007) Keeping in touch: talking to older people about computers and communication. Educ Gerontol 33(8):613–630. https://doi.org/10.1080/03601270701363877

Ehn P, Kyng M (1987) The collective resource approach to systems design. In: Bjerknes G et al (eds) Computers and democracy—a Scandinavian challenge, Aldershot, Avebury, pp 17–58

Ferreira SM, Sayago S, Blat J (2016) Going beyond telecenters to foster the digital inclusion of older people in Brazil: lessons learned from a rapid ethnographical study. Inf Technol Dev 22(1):26–46. https://doi.org/10.1080/02681102.2015.1091974

Fischer G, Herrmann T (2015) Meta-design: transforming and enriching the design and use of socio-technical systems. In: Wulf W, Schmidt K, Randall D (eds) Designing socially embedded technologies in the real-world. Springer, London, pp 79–109

Forbes A (1996) Caring for older people: loneliness. BMJ 313(7053):352–354. https://doi.org/10.1136/bmj.313.7053.352

Forghani A, Neustaedter C (2014) The routines and needs of grandparents and parents for grandparent-grandchild conversations over distance. In: Proceedings of the ACM SIGCHI conference on human factors in computing systems (CHI 2014). ACM Press, pp 4177–4186. https://doi.org/10.1145/2556288.2557255

Garattini C, Wherton J, Prendergast D (2012) Linking the lonely: an exploration of a communication technology designed to support social interaction among older adults. Univ Access Inf Soc 11(2):211–222. https://doi.org/10.1007/s10209-011-0235-y
Gutierrez FJ, Ochoa SF (2016) Mom, I do have a family! Attitudes, agreements, and expectations on the interaction with Chilean older adults. In: Proceedings of the ACM conference on computer-supported cooperative work and social computing (CSCW 2016). ACM Press, pp 1400–1409. https://doi.org/10.1145/2818048.2820000
Gutierrez FJ, Ochoa SF (2017) It takes at least two to tango: understanding the cooperative nature of elderly caregiving in Latin America. In: Proceedings of the ACM conference on computer-supported cooperative work and social computing (CSCW 2017). ACM Press, pp 1618–1630. https://doi.org/10.1145/2998181.2998314
Gutierrez FJ, Ochoa SF, Vassileva J (2017) Mediating intergenerational family communication with computer-supported domestic technology. In: Gutwin C, Ochoa SF, Vassileva J, Inoue T (eds) Collaboration and technology—CRIWG 2017. Lecture notes in computer science, vol 10391. Springer, pp 132–147. https://doi.org/10.1007/978-3-319-63874-4_11
Harley D, Fitzpatrick G (2009) YouTube and intergenerational communication: the case of Geriatric1927. Univ Access Inf Soc 8(1):5–20. https://doi.org/10.1007/s10209-008-0127-y
Harwood J, Lin MC (2000) Affiliation, pride, exhange, and distance in grandparents' accounts of relationships with their college-aged grandchildren. J Commun 50(3):31–47. https://doi.org/10.1111/j.1460-2466.2000.tb02851.x
Hirschheim R, Klein HK, Lyytinen K (1995) Information systems development and data modeling: conceptual and philosophical foundations. Cambridge University Press, Cambridge
Hope A, Schwaba T, Piper AM (2014) Understanding digital and material social communication for older adults. In: Proceedings of the ACM SIGCHI conference on human factors in computing systems (CHI 2014). ACM Press, pp 3903–3914. https://doi.org/10.1145/2556288.2557133
Huber L, Shankhar K, Connelly K et al (2013) How in-home technologies mediate caregiving relationships in later life. Int J Hum Comput Interact 29(7):441–455. https://doi.org/10.1080/10447318.2012.715990
Kennedy TLM, Wellman B (2007) The networked household. Inf Commun Soc 10(5):645–670. https://doi.org/10.1080/13691180701658012
Kurniawan S, Zaphiris P (2005) Research-derived Web design guidelines for older people. In: Proceedings of the international ACM SIGACCESS conference on computers and accessibility (ASSETS 2005). ACM Press, pp 129–135. https://doi.org/10.1145/1090785.1090810
Lee C, Coughlin JF (2015) PERSPECTIVE: Older adults' adoption of technology: an integrated approach to identifying determinants and barriers. J Prod Innov Manag 32(5):747–759. https://doi.org/10.1111/jpim.12176
Leitch S, Warren MJ (2010) Ethics: the past, present and future of socio-technical systems design. In: Tatnall A (ed) History of computing: learning from the past. Springer, Berlin, pp 189–197
Lindley SE (2012) Shades of lightweight: supporting cross-generational communication through home messaging. Univ Access Inf Soc 11(1):31–43. https://doi.org/10.1007/s10209-011-0231-2
Lindley SE, Harper R, Sellen A (2008) Designing for elders: exploring the complexity of relationships in later life. In: Proceedings of the British HCI group annual conference on HCI (BCS-HCI 2008). British Computer Society, pp 77–86
Lindley SE, Harper R, Sellen A (2009) Desiring to be in touch in a changing communications landscape: attitudes of older adults. In: Proceedings of the ACM SIGCHI conference on human factors in computing systems (CHI 2009). ACM Press, pp 1693–1702. https://doi.org/10.1145/1518701.1518962
Lynch C (2015) Design for aging: perspectives on technology, older adults, and educating engineers. Anthropol Aging 36(2):127–134. https://doi.org/10.5195/aa.2015.108
Moffat K (2013) Older-adult HCI: why should we care? Interactions 20(4):72–75. https://doi.org/10.1145/2486227.2486242

Muñoz D, Cornejo R, Gutierrez FJ et al (2015) A social cloud-based tool to deal with time and media mismatch of intergenerational family communication. Futur Gener Comput Syst 53:140–151. https://doi.org/10.1016/j.future.2014.07.003

Mynatt ED, Melenhorst AS, Frisk AD et al (2004) Aware technologies for aging in place: understanding user needs and attitudes. IEEE Pervasive Comput 3(2):36–41. https://doi.org/10.1109/MPRV.2004.1316816

Nef T, Ganea RL, Müri RM et al (2013) Social networking sites and older adults—a systematic review. Int Psychogeriatr 25(7):1041–1053. https://doi.org/10.1017/S1041610213000355

Newall NE, Chipperfield JG, Clifton RA et al (2009) Casual beliefs, social participation, and loneliness among older adults: a longitudinal study. J Soc Pers RelatShip 36(2–3):273–290. https://doi.org/10.1177/0265407509106718

Papastavrou E, Kalokerinou A, Papacostas SS et al (2007) Caring for a relative with dementia: family caregiver burden. J Adv Nurs 58(5):446–457. https://doi.org/10.1111/j.1365-2648.2007.04250.x

Pekkola S, Kaarilahti N, Pohjola P (2006) Towards formalised end-user participation in information systems development process: bridging the gap between participatory design and ISD methodologies. In: Proceedings of the ninth conference on participatory design: expanding boundaries in design, vol 1. ACM Press, pp 21–30. https://doi.org/10.1145/1147261.1147265

Procter R, Greenhalgh T, Wherton J et al (2014) The day-to-day co-production of aging in place. Comput Support Coop Work 23(3):245–267. https://doi.org/10.1007/s10606-014-9202-5

Redondo N, Díaz-Fernández M, Llorente-Marrón MM et al (2015) El espacio residencial del cuidado de los adultos mayores en América Latina y España [The residential space of elderly caregiving in Latin America and Spain, in Spanish]. Notas de Población 100:223–258

Riche Y, Mackay W (2010) PeerCare: supporting awareness of rhythms and routines for better aging in place. Comput Support Coop Work 19(1):73–104. https://doi.org/10.1007/s10606-009-9105-z

Roupa Z, Nikas M, Gerasimou E et al (2010) The use of technology by the elderly. Health Sci J 4(2):118–126

Sayago S, Sloan D, Blat J (2011) Everyday use of computer-mediated communication tools and its evolution over time: an ethnographical study with older people. Interact Comput 23(2011):543–554. https://doi.org/10.1016/j.intcom.2011.06.001

Schorch M, Wan L, Randall D, Wulf V (2016) Designing for those who are overlooked—insider perspectives on care practices and cooperative work of elderly informal caregivers. In: Proceedings of the ACM conference on computer-supported cooperative work and social computing (CSCW 2016). ACM Press, pp 787–799. https://doi.org/10.1145/2818048.2819999

Schulz R, Beach SR, Matthews JT et al (2013) Willingness to pay for quality of life technologies to enhance independent functioning among baby boomers and the elderly adults. Gerontologist 54(3):363–374. https://doi.org/10.1093/geront/gnt016

Siibak A, Tamme V (2013) Who introduced Granny to Facebook? An exploration of everyday family interactions in web-based communication environments. Nothern Light Film Media Stud Yearb 11(1):71–89. https://doi.org/10.1386/nl.11.1.71_1

Stuifbergen MC, van Delden JJM, Dykstra PA (2008) The implications of todays' family structures for support giving to older parents. Ageing Soc 28(3):413–434. https://doi.org/10.1017/S0144686X07006666

Suárez J (2004) Colombia. In: Tompkins C, Sternberg K (eds) Teen life in Latin America and the Caribbean. Greenwood Press, Westport, CT, pp 77–98

United Nations, Department of Economic and Social Affairs, Population Division (2017). World Population Ageing 2017—Highlights (ST/ESA/SER.A/397)

Venkatesh V, Davis F (2000) A theoretical extension of the technology acceptance model: four longitudinal field studies. Manage Sci 46(2):186–204

Vines J, Lindsay S, Protchard GW et al (2013) Making family care work: dependence, privacy and remote home monitoring telecare systems. In: Proceedings of the ACM international joint conference on pervasive and ubiquitous computing (UbiComp 2013). ACM Press, pp 607–616. https://doi.org/10.1145/2493432.2493469

Waycott J, Vetere F, Pedell S et al (2013) Older adults as digital content producers. In: Proceedings of the ACM SIGCHI conference on human factors in computing systems (CHI 2013). ACM Press, pp 39–48. https://doi.org/10.1145/2470654.2470662

World Wide Web Consortium (2008) Web Content Accessibility Guidelines (WCAG) 2.0. http://www.w3.org/TR/WCAG20/. Accessed 19 Jan 2017

Francisco J. Gutierrez (Ph.D., Computer Science, University of Chile) is Adjunct Professor in Computer Science at the University of Chile. His research focuses on interpersonal communication and cooperative practices in face-to-face and computer-mediated scenarios using qualitative and quantitative methods, as well as analyzing human traces and interaction on the Social Web. He has a particular interest in applying this knowledge to design and evaluate new technology to connect people in a variety of scenarios, such as families, local communities, and educational settings.

Sergio F. Ochoa (Ph.D., Computer Science and Engineering, Pontificia Universidad Católica de Chile) is Associate Professor in Computer Science at the University of Chile. His research interests are social computing, collaborative systems, ubiquitous computing and software engineering. He has a particular interest in understanding the interaction technology design for user diversity, the design of awareness and persuasive mechanisms to promote behavior change, and the development of interaction technology easy to adopt by the end-users.

Raymundo Cornejo (Ph.D., Computer Science, Center for Scientific Research and Higher Education of Ensenada, Mexico) is a professor at Autonomous University of Chihuahua and member of the CONACYT Thematic Network on Ageing, Health and Social Welfare. His areas of interest are human-computer interaction, pervasive computing, and aging.

Julita Vassileva (Ph.D., Mathematics and Computer Science, Bulgarian Highest Attestation Commission) is Professor in Computer Science at the University of Saskatchewan, Canada. Her research is in the general area of human-centered computing: user modeling, personalization and social computing, intelligent tutoring systems, recommender systems, multi-agent systems, trust and reputation mechanisms, persuasive technology and behavior change.

Part V
Research Methods and Programming Acceptance

Chapter 14
Why and How Think-Alouds with Older Adults Fail: Recommendations from a Study and Expert Interviews

Rachel L. Franz, Barbara Barbosa Neves, Carrie Demmans Epp, Ronald Baecker and Jacob O. Wobbrock

14.1 Introduction

Older adults (aged 65+) constitute the fastest growing age group in most nations, projected to double by 2050 (World Population Ageing 2017 2017). Concurrently, older adults in developed countries are adopting new technologies (Anderson and Perrin 2017). Yet, older adults are still less likely to adopt new technologies compared to other age groups, and they are more likely to discontinue use with age (Berkowsky et al. 2015). One of the factors influencing adoption and use is the usability of technologies (Neves et al. 2015).

Understanding how to adapt usability testing methods to the needs of older adults is essential to developing innovative technologies that serve this population. Contrary to popular belief, the challenges of using technology do not appear to be a current generational challenge. Rather, they are a life course one: as we age, our skills, needs, and aspirations change and we are more likely to face cognitive and

R. L. Franz (✉) · J. O. Wobbrock
University of Washington, Seattle, WA, USA
e-mail: franzrac@uw.edu

J. O. Wobbrock
e-mail: wobbrock@uw.edu

B. B. Neves
University of Melbourne, Melbourne, Australia
e-mail: barbara.barbosa@unimelb.edu.au

C. D. Epp
University of Alberta, Edmonton, AB, Canada
e-mail: cdemmansepp@ualberta.ca

R. Baecker
University of Toronto, Toronto, ON, Canada
e-mail: ron@taglab.ca

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_14

functional decline (Neves et al. 2018a). Cognitive and functional decline can lead to frailty, which is defined as having three or more of the following: low physical activity, muscle weakness, slowed performance, fatigue, and involuntary weight loss (Torpy et al. 2006). Frail older adults are likely to stop using technology; authors suggest that abandonment is related to poor usability of technology (Gell et al. 2015). Poor usability also influences older adults' self-efficacy and anxiety surrounding technology (Vroman et al. 2015).

Although the suitability of design methods for older adults has been investigated (e.g., participatory design) (Vines et al. 2012), little attention has been paid to the suitability of usability testing methods for frail older adults. If usability testing methods do not capture the usability issues that frail older adults experience, it is likely these technologies will be abandoned. Despite the employment of usability testing methods with older adults, these methods have not been directly compared. Undoubtedly, individual researchers have learned some of the challenges of these methods, but to the best of our knowledge, there are no systematic accounts that compare usability testing methods with frail older adults.

Given the lack of research on how to effectively employ usability testing methods with frail older adults, we conducted a study to compare three variants of a commonly employed usability testing method, the think-aloud (Ericsson and Simon 1980). We compared Concurrent Think-Aloud, Retrospective Think-Aloud, and Co-discovery with frail older adults (study 1). Additionally, we interviewed Human-Computer Interaction (HCI) experts working with older adults to gain insight into their usability testing practices (study 2).

The think-aloud, based on the verbal protocol by Ericsson and Simon (1980), is the most established usability evaluation. The most common variant is the Concurrent Think-Aloud (CTA), in which participants verbalize their thought process while performing tasks to give insight into their mental model of the system. In another variant, the Retrospective Think-Aloud (RTA), participants perform tasks silently and then think aloud while recalling how they performed those tasks. Co-discovery (CD) involves two participants working as a team to complete tasks: as they interact with each other they also verbalize their thought processes.

Our study with frail older adults showed that Co-discovery is the most suitable think-aloud variant because with it (and only it), older adults verbalized their thought process throughout the entire usability test. We also found that older adults perform impression management during usability tests (i.e., try to present themselves in a favorable light). Our findings from interviews with HCI experts suggest that usability tests can be leveraged to enhance/maintain participants' motivation to engage with technology in their daily lives. Experts also warned that participants' impression management efforts and low self-efficacy can impact the usability test by making the participant appear less competent.

Taken together, our results support a contextual approach—i.e., a perspective that includes context as both a core variable and framework—to usability studies. This approach considers the complexity of working with a heterogeneous but vulnerable older population and includes the need to understand users and empower them in usability studies through adjusted and user-sensitive multi-methods. Thus, this contextual perspective contributes to methodological innovation in HCI, advancing methodological eclecticism (multi-methods) and flexibility when studying sensitive populations (Neves et al. 2018b).

14.2 Deployment with Frail Older Adults

To compare the three usability testing methods with frail older adults, we conducted a usability test with 12 participants in the context of a three-month technology deployment study (Neves et al. 2017). Participants experienced one of three usability testing methods: Concurrent Think-Aloud (CTA), Retrospective Think-Aloud (RTA), or Co-discovery (CD).

14.2.1 Participants

We recruited participants in collaboration with staff from a care home. We jointly organized two information sessions for residents and relatives. Staff then approached interested residents who met our selection criteria, excluding those with dementia or unable to consent. Twelve participants completed the study (see Table 14.1); their enrollment was staggered, occurring over six months. Participants were considered frail, having visual, hearing, speech, motor and cognitive impairments.

This purposive sample was appropriate to our in-depth study, particularly of institutionalized older adults with different impairments and frailty levels.

Two participants, a married couple (P8a and P8b), wanted to share a tablet and used the same device throughout the study. Participant ages ranged from 74 to 95 (M = 82.6; SD = 5.5). Most had a college degree, but different levels of digital literacy.

14.2.2 Apparatus

The technology used during the usability study was an iPad-based accessible email client that was designed with older adults who had motor impairments and low digital literacy. The tool was based on participatory design sessions and field studies. It had four main messaging options: picture, short preset text, video, and audio. The user could also receive text, video, and picture messages. Contacts were associated with photos in an alphabetized list and the interface was icon-based.

Table 14.1 Demographics of deployment participants and usability testing method experienced: Concurrent Think-Aloud (CTA), Retrospective Think-Aloud (RTA), Co-discovery (CD)

Code	Age	Gender	Previous occupation	Impairments	Digital literacy	Method
P1	84	F	N/A	Speech & motor	Low	CTA
P2	86	F	Teacher	N/A	Medium	RTA
P3	80	F	Librarian	Motor, visual, & hearing	Low	RTA
P4	86	M	Minister	N/A	Medium	CTA
P5	95	M	Physician	Visual	Medium	CD
P6	–	–	Withdrew	–	–	CTA
P7	74	M	Engineer	Parkinson's disease	Medium	CTA
P8a	80	M	Accountant	N/A	Medium	CD
P8b	77	F	Teacher	Scoliosis	None	CD
P9	86	F	Artist	Visual & motor	None	RTA
P10	79	F	History teacher	Aphasia	None	RTA
P11	80	F	Nurse	Visual	None	CD
P12	84	F	Teacher	N/A	Low	RTA

14.2.3 Study Design

Our usability study was a part of a larger deployment study. In this section we describe the deployment and usability study design.

14.2.3.1 Deployment Study

We conducted a three-month deployment in a Canadian care home. Participants kept our iPad-based tool and used it independently every week to send messages to relatives. We performed the usability study at the end of the deployment study. The deployment included training sessions, semi-structured interviews, and field observations; used to contextualize the usability tests' findings.

14.2.3.2 Usability Study

Each participant experienced one usability testing method, as in a between-subjects design. As usability tests could cause fatigue, we didn't perform a within-subjects comparison of the methods. We had three participants in the Concurrent Think-Aloud (CTA) condition, which required verbalization while completing tasks. Five participants were in the Retrospective Think-Aloud (RTA) condition, in which they verbalized while watching a video of themselves completing the tasks. Four participants were in the Co-discovery (CD) condition, working in pairs to complete tasks. Participants were randomized to the RTA and CTA conditions, and from these conditions, four participants were selected (based on personal circumstances) to be in the CD condition. We involved P8b in the testing session by doing CD with her husband; P5 and P11 were selected for the CD condition based on similar levels of comfort with the tool. We could not balance the conditions due to unforeseen circumstances that required sensitivity, such as P8a bringing his wife to the usability testing session.

We designed the usability test to have five tasks and take an average of 15 min. We printed the tasks on 3 × 5 inch notecards. The tasks progressed from navigating to the researcher's contact information to sending and receiving messages. We based the tasks on common and uncommon scenarios of use. The uncommon scenarios drew on what participants reported to be the least used feature (video messaging). These tasks were chosen to test for strategies, such as participants' abilities to draw inferences between tasks, given that the audio and picture features had analogous interfaces/steps. We arranged the tasks in order of difficulty, with the least difficult task being first, to ease the participant into the tasks and avoid lowering their confidence from the start. Along with testing whether they could operate some features, we wanted to know whether: (1) they could follow a longer navigation path, (2) they knew how to go back or cancel an action, and (3) they understood message history and contact order. These tasks provided insight into participants' level of system comprehension in as few tasks as possible.

14.2.4 Usability Testing Procedure

There were ten testing sessions in total (three CTA, five RTA, two CD), which lasted on average 36 min each (SD = 8.82). We began the session with warm-up questions, followed by the condition (CTA, RTA, or CD).

The researcher emphasized that the tool was being tested and not the participant. Participants were then instructed to complete the task and to ask for help only when stuck. One researcher sat next to the participants, while another researcher stood behind the participants and videotaped their hands as they interacted with the iPad.

For the CTA condition, the participants were instructed "to say what's on your mind as you are doing the task." The researcher demonstrated the CTA with a simple task on her tablet. The researcher emphasized that the participants could stop thinking aloud if it became burdensome but asked that the participants try to finish the task. For ethical reasons that may result from CTA's additional cognitive load, such as causing distress and making participants more aware of their limitations, the researcher did not prompt participants to continue to think aloud if participants fell silent.

For the RTA, the researcher gave instructions after participants completed the tasks. The instructions were for participants to verbalize their thoughts during the task while watching the video recording of themselves performing the task. The researcher also demonstrated the RTA with a video of herself doing a simple task on her tablet. Additionally, the researcher showed participants how to pause and play the video. If participants fell silent for more than 20 s, the researcher prompted participants to think aloud by asking, “Do you remember doing the task? What were you thinking?” Because participants were not multi-tasking in the RTA, it seemed appropriate to prompt participants.

In the CD condition, participants were instructed to work together to finish tasks. The researcher also advised participants to consult one another if they got stuck before asking our assistance.

14.2.5 Analysis

We analyzed the usability tests with a tabulation of task completion, task time, errors, and challenges encountered. We also used thematic analysis (Patton 1990) to uncover general patterns, including categories and themes, within and across cases. Our thematic analysis was based on an inductive and deductive approach—i.e., codes were identified from the data based on both a priori and new insights regarding: benefits, challenges, and outcomes of the usability testing methods. Authors coded independently to identify categories and themes, following an open and then a structured coding process. An external coder determined a basic inter-rater reliability of 98% using the procedures described in (Patton 1990): this coder counted the discrepancies in category assignment between the codes and themes of the coders for half of the data. This simple procedure suits our data, sampling, and analytical technique, as recommended in the literature (Patton 1990).

14.3 Study 1: Results and Discussion

We present a comparison of the usability testing methods and three overarching themes identified from the thematic analysis: *Impression Management*, *Low Self-efficacy*, and *The Researcher’s Role*.

14.3.1 Comparing the Thinking-Aloud Variants

We compared the suitability of three usability testing methods: Concurrent Think-Aloud (CTA), Retrospective Think-Aloud (RTA), and Co-discovery (CD).

14.3.1.1 Concurrent Thinking-Aloud (CTA)

We found that P1 and P4 could perform the CTA to a certain point. However, they stopped thinking aloud as soon as they became stuck/lost. Their comfort with CTA was unexpected, especially for P1 who had speech impairment: "*I can do that, I'm a good talker. I actually talk to myself.*" It was clearly difficult for P7, as he was very frail. He spoke quietly, and it was difficult to hear his verbalizations. At the end of the session, he reported a negative impact on his physical and emotional state:

"*Tired is one thing I am, but I'm also quite tense to be trying to concentrate on this (…) which is more of a problem than being tired. I don't know, we've been doing it for 10 or 15 min now, but my hands are quite tense, and I start to shake (…) For Parkinson's disease some people get a lot of anxiety.*"

P7's discomfort suggests that the frailty level could contribute to a participant's ability to perform a CTA.

14.3.1.2 Retrospective Think-Aloud (RTA)

Retrospective Think-Aloud was unsuccessful for several reasons. Three of the participants had difficulty understanding the instructions for the RTA or its purpose: *"[There's] not much action going on in the picture though…"* (P3). Of the five participants, only two completed the RTA but reported several challenges. We ended the RTA early for three participants: P3 became frustrated and stopped watching the recording, P9 reported that watching the recording made her eyes hurt, and P12 also found it difficult to watch. Watching themselves made P10 and P12 more aware of their mistakes during the test: "*I don't want to go through this again. I found it very stressful.*", P12 reports; P10 noted, "*[I completed the tasks] after a while…but [the researcher] had to fix [my mistakes].*"

Even when the participants performed the RTA, there were challenges. First, despite prompts to think aloud, participants usually watched the recording silently. Second, when they thought aloud, their verbalizations were not revealing. They commented on what they were seeing rather than what they were thinking while completing the task: "*Now I'm following the instructions and I was just told to put a short message in*" (P2). They also had difficulties remembering what the task was and what they were doing in the video, as found in prior work (Dickinson et al. 2007).

14.3.1.3 Co-discovery (CD)

Of the three conditions, Co-discovery (CD) was most appropriate for our participants. The four participants in the CD condition completed all five tasks successfully and without the researcher's assistance. Participants worked effectively as a team in the CD condition and overcame challenges together by compensating for the other participant's missing knowledge.

All four participants verbalized to keep their partner on the same page while completing a task: "*So we want a picture, and we want to turn it around (…) and now we don't want to send it*" (P11). Unlike CTA, participants continued to verbalize when they did not know how to do something by asking the other participant: "*Where's the garbage pail gone?*" (P11).

Additionally, P11 learned from P5 that she could communicate with people overseas like P5 did with his granddaughter in Iran. Sharing knowledge is a known advantage of CD over other methods: CD can uncover the overlap of the participants' knowledge while highlighting where this overlap does not exist (Miyake 1986).

Another relevant observation was the participants' interpersonal dynamic. A "pilot" and a "co-pilot" emerged: the pilot interacted with the tablet while the co-pilot suggested alternative paths, reminded the other participant of the task, and supported the other participant's decisions. This might also be because co-pilots, P8b and P11, already had a secondary role surrounding technology, which was based on deferring to their husbands for technical support. So, it may have felt natural to let the other participant lead.

14.3.2 Usability Tests: Thematic Analysis

The thematic analysis of the usability tests identified three themes: *Impression Management*, *Low Self-efficacy*, and *The Researcher's Role*. These were present across conditions and provide insight into conducting usability tests with older adults regardless of the think-aloud method.

14.3.2.1 Impression Management

Five participants engaged in impression management, i.e., behavior stemming from the desire to make a positive impression on the researcher (Goffman 2012). Many felt the need to explain why they struggled or could have performed better during the test, even when able to complete most tasks. This need may have been related to knowing the researchers over the course of the study and not wanting to disappoint them. For example, after sending/receiving a video message, P1, P2, P10, P11, and P12 told us they had never used the video feature before to justify their issues with the task. After expressing that she did not perform well on the test and apologizing to us, P10 also pointed out that she was 79 and had had two strokes. P12 also noted that she had difficulty holding the tablet because of the weakness in her hand.

P1's behavior was another example of impression management. At the beginning of the test she told us that the app was "*amazing*," that her family liked that she was using the app, and that the app was better than a phone. However, during the test it became clear that the learnability of the app was poor as she showed gaps in her understanding even after using the app for three months. Most participants (3 out of 5) who performed impression management were in the RTA condition.

14.3.2.2 Low Self-efficacy

Apologizing throughout the test was common, particularly for three participants (P1, P9, P12). These participants apologized for making mistakes and for not knowing how to perform a task. P1 and P11 verbalized their low self-efficacy by explaining they were "forgetful" and "not electronically-savvy." P10 and P12 told the researcher that they did not do well on the test saying, "*I just goofed" and "I was very hesitant about all of this*."

14.3.2.3 The Researcher's Role

Despite instructions to only consult the researcher when it was absolutely necessary, most participants engaged the researcher even when completing tasks. To avoid increasing their stress levels, we felt the need to frequently provide supportive comments and acknowledgements. Some participants needed more support from the researcher, since they were internalizing fault for making mistakes (P10, P12).

However, three participants did not want our support. Instead of asking the researcher for guidance, P2 relied on the task cards to complete the tasks. If she made a mistake, she re-read the task card before attempting another approach. P2 did not start off the deployment study with a high level of digital literacy, yet she practiced using the app, and by the time of the usability test, she had learned how to use most features and was enthusiastic about the app.

P3 struggled to complete most tasks, only completing one of five: she repeated the same steps even after they proved futile. Despite her apparent frustration, she did not ask questions and ignored the researcher's attempts to guide her. After a while she indicated that she was done with the usability test with her body language: by sitting back, with her chin on her chest. In contrast to P2, P3 showed little interest in the technology throughout the deployment study, even though she remained until its completion. She did share, however, one illuminating story: she used to work as a librarian and found the command prompt easy to use when it was first introduced at her work. When they switched to using a Graphical User Interface, she couldn't understand it. Her difficulty with the system was a major factor in her decision to retire. She carried with her this negative experience of technology, which affected her self-efficacy with technology. The researcher involvement may have been detrimental in this case, reinforcing her self-perceived incompetence.

P5 also did not ask for help during the test, partially because he could rely on P11 for support during the Co-discovery (CD). He may not have wanted assistance from the researcher to maintain his sense of autonomy (as the "pilot") and show that he could still learn something new. P5 was a highly-esteemed doctor who worked in rural areas until his retirement. He had recently begun to show signs of cognitive decline, which were difficult for him and family because of his identity as an educated and intelligent man. He enrolled in the study to slow the effects of decline. The CD may have worked well for P5 because he did not have to rely on the researcher and had a peer support (P11).

Due to participants' low self-efficacy and to minimize stress, assistance from the researcher was necessary when requested. But we also found that alternative forms of support (e.g., task cards and peer-support) were essential for keeping participants' sense of autonomy intact and bolstering their confidence.

14.3.3 Summary

Results from our deployment study suggest that Co-discovery (CD) is the most appropriate usability testing method for this group of individuals. Additionally, several insights that contribute to our recommendations: (1) Participants' impression management and low-self efficacy impacted the test more than participants' frailty, (2) the researcher should be involved in guiding and supporting the participant, but be sensitive to those who do not want assistance, and (3) for participants who do not want assistance, researchers should provide alternative means of support to boost self-efficacy and autonomy. Many of our findings were reinforced by experts in our interview study, reported below.

14.4 Study 2: Interviews with Experts

To uncover usability testing practices of HCI experts who work with older adults, we conducted an interview study. In this study, experts designed hypothetical usability tests for different personae, which were based on participants from Study 1. The usability test exercise aimed to understand experts' decision-making process and how they would account for different participant characteristics.

14.4.1 Participants

Researchers and professionals with international reputations for working with older adults while developing and evaluating technology were identified. Care was taken to identify experts from different regions and with different backgrounds. These considerations resulted in contacting 11 experts via email, six of whom agreed to be interviewed in 2015. These six HCI researchers and practitioners (three women and three men) had backgrounds in psychology, engineering, computer science, and occupational therapy. All of them had worked in centers/laboratories dedicated to studying the use of technology by older adults or by those living with aging-related impairments (e.g., tremors, speech impairments, cognitive decline). All experts had peer-reviewed publications reporting the results of usability tests with older adults. These experts were distributed across three continents and worked with older adults in English, Spanish, and French language environments.

14.4.2 Interview Procedure

The semi-structured interviews included: (1) questions about experts' use of usability testing methods with older adults, and (2) a scenario involving a usability test. The first and third authors conducted the interviews via Skype, in person, or by phone depending on the expert's preference. All interviews were recorded and conducted until theoretical saturation was reached (Morse 2012). We stopped recruiting experts when we saw overlap in their use of methods and we had an overarching understanding of their approaches.

The general question portion of the interviews elicited information about experts' experiences with different usability testing methods. It also asked about adaptive methods to meet both the participants' and their needs. Then, we gave experts a usability testing scenario; experts had to plan a usability test for a specific technology. The scenario was constrained through the specification of usability test goals and the inclusion of four hypothetical participants with varying abilities and dispositions towards technology. The personae describing these hypothetical participants were based on participants P1, P3, P4 and P7 from our deployment study (see Table 14.1). Included in the descriptions were the personae's levels of digital literacy, attitudes towards learning, and impairments. The technology to test for was similar to the one evaluated in Study 1. Experts were asked to design a usability test based on the described goals, technology, and hypothetical participants. They were also asked to justify the choices they made so that we could uncover experts' decision-making processes.

14.4.3 Analysis

An inductive thematic analysis was applied to the interviews. The procedures used were similar to those from Study 1, including calculating a basic inter-rater reliability (Patton 1990), which was also 98%.

14.5 Study 2: Results and Discussion

The thematic analysis of the interviews with experts identified four main themes: *Experts' Current Practice*, *Adapting to Participant Characteristics*, *Ethics*, and *The Researcher's Role*.

14.5.1 Experts' Current Practice

Our experts report using a variety of usability testing methods, including: task-based usability tests (E5, E6, E2), think-alouds (E1, E3, E5), observation (E1, E4), Likert-type rating scales (E1, E2), cognitive walkthroughs (E6), validated instruments such as QUEST 2.0 (E1), interviews (E1), and usability questionnaires (E4). We report on their evaluation of think-alouds and task-based usability tests.

14.5.1.1 Advantages and Disadvantages of Think-Alouds and Task-Based Usability Tests

Experts reported that the advantage of task-based tests is that they produce quantitative data and the researcher can control how participants interact with the technology, which facilitates data comparison across participants. The disadvantages of task-based tests and think-alouds are that they can cause frustration and anxiety in the participant. When the test is structured more informally, the researcher can see how participants do tasks they are already familiar with. Regarding think-alouds, E1 noticed that she had to prompt participants frequently for the think-aloud to be successful. While E3 reported that the problem with this method is that participants think aloud as long as they know what they are doing and stop when they do not know—precisely the moment at which the researcher needs to gain the most insight.

14.5.2 Adapting to Participant Characteristics

All experts except for E2 reported adapting methods to the individual and context. E5 expressed the importance of being flexible when designing the test due to the nature of the participants: "*Because we [are] dealing with a vulnerable cohort, we [are] very mindful not to have formal methods or formal processes that would start to engender fear or concern, or at all lack sensitivity to the situation (…) any method or technique had to be a servant to the context of the fragility and the vulnerability of the participants*" (E5). Although this methodological flexibility seemed common across experts' accounts, it is seldom reported on. This calls attention to the need to recognize the complexity and messiness of fieldwork and our responsibility as researchers to both our participants and scientific community. While design flexibility might affect replication or reliability of instruments across studies, it ensures validity. Reliability can then be guaranteed with a multi-methods approach (triangulation, mixed-methods) as suggested by our study and the experts.

14.5.2.1 Participant Motivation to Use Technology

The primary concern of most experts was adapting tests to maintain and enhance participants' motivation to use technology both during and after the study. Of all the hypothetical participants, experts had the most advice for P3 due to her lack of interest in the technology. First, they would interview her to understand her lack of motivation. Second, they would enhance her motivation through adapting the usability testing session so it was also training in basic computing skills to build her self-efficacy. Another way was to make clear the benefits of using the technology. For example, E5 found that putting the app in the context of communicating with overseas family was a motivator for his participants. Experts explained that while there are work-arounds for physical or cognitive frailty, there is not much the researcher can do when a participant lacks motivation. Thus, experts found it critical to address motivation, keeping participants in the study and preventing the experience from negatively affecting their self-efficacy. Similarly, Waycott et al. (2016) found that participants' experiences with technology during a study affected their self-efficacy and contributed to older adults' decision to drop out.

14.5.2.2 Low-Self Efficacy and Self-confidence

Experts reported that low self-efficacy was an issue during usability tests. E6 mentioned that participants often apologized and felt like they had let him down. To bolster their confidence, experts employed different strategies. One was to ask the participant to lead test and show the features they used most often and enjoyed using. E6 also mentioned that conducting the test from a lab can be detrimental to participants' self-confidence because "*many seniors don't have a university education [and] they get intimidated by the university setting*." E2 and E6 mentioned celebrating small successes and reassuring them "*that just by being themselves they are very valid participants*." Considering the effect of low self-efficacy on the test, E3 mentioned using a mixed approach to tease out whether participants' self-consciousness was making them perform worse.

14.5.2.3 Impression Management

Experts noted how low self-efficacy and self-perception resulted in impression management efforts, i.e., participants saying things they believe the researcher wants to hear (E1, E2, E4, E6). For instance, E1 explained that participants often say researchers "*are lovely people*" and that a given technology "*is great and wonderful (…) but then show signs of frustration and confusion.*" For this, E1 combines methods, such as behavioral coding and Likert-type scales, to identify usability issues from overly optimistic self-reports. E3 also found theatre beneficial for overcoming impression management because participants are more honest about their opinions when acting. Establishing a relationship with the participant may help reduce the conscious and unconscious need to please and be seen in a favorable light (E2, E6).

14.5.2.4 Physical and Cognitive Abilities

Experts frequently adapted usability testing sessions to their participants' abilities, primarily by doing the session from participants' homes. Not only does this allow experts to see how participants use the app in their natural environment, but their home will be set up for participants' accessibility needs. So, most experts would conduct the session with P7 (who had Parkinson's Disease) from his home. E3 also mentioned doing a remote usability test with P1 (who had a speech impairment) and P7 (who had Parkinson's disease) by asking them to do tasks and fill out a form afterwards, to avoid making them self-conscious about their impairments. For E3, the test design was sensitive not only to P1's and P7's impairments, but also to their attitudes towards their impairments.

14.5.2.5 Digital Literacy

All experts agreed that traditional usability testing methods such as think-alouds and task-based tests could be used with P4 because of his high level of digital literacy and low frailty.

14.5.3 Ethics

Experts stressed that there is a lot at stake when conducting usability tests with older adults. The usability tests can have a lasting impact on participants' perceptions of technology and on their competence and self-confidence. E6 asked, *"[If] we suspect there are already usability issues, why do we confirm our suspicions with people?"* He went on to say that in industry "*we are often just trying to get data to convince somebody else because a hunch wasn't enough.*" To avoid usability tests being a negative experience for the participant, E4 emphasized first piloting the app and the usability protocol in the lab. Having an expert do a heuristic evaluation of the app is another strategy. E6 would use P4 (who had high digital literacy and no major impairments) as a control participant to test out the tasks and see if the amount of data was enough for the designers on the product team.

14.5.4 The Researcher's Role

Experts highlighted the need to communicate the purpose of the study (E1, E2, E4, E6) and the participant's role in the test (E6). Although it is important to adapt tests, participants may feel the researchers think they do not have the capacity to perform challenging tasks (E2). The researcher should be careful when adapting the test and avoid assuming low self-efficacy means low competency. Instead, adapt the test to the level of motivation, abilities, and digital literacy. The researcher can also remind the participant that the method is not "dumbed down" but used with many different populations (E2). With the hypothetical participants, experts would be more involved in the test with P1 and P3 (both had low digital literacy). E5 also talked about having participants use the technology with one another, saying "*I would use P1 as a champion*" to facilitate relationships with the other participants through the app. He would also challenge P4 to explore assistive technologies for P7, saying that participants can contribute to the study as "*not just recipients of care, [but as] careers*." However, E2 warned facilitating peer-to-peer support should be carefully handled: peers should have similar levels of digital literacy because proficient users can disincentivize participants with low digital literacy.

14.5.5 Summary

Experts use various usability testing methods with older adults and often adapt tests to participant characteristics. Enhancing and maintaining participants' motivation to use the technology and stay in the study is crucial, followed by other issues such as self-efficacy, impression management, physical and cognitive abilities, and digital literacy. Experts focus on motivation because of usability tests' impact: these tests can have a lasting influence on participant self-confidence and perception of technology. Experts highlight the researcher's role to communicate higher level information and not assume low competence to avoid "dumbing down" the test. Finally, experts encourage peer-to-peer support to give participants a clear purpose in the study.

14.6 Recommendations

We compiled our think-aloud findings and expert insights to present four main take-aways. These recommendations gain from an approach that brings together different perspectives (end-users and experts) and an in-depth and contextualized research design.

14.6.1 Takeaway 1: Recruit and Plan for Co-discovery

We found that Co-discovery (CD) is more appropriate than Concurrent Think-Aloud (CTA) and Retrospective Think-Aloud (RTA) for our frail older adult participants. Participants in RTA struggled to see and remember what was happening in the video recording. Additionally, it reminded participants of their mistakes, influencing their self-efficacy. CTA was successful with participants who were not highly frail, and experts agreed that P4, who had no serious impairments and high digital literacy, could use traditional usability methods. One downside of CTA encountered in both studies is that participants stop thinking aloud once they did not know what they are doing.

If participants are interested in working with their peers, E5 encouraged involving more than one participant in the usability test, and we found CD effective in eliciting participant verbalizations. CD may reflect participants' existing roles toward technology, as we found a "pilot-co-pilot" dynamic with participants who deferred to their husbands for technical support. However, researchers should match participants with similar digital literacy levels. Two experts warned that grouping a high digital literacy participant with a lower digital literacy participant could be detrimental.

14.6.2 Takeaway 2: Discover and Enhance Participant Motivation to Use Technology

Experts expressed that usability tests can have a lasting impact on participants' self-efficacy and perceptions of technology. For this reason, experts emphasized ensuring the test does not demotivate participants by being too difficult; motivation to use technology appears to relate to self-efficacy, as found in prior work (Waycott et al. 2016). For P3, her lack of interest affected her performance, which may be due to negative past experiences with technology. For this participant, the usability test and study in general was an opportunity to help regain confidence with technology. P3 may have benefitted from a test including tasks that she knew and enjoyed performing. Informal testing approaches can be used for participants with low enthusiasm.

14.6.3 Takeaway 3: The Researcher's Role Includes Enhancing Participants' Sense of Autonomy and Self-confidence

How much information and guidance to provide participants in usability tests can be non-intuitive. We recommend sharing high-level information about the study, guiding participants if they ask for help, and providing alternative forms of support.

14.6.3.1 Share High-Level Information

Experts emphasized sharing high-level information such as the purpose and goals of the usability test with participants, while establishing their role as the expert in that process.

14.6.3.2 Guide the Participants When Asked

Although we instructed participants to only ask for our assistance when they were stuck, participants would often engage us in the test. Thus, we recommend a greater degree of researcher involvement when participants want it, providing encouragement and support.

14.6.3.3 Provide Alternative Forms of Support for Participants Who Do not Want Researcher Assistance

Involving two or more participants in a usability test can be beneficial for maintaining participants' sense of autonomy (as we found) and for giving them a sense of purpose in the study (according to E5). Alternative forms of support such as task cards can be helpful for participants who need some assistance but want to work through tasks independently.

14.6.4 Takeaway 4: Low Self-efficacy and High Impression Management Can Have a Greater Impact on the Usability Test Than Frailty

Results from both Study 1 and Study 2 suggest that participants' low self-efficacy and high impression management efforts can affect usability tests more than level of frailty. To offset challenges with low self-efficacy and high impression management, we recommend using multi-method approaches, allowing participants to lead, and pilot-testing.

14.6.4.1 Use Multi-method Approaches

Impression management and low self-efficacy were identified as challenges in both studies. As experts suggested, multi-method approaches can help reduce the effects of impression management and tease out whether participants' self-consciousness is making them perform poorly. Furthermore, multi-method approaches can make the best use of participants' time (e.g., combining training and usability testing in one session).

14.6.4.2 Allow the Participant to Take the Lead

For participants with low self-efficacy, experts highlighted the importance of informal approaches, such as not enforcing a list of tasks but asking participants to walk through the system with the researcher. By emphasizing participants' central role in the test, we can increase their confidence and help reduce impression management efforts.

14.6.4.3 Ensure the Prototype Works Well Before Testing It with People

Usability tests should not diminish participants' self-efficacy and confidence. Therefore, E2 and E6 emphasize piloting the tool or doing a heuristic evaluation by an expert. To conclude, by combining fieldwork with older adults and interviews with experts, we put forth recommendations to conduct usability tests with frail older adults—a diverse population with varying needs and expectations. This practical information can assist researchers with method application, development, and refinement.

14.7 Conclusion

This study is limited by a purposive sample, so insights cannot be generalized to all usability testing contexts in which frail older adults participate. However, the breadth of experts' experience and older-adults' abilities enabled a rich understanding and comparison of a variety of issues of interest to the community.

We conducted two studies to investigate usability testing with frail older adults. Study 1 showed that Co-discovery (CD) was most suitable for our group of participants because they were able to think aloud throughout the test. Our second study with HCI experts who work with older adults showed that experts adapt to participant characteristics, such as self-efficacy, and focus on keeping participants motivated in the study. Based on these two studies, we advanced recommendations for conducting usability tests with frail older adults.

References

Anderson M, Perrin A (2017) Tech adoption climbs among older adults. Retrieved from http://www.pewinternet.org/2017/05/17/technology-use-among-seniors/

Berkowsky RW, Rikard RV, Cotten SR (2015) Signing off: predicting discontinued ICT usage among older adults in assisted and independent living. In: Zhou J, Salvendy G (eds) ITAP 2015. Springer International Publishing, Cham, pp 389–398

Dickinson A, Arnott J, Prior S (2007) Methods for human-computer interaction research with older people. Behav Inf Technol 26:343–352

Ericsson KA, Simon HA (1980) Verbal reports as data. Psychol Rev 87:215–251

Gell NM, Rosenberg DE, Demiris G et al (2015) Patterns of technology use among older adults with and without disabilities. Gerontologist 55:412–421. https://doi.org/10.1093/geront/gnt166

Goffman E (2012) The presentation of self in everyday life (1959). In: Calhoun C, Gerteis J, Moody J, Pfaff S, Virk I (eds) Contemporary sociological theory. John Wiley & Sons, pp 46–61

Miyake N (1986) Constructive interaction and the iterative process of understanding. Cogn Sci 10:151–177

Morse JM (2012) Introducing the first global congress for qualitative health research: what are we? What will we do—and why? Qual Health Res 22:147–156. https://doi.org/10.1177/1049732311422707

Neves BB, Fonseca JRS, Amaro F, Pasqualotti A (2018a) Social capital and Internet use in an age-comparative perspective with a focus on later life. PLoS One 13:e0192119

Neves BB, Baecker R, Carvalho DD, Sanders A (2018b) Cross-disciplinary research methods to study technology use, family, and life course dynamics: lessons from an action research project on social isolation and loneliness in later life. In: Neves BB, Casimiro C (eds) Connecting families? Information & communication technologies, generations, and the life course. Policy Press, Bristol, pp 113–132

Neves BB, Franz RL, Judges R, Beermann C, Baecker R (2017) Can digital technology enhance social connectedness amongst older adults? A feasibility study. J Appl Gerontol 38(1):49–72

Neves BB, Franz RL, Munteanu C et al (2015) "My hand doesn't listen to me!": adoption and evaluation of a communication technology for the 'oldest old.' In: CHI 2015, Seoul, Korea, pp 1593–1602

Patton MQ (1990) Qualitative evaluation and research methods. Sage

Torpy JM, Lynm C, Glass RM (2006) Frailty in older adults. JAMA 296:2280. https://doi.org/10.1001/jama.296.18.2280

UN (2017) World Population Ageing 2017, New York

Vines J, Blythe M, Lindsay S et al (2012) Questionable concepts: critique as resource for designing with eighty somethings. In: CHI, pp 1169–1178

Vroman KG, Arthanat S, Lysack C (2015) "Who over 65 is online?" Older adults' dispositions toward information communication technology. Comput Human Behav 43:156–166

Waycott J, Vetere F, Pedell S et al (2016) Not for me: older adults choosing not to participate in a social isolation intervention. In: CHI 2016. ACM, New York, NY, USA, pp 745–757

Rachel L. Franz is a Ph.D. student in Information Science at the University of Washington working with Jacob O. Wobbrock. Before starting her Ph.D. she graduated with an MSc in Computer Science from the University of Toronto. Her research focuses on making technologies for older adults that are accessible and enjoyable to use.

Barbara Barbosa Neves is Assistant Professor of Sociology at the University of Melbourne, Australia. Prior to that, she was Associate Director and Researcher at the 'Technologies for Aging Gracefully Lab' (TAGlab), University of Toronto, Canada. Her research has been examining social determinants and effects of adoption and non-adoption of digital technologies in a life course perspective. In particular, she is interested in the links between digital and social inequalities. More recently, Barbara has been studying how digital technologies can help combat social isolation and loneliness in later life. Her work has been published in a range of top-tier outlets in sociology and human-computer interaction.

Carrie Demmans Epp earned her Ph.D. from the University of Toronto and her MSc from the University of Saskatchewan. Since then, she has joined the Department of Computing Science at the University of Alberta where she leads the Educational Technology, Knowledge, Language, and Learning Analytics (EdTeKLA) Research Group. Her work focuses on the development of adaptive educational technologies, with much of her work focusing on supporting members of vulnerable populations.

Ronald Baecker is Chairman of famli.net Communications Inc., Emeritus Professor of Computer Science at the University of Toronto, and Founder of the Technologies for Aging Gracefully Lab (TAGlab).

Jacob O. Wobbrock is a full Professor of human-computer interaction in The Information School and an Adjunct Professor in the Paul G. Allen School of Computer Science & Engineering at the University of Washington in Seattle, WA, USA. His research focuses on input and interaction, human performance measurement and modeling, research and design methods, mobile computing, and accessible computing. He received the 2017 SIGCHI Social Impact Award for his development of ability-based design.

Chapter 15
Working Towards Fostering Programming Acceptance in the Everyday Lives of Older and Adult People with Low Levels of Formal Education: A Qualitative Case Study

Sergio Sayago, Angel Bergantiños and Paula Forbes

15.1 Introduction

This chapter discusses factors that contribute to the *possible*[1] acceptance (or rejection) of programming in the everyday lives of older and adult people with low levels of formal education. We do this by drawing upon three in-person courses on learning programming. The courses were hands-on introductions to Java, Scratch, App Inventor, and Processing. We conducted these courses with (N = 29) older and adult people with different cultural backgrounds (Spanish, Latin-American, East-European, Asian, and Arabian), over an 8-month period, between 2017 and 2018. We carried out the courses in an adult educational center in a working class neighborhood in Barcelona (Spain).

Technology acceptance is concerned with the factors that help us predict and explain why some technologies are accepted or rejected. With the introduction of digital technologies in multiple facets of contemporary living, and the pivotal role they play in most of them, technology acceptance has become an important and active research area. Technology acceptance research dates back to the 1980s, when

[1] We focus on possible rather than actual acceptance because the results of the case study show that programming and our participants are two worlds apart.

S. Sayago (✉) · A. Bergantiños
Universitat de Barcelona, Barcelona, Spain
e-mail: ssayago81@gmail.com

A. Bergantiños
e-mail: anbeye-94@hotmail.com

P. Forbes
Abertay University, Scotland, UK
e-mail: p.forbes@abertay.ac.uk

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_15

the seminal Technology Acceptance Model (TAM) was published (Davis 1986). Since then, TAM-like models, such as TAM2 (Venkatesh and Davis 2000) and UTAUT (Unified Theory of Acceptance and Use of Technology) (Venkatesh et al. 2003) have been published, with the goal of dealing more accurately with technology adoption in a context of growing widespread technology usage. These models have been applied—and validated—in a broad array of workplace/organizational contexts (Marangunić and Granić 2015), accounting for moderate-to-large percentages (between 17 and 70%) of the variance in user intentions to use technologies (Venkatesh et al. 2003). Much of this research is quantitative and has employed self-reported data (Chuttur 2009), which has some limitations—such as not actually focusing on technology usage. In this chapter, we explore technology (in particular, programming) acceptance—to be more precise, possible rather than actual acceptance—in a voluntary (learning) context, which differs considerably from the contexts in which much technology acceptance research has taken place, inasmuch as productivity, effectiveness, and efficiency, which are key constructs in TAM-like models, play a very minor role. We do this by adopting a qualitative approach, based on first-hand observations and conversations, in an attempt to better understand actual technology use and the reasons for the participants' behaviors and intentions.

In recent years, there has been a surge of public interest in promoting computer programming for all. Examples are the European Commission supported initiatives *Code Week* and *All You Need is Code*, along with specialized initiatives intended to introduce programming to school-aged children (K-12) and the launch of introductory programming university courses for students outside Computer Science (Chilana et al. 2016). This has given rise to critical views, which challenge the need of having *everyone* learn to code, e.g. (Shein 2014). Yet, programming, understood either in its traditional, low-level sense (i.e., turning out code) or from the viewpoint of computational thinking, i.e., learning how to think like a programmer, is widely seen as a key skill in the 21st century (Montfort 2016). As stated in (Guo 2017), programming skills can empower older people (65+), who represent a large and fast-growing fraction of the global population, to improve their quality of life, maintain part- or full-time employment, and compensate for the shortage of programming teachers in primary and secondary schools. However, little is known about the relationship between programming and older people. (Guo 2017) is the first known study of older adults learning computer programming. The profile of the older adults who participated in (Guo 2017) was skewed towards highly educated, technology-literate and self-motivated. In this chapter, we are interested in exploring the factors that can foster programming acceptance in the everyday lives of a very different profile of older people than that of those older adults who participated in (Guo 2017). We also enrich the discussion by adding an intergenerational perspective, which is important to understand similarities and differences between older and non-older people.

What factors can help us predict and explain the possible acceptance or rejection of programming among older and adult people with low levels of formal education? We discuss the relative relevance of key technology acceptance constructs, showing that Perceived Ease-Of-Use (PEOU) is much less important than Perceived Usefulness (PU) in fostering programming acceptance. All our participants perceived that they had to discover and understand the fit of programming in their lives, as opposed to those older people who participated in (Guo 2017), in order to decide to explore the technology further. PU has therefore a non-instrumental meaning in our case study. We also show that the figure of the course instructor and the group played a key role in fostering programming acceptance. The social atmosphere turned out to be key to encourage decision-making. Thus, we argue that the predominant focus on the individual in technology acceptance does not seem to predict and explain well enough possible acceptance or rejection in our case study; a shift to social acceptance seems more suitable for doing so. We also discuss some methodological—and ethical—issues, such as the difficulties in asking validated items of TAM (e.g., "I have the knowledge necessary to use the system") to older and adult people with low levels of formal education.

15.2 Overview of Related Works

There is a great deal of research on technology acceptance. In Sect. 15.2.1, we review selected studies, which help us to focus on three key aspects of previous research we aim to highlight in this chapter, because of their connection with the case study: the origins of TAM, its evolution, and criticisms. In Sect. 15.2.2, we turn to computer programming, which is also gaining traction in the HCI community, and discuss the 'for all' aspect from the viewpoint of older people and technology acceptance.

15.2.1 Technology Acceptance

"With growing technology needs in the 1970s, and increasing failures of system adoption in organizations, predicting system use became an area of interest. However, most of the studies carried out failed to produce reliable measures that could explain system acceptance of rejection" (Chuttur 2009, p. 159). To fill this gap, Fred Davis, in 1985, published the Technology Acceptance Model (TAM), wherein the user's attitude toward a system use is influenced by two major beliefs: Perceived Usefulness (PU) and Perceived Ease Of Use (PEOU). PU and PEOU are, respectively, originally defined as "The degree to which a person believes that using a particular system would enhance his or her job performance" and "The degree to which a person believes that using a system would be free of effort". The origins of TAM can be traced to a psychological theory, the Theory of Reasoned Action (TRA 2018). According to this theory, intention to perform a certain behavior precedes the actual behavior, and behavioral intention is a function of both attitudes and subjective norms, which are defined as a person's perception that most people who are important to him or her think s/he should or should not perform the behavior in question.

As stated in (Marangunić and Granić 2015), consistent findings that PU was a major determinant of the intention to use gave rise to an extended model, named TAM 2 (Venkatesh and Davis 2000), which sought to identify the variables that influence PU. The variables included are subjective norm, image (the desire of the user to maintain a favorable standing among others), job relevance (the degree to which the technology was applicable), output quality (the extent to which the technology adequately performed the required tasks), and result demonstrability (the production of tangible results). The Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003) is another important extension of TAM, formulating a unified model that integrates elements across eight models, including TRA and the Diffusion of Innovation of Rogers (2003). More recently, and prompted by the realization that new contexts of technology use might result in changes in theories, an extended version of UTAUT, named UTAUT 2 (Venkatesh 2012), has been proposed to study acceptance and use of technology in a consumer context, where price and hedonic motivation, such as fun and entertainment, are important factors. As stated in the introduction, several reviews indicate that TAM-like models have been validated in different workplace/organizational contexts (Marangunić and Granić 2015; Chuttur 2009). Yet, and despite a growing ageing population, older people have been mostly overlooked (Chen and Chan 2011; Comunello et al. 2015). In an attempt to fill this gap, and in light of the predictive and explanatory power of TAM-like models, an extended TAM for older people in gameplay contexts has been proposed (Wang and Sun 2016). The factors influencing acceptance of technology for aging in place have also been examined—although very little of this research has considered TAM-like models (Peek et al. 2014).

TAM has also been criticized, despite its predominant role in technology acceptance research. According to (Benbasat and Barki 2007), TAM-based research has paid scant attention to the antecedents of its belief constructs, failing to understand what actually makes a system useful, and the efforts to "patch-up" TAM in evolving IT contexts have not been based on solid and commonly accepted foundations, resulting in a state of theoretical confusion and chaos. In Chuttur (2009), it is stated that one of the main criticisms is that self-reported use data are used to measure system use instead of *actual* use data. Another important limitation, suggested and discussed in Chuttur (2009), is that TAM is a deterministic model, overlooking the fact that evaluation and reflection might direct a person to reformulate his or her intention, or even to take a different course of action. This is echoed in Benbasat and Barki (2007) by focusing on the "dynamic interplay" of the various behaviors that revolve around system use.

In this chapter, we do not aim to replicate, validate or propose a new TAM model. This is beyond the scope of this chapter. Our objective is to identify and discuss key constructs of TAM and TAM-like models—and to suggest new ones, if any—that aid in predicting and explaining the possible acceptance (or rejection) of programming among a potential, and mostly overlooked, group of programmers.

15.2.2 Computer Programming

Computer programming is no longer the domain of *programmers*. As stated in the Introduction, there is an increasing interest in opening up programming to everybody. However, computer programming for all falls behind its inclusive goal. Older people have been overlooked in most of the efforts, which tend to focus on kids and young people, and have been conducted at different levels, ranging from public initiatives to technological developments, such as Scratch[2] and App Inventor,[3] and research studies (Kafai and Burke 2014). A noteworthy exception is Guo (2017), which is based on an online survey on the motivations, learning practices, and frustrations of approximately 500 English-speaking older people (over 90% were Managers, Professionals or Technicians), from 52 different countries, who were learning programming by using an educational website. Guo (2017) shows that making up for missed learning opportunities during youth, keeping their brains challenged, and implementing a specific hobby project idea were the respondents' top three motivations for learning programming. The respondents also reported using free online resources, mostly MOOCs, blogs, and web tutorials. The three most important reported learning frustrations were bad pedagogy, cognitive impairments and no human contact with tutors or peers. Guo (2017) does not discuss the results in terms of, or by taking into account, technology acceptance constructs, despite its connection. We make this connection explicit, and discuss it, in this chapter.

15.3 The Case Study

In Sect. 15.3.1 we situate the case study in its context. In Sect. 15.3.2, we set out its key objective and provide an overview of how we conducted the case study and the profile of the participants who took part in it. In Sect. 15.3.3, we summarize the courses and present key aspects of the setting where we conducted them. In Sect. 15.3.4 we deal with data gathering and analysis.

15.3.1 Context

We carried out this case study within the context of the AGORA 4.0 project (https://agora4.org/), which aims to democratize technologies related to digital making amongst older and adult people in risk of social exclusion. In Barcelona, there is a growing interest in fostering digital making amongst its citizens. Examples are FabLab Barcelona,[4] which belongs to the fab.city global initiative,[5] intended to make locally productive, globally connected cities and citizens, and the *Ateneus de Fabricació* (in English, Athenaeum of Fabrication), which are a public service designed to disseminate digital making in society. These examples share the democratization goal

[2]https://scratch.mit.edu/. Accessed November 10, 2018.
[3]http://appinventor.mit.edu/explore/. Accessed November 10, 2018.
[4]https://fablabbcn.org/. Accessed November 10, 2018.
[5]https://fab.city/. Accessed November 10, 2018.

of the international digital making movement (Ames et al. 2014; Dougherty 2012). Making is also seen as enabling marginalized groups to participate in computing innovation (Lindtner et al. 2016). Yet, prior works point out that making in practice often falls short of its ideals, because those who participate in maker communities are mostly from the middle and upper classes, and the presence of women and minority populations remains low (Ames et al. 2014; Meissner et al. 2017). A noteworthy exception is Meissner et al. (2017), which reports on a qualitative study of making with people with disabilities. In AGORA 4.0, we have realized—in informal conversations and visits to the *Ateneus de Fabricació*—that a similar situation happens, as people at risk of social exclusion do not tend to participate in digital making activities, due to a number of factors, ranging from a lack of interest or technical knowledge to feeling 'like a fish out of water' and economic reasons.

15.3.2 Objective, Implementation and Profile of the Participants

The case study aims to contribute to this goal of digital democratization by focusing on programming, which is important for enabling participation in some digital making practices, such as modifying or building digital artifacts.[6] Working towards this end, we have carried out 3 free courses intended to provide older and adult people with low levels of formal education with a hands-on introduction to programming. The participants included a mix of older and adult active computer users. Most of the participants (23) were original from Spain. A few of them (6) were from Latin America, Eastern Europe, Asia and Arabic countries.

- Total number of participants: 29
- Age ranges: <30: 4; 31–40: 2; 41–50: 2; 51–60: 7; 61–70: 12; 71–80: 2
- Sex: 18 men, 11 women
- Participants/course: 6 participants in the first course; 11 in the second; 12 in the third. No participant took more than one course.

The courses focused on Java,[7] Scratch, App Inventor, and Processing.[8] Although the choice of the programming language or environment is not as important in this context as programming per se, we choose JAVA because of its popularity (TIOBE 2018), its connection with smartphones—via Android—and our previous experience of teaching it to undergraduate students. Scratch and App Inventor were chosen because of their apparent ease-of-use, they are block-based programming tools, and their connection, especially App Inventor, with mobile apps and smartphones, which are very popular nowadays. We also explored Processing because of it creativity

[6]Programming is also important in End-User Development (Díaz et al. 2015), which, in our view, is related to making in the sense of ordinary people creating their own technologies.

[7]https://www.java.com.

[8]https://processing.org/. Accessed November 10, 2018.

and visual aspect, being a programming language targeted at designers, with little experience of programming.

15.3.3 Courses and Setting

The in-person courses, which lasted between one and three months, were conducted by the first and second author. Overall, the structure of the courses was similar, with slightly different implementations, depending on the course and the participants' interests. We ran practical sessions, in which we conducted live coding and asked the participants to make predictions (i.e., what they thought the program would do). The participants also did a number of classical exercises (e.g., writing a program to check if a number is odd or even) by programming individually and in pairs, and solving Parsons Problems (where chunks of code have to be placed in the correct order). We followed a number of tips for teaching programming "at any level and to any audience" (Brown and Wilson 2018, p. 1).

We conducted these courses in Àgora (AG), an adult educational center in Barcelona, Spain, and partner of the project (see Fig. 15.1). These courses had the same format (weekly sessions of 2-h long) as the other courses on computers in AG, which has been operating for almost 40 years. Since the 1980s, AG has been fostering the social and digital inclusion of people who are, or might be, excluded from the Catalan society, such as immigrants and older people. To this end, AG adopts a dialogical learning approach, which empowers the students—using AG terminology, participants—to decide what they want to learn in free courses. AGORA conducted the recruitment of the participants, and written consent forms were obtained.

Fig. 15.1 Participants in one of the programming courses

15.3.4 Data Gathering and Analysis

We took paper and computer notes of our conversations and observations immediately after the sessions, which were so active that they hindered in situ note-taking. We then analysed these notes by reading them every week and finding key topics related to technology acceptance constructs. We wrote working drafts of the results (and this chapter) and shared them with the authors of this chapter and colleagues who did not take part in the fieldwork. These drafts were updated until the authors agreed on the results.

15.4 Relevant Findings

PU and PEOU are two key constructs in TAM-like models. In Sect. 15.4.1, we discuss their relative relevance in the case study. While technology acceptance has a strong focus on the individual, in Sect. 15.4.2 we highlight the importance of two key social aspects in the participants' possible acceptance of computer programming: the group and the course instructor. In Sect. 15.4.3 we discuss an important implementation aspect—the order in which programming tools are introduced in courses—and suggest an important construct in technology acceptance in this context: perception of exclusion. In Sect. 15.4.4, we present some difficulties in conducting questionnaires to measure possible technology acceptance constructs with older people with low levels of formal education.

15.4.1 PU is More Important than PEOU

Overall, observations and conversations confirmed that PU is far more important than PEOU in fostering programming acceptance. This relative relevance is exemplified in three key aspects.

Firstly, when asked about the reasons for taking on the courses, participants answered that they were there "*to know what programming is*", "*to know what I can do with programming*", and "*to learn more about computers and the Internet*". Our interpretation of these answers is that they were finding out the usefulness—in a broad sense, 'what it is and what I can do with it'—of programming.

Secondly, although learning programming was not easy, participants' attendance was very regular, and they felt unease when they could not come. During the courses, we observed that learning programming was far from straightforward for them. Their most common difficulties were to write programs without syntactical errors—common errors were missing symbols, such as a semicolon, and parenthesis or brackets—and turning a problem into a representation the computer understands (i.e., a program) by using key structures, such as conditional (if-else) and iterative (while, for) statements. Yet, these difficulties did not put our participants off taking on the courses.

Thirdly, as the participants were gaining more programming experience, their questions and comments highlighted the usefulness—namely, the *fit*—of programming in their lives. For instance, some participants showed us exercises, which related to their interests, they had done at home in order to know more about programming and what they could do with it. Others told us that they were trying to see the role or usefulness of programming in their everyday lives. In this sense, participants, especially the younger ones, and those with more experience with computers, wanted to know things that mattered to them, for instance, how to program a game or a chatbot in their smartphone.

The relative relevance of PU over PEOU was also visible in programming rejection. Throughout the project, we met participants who took the first course. These participants did not enrol on any other courses on programming. Our conversations with them stressed the importance of PU. As one of them told us "*the course was interesting, and you're a great teacher, but I don't see the fit of programming in my life. It's something far removed from my life—at least now*".

15.4.2 Social Technology Acceptance: The Group and the Course Instructor

Two social aspects stood out in working towards programming acceptance among our participants: the group and the course instructor. The group played a key role in sustaining participants' interest over time. Learning computer programming in the company of others, sharing their comments and doubts, supporting and learning from each other, was very important for the participants to learn and discover programming, which is a key step towards acceptance. As acknowledged by them, "*Being here is very important. I don't see myself learning programming alone at home*". Within this context, another significant social aspect was the figure of the course instructor.[9] In the courses, the instructors were the first two authors of the chapter. They were the people responsible for creating the learning materials, which are available online (agora4.org), and running the sessions, and were faced with a number of important difficulties. What is an authentic learning activity in programming in this context and with this profile of participants? How does one explain what a variable, a program, a conditional statement, debugging… is to older and adult people with low level of formal education? They could not fall back to their—mostly, the first author's—previous experience of teaching other computer-based technologies to older people, as they did not know either the interests or needs of our participants. Our technological background did not help us either, because we found it very difficult to find appropriate examples and exercises, understandable terminology…Most of these difficulties

[9]This finding is more related to the authors' own reflection on their impact on the case study than on participants' comments and views.

were not overcome at the end of the courses. Yet, by being patient and attentive to participants' interests and needs, and encouraging them to participate in the sessions (by voicing their views, opinions…and definitions!), the instructors managed to run the sessions smoothly and maintain participants' motivation throughout them.

15.4.3 POE (Perception of Exclusion)

The possible acceptance of programming, and some programming tools, was either hindered or fostered by the order in which they were introduced in the courses. We were not aware that the order mattered. However, the order of introduction helped us identify a new (or different) construct in technology acceptance—perception of exclusion, which we define as the degree to which a person believes that using a technology makes them become or feel like an 'extraordinary' computer user. In the first course, participants programmed in JAVA with Netbeans, a professional IDE, and Scratch was introduced at the end of the course. Participants' refused to use Scratch, on the grounds that it was perceived as something too simple that made them feel stupid. In the other courses, however, we introduced Scratch—and another block-based programming tool, App Inventor—during the first weeks. We did so because we considered that both could be a smooth, visual and useful introduction to programming. The participants' acceptance of both was positive, confirming our hypothesis. Some of the reasons stated were simplicity and clarity. Their opinion did not make them refuse other, more professionally looking programming tools, such as the Processing IDE.[10]

15.4.4 'I Consider I Have the Knowledge Necessary'

In a previous project, which was about digital games and older people, we explored the acceptance of digital games. We did so by using questionnaires, which consisted of Likert scales of validated technology acceptance constructs, such as "I have the knowledge necessary to use the system". In addition to modifying these constructs, which make reference to productivity and efficiency issues, we found, as one could expect, that our participants were 'insulted' when asked about their knowledge. Prompted by the heterogeneity of the older population, we wanted to know if a similar behavior could be exhibited by a different group of participants in a different context. In the first course, we also attempted to administer a questionnaire based on TAM constructs, with very similar comments. For instance, "*I think some people can take offense if you ask them about their knowledge. We know we don't have much knowledge of many things (…)*" We did not ask the participants to complete any questionnaires about acceptance in the other courses. Instead, we talked to them, which was far more natural, and easy for them.

[10]http://download.processing.org/processing-3.3.7-windows32.zip. Accessed November 10, 2018.

15.5 Discussion

This chapter has explored technology acceptance in a, perhaps, rather unusual way. To begin with, given that the case study has been conducted in a learning scenario, it could be argued that this chapter has not explored technology acceptance but learning motivations and difficulties. While we acknowledge the likely and unavoidable overlap,[11] the results show that a voluntary learning scenario is very rich in terms of technology acceptance, as it helps us identify potential factors that contribute to foster programming acceptance amongst older and adult people with low levels of formal education. In light of the results presented, there are also reasons to argue that *actual* programming acceptance is very difficult to explore in other contexts with this profile of participants, as programming is very far removed from their everyday lives, and they first need to discover it. In addition to this, while technology acceptance research traditionally focuses on a single system, which system have we explored? We have not focused on any programming tool in particular, as the challenge was to start to understand the almost overlooked relationship between our participants and programming. Having focused on a single programming tool could have provided, in our opinion, a very partial and limited view.

In the first three subsections (Sects. 15.5.1, 15.5.2 and 15.5.3), we discuss the three key contributions this chapter makes to HCI research with older people. In Sect. 15.5.4, we discuss some implications that can be drawn from the results, and in Sect. 15.5.5, important limitations.

15.5.1 An Intergenerational Case Study of Fostering Programming Acceptance

As discussed in Sect. 15.2, technology acceptance research has mostly overlooked older people. To the best of our knowledge, this chapter is the first study that explores factors that can contribute to foster programming acceptance amongst older and adult people with low levels of formal education. Despite the evident heterogeneity of older people, which is often alluded to in older-adult HCI, the results show that our participants, with different cultural backgrounds and age ranges, do not differ considerably as far as possible programming acceptance (or rejection) is concerned. This chapter has adopted a qualitative approach, which does not predominate—an exception is Peek et al. (2014)—in technology acceptance research, which is heavily dominated by questionnaires and surveys. The results show that a quantitative approach can prove to be very difficult—if not impossible—with the profile of participants. This qualitative approach has been implemented in a learning and voluntary scenario, which differs considerably from the mandatory, workplace/organizational contexts where technology acceptance research tends

[11] Learning is an item of PEOU, e.g. "Learning to operate the system would be easy for me" (Venkatesh et al. 2003).

to be conducted. This scenario also differs from previous studies of technology acceptance for ageing in place (Peek et al. 2014). This learning scenario, which has prompted us to focus on possible rather than actual acceptance, corresponds to an "in the wild" situation (Rogers and Marshall 2017), which is gaining traction in HCI, and is in accordance with changes in TAM (e.g. UTAUT2), which have been prompted by changes in contexts of technology usage.

15.5.2 Relative Relevance of Technology Acceptance Constructs

We have revealed and explained that PU is far more important than PEOU in fostering programming acceptance (and rejection) among our participants. In particular, we have argued for changing "usefulness" for *fit in their lives*, which is a more suitable expression or concept in the context of our case study, as usefulness seems to be narrowed down to 'getting things done' in technology acceptance research. The concept of 'fit in their lives' shows the importance of a purposeful interaction with the world and activity, which are key elements of a theoretical foundation in HCI—Activity Theory (Kaptelinin and Nardi 2006).

We have not seen other technology acceptance constructs, such as price, computer anxiety, society norms, and gender, playing an important role in our results. Nevertheless, this is not to say that they play no role—technology acceptance research dates back from the 1980s and it would be risky to make such a claim. This lack of importance might be due to the yet-to-be explored relationship between programming and older and adult people with low levels of formal education. Future research can deepen and widen our results.

15.5.3 New (or Different) Elements of and Constructs in Technology Acceptance

We have highlighted the importance of the group and the course instructor. The former is, or can be seen as being, loosely tied to the subjective norm element of TAM-like models, in the sense of 'the impact of others on my acceptance'. The latter is, to the best of our knowledge, not acknowledged in any TAM-like models. This reinforces previous claims, which argue for looking at social acceptance (Benbasat and Barki 2007), and one of the key elements in the diffusion of innovation: a social system (Rogers 2003). The importance of the group and the course instructor are two concrete and practical examples of this social side of technology acceptance beyond subjective norms.

We have also stressed the need to consider Perceived Exclusion (PE), which has not been addressed in any TAM-like model we are aware of. On the one hand, the addition of this new construct reinforces claims about the lack of a consolidated theory in TAM (Benbasat and Barki 2007). On the other hand, this construct can be taken as an opportunity to keep improving our understanding of technology acceptance and, eventually, to formulate—if it can exist at all—a general, or more inclusive, theory of technology acceptance. Working towards this goal, it is interesting to note that our PE is similar to the stigmatization found in a systematic review of technology acceptance for ageing in place (Peek et al. 2014).

15.5.4 Some Implications

The results show a number of concrete aspects, such as the importance of the fit of programming in people's lives, the need to consider both individual and social acceptance, and the relevance of the order in which some programming tools are introduced, that can both help us to foster programming acceptance among people who are not usually regarded as programmers and contribute to either achieve or reinforce the inclusive aspect of computer programming for all initiatives.

The results show that computer programming for all can be approached not only from the perspective of learning but also from the viewpoint of technology acceptance—understanding technology not as a single system but in a broader, and, perhaps, richer, sense. The results also show that doing so helps us understand further the—arguably complex—relationship between older and adult people with low levels of formal education and computer programming. Our results differ considerably from those discussed in Guo (2017). Yet, taken together, the results provide a richer picture of computer programming and older people.

The current or predominant perspective on HCI research with older people discussed in the book does not seem to account well enough for the type of technology acceptance discussed in this chapter, as the focus on help and compensation does not reflect well enough other aspects—such as PE and fit in their lives—that come into play into our participants' possible acceptance of programming. The current—third—wave of HCI research seems more suitable for doing so.

Older people might not be such a heterogeneous user group as they might be in other contexts as far as programming acceptance is concerned. As discussed in Sect. 5.1, we have not identified major differences amongst our participants. This apparent homogeneity suggests that the issues discussed in the chapter can apply to several potential adopters of programming, regardless of their chronological age—and even cultural background.

15.5.5 Main Limitations

We have focused on possible and not actual programming acceptance. While this can be seen as an important limitation, our results suggest that we are still far from being able to explore actual programming acceptance among older and adult people with low levels of formal education.

The data gathered does not allow us to claim that our participants will adopt programming after the courses. Yet, these courses have provided them with a hands-on introduction to an unknown technology for them, and this might pave the way for further exploration, acceptance and use. This is not a small result; the findings of the chapter show that our participants and programming are thus far, two worlds apart.

We do not claim that our results can be generalized to other contexts, either online or f2f, and users. This was not our objective, as we aimed to understand technology acceptance within a particular case. Methodologically speaking, a case study is not the best method to argue for general results. Yet, this is not to say that the results cannot apply to other contexts. For instance, we ran a number of 3D printing courses within the context of AGORA 4.0 with different users, and we found very similar results. With the exception of the first author, none of the others was involved in the 3D courses. Further—perhaps, a combination of qualitative and quantitative—research can validate our findings.

Another relevant limitation is the interplay of constructs in programming acceptance (or rejection). We have not addressed the extent to which a construct modifies or determines another. Nor have we examined the temporal aspect of programming acceptance or the consequences of doing so. Adopting—or, in the participants' words—finding the fit of a completely new technology into one's lives takes time, and this process is, arguably, iterative, dynamic, and not deterministic. Perhaps, the complexity of the relationship between programming and older and adult people with low levels of formal education makes it difficult to explore these aspects in a single case study.

15.6 Conclusion

This chapter makes four distinguishing contributions to HCI research with older people. This chapter

- discusses factors that can contribute to help us predict and explain, and foster, programming acceptance among older and adult people with low levels of formal education,
- discusses the relative relevance of important technology acceptance constructs in a relatively unexplored context, and with a mostly overlooked profile of people,
- suggests new elements and constructs to better understand and encourage programming acceptance among older and adult people with low levels of formal education and different cultural backgrounds,
- discusses some methodological issues, which reinforce the need to adapt research methods to older people discussed in chapters of this book.

These contributions introduce a new perspective not only on HCI research with older people, especially that concerned with programming, but also technology acceptance research.

In terms of future perspectives, we plan to look at the results of the courses on 3D printing, and other activities carried out in the AGORA 4.0 project, such as public events in the local neighborhood, from the perspective of technology acceptance, and write the final report of the project. We also aim to understand further the model of Diffusion of Innovations, within which programming can be understood as an *innovation*, which is *communicated* through certain channels over *time* among the members of a *social system*. Addressing these issues seems to provide a complementary and interesting explanation for some of the results of our case study, and operationalized ways of democratizing further programming.

Acknowledgements We are indebted to l'Escola d'Adults de la Verneda—St. Martí, l'Associació de Participants Àgora, and to all our lovely participants, for their interest in the project and allowing us to collaborate with them, share their views and opinions in publications related to our research, and for helping us to keep learning more about the 'older' side of digital technologies. We also acknowledge the outstanding tasks carried out by Pau Blanco, Irene Sainz, Rosa Lloret and Mª Jesús Quesada in the 3D courses. We thank Josep Blat and Mireia Ribera for their comments on earlier versions of the chapter. We acknowledge the support from the Barcelona city council.

References

All you need is code (2018). http://www.allyouneediscode.eu/. Accessed 10 Nov 2018

Ames M, Bardzell J, Bardzell S et al (2014) Making cultures: empowerment, participation, and democracy—or not? In: CHI 2014 extended abstracts on human factors in computing systems (CHI EA 2014), pp 1087–1092

Benbasat I, Barki H (2007) Quo vadis, TAM? J Assoc Inf Syst 8(4):211–218

Brown N, Wilson G (2018) Ten quick tips for teaching programming. PLoS Comput Biol 14(4):1–8

Chen K, Chan, AHS (2011) A review of technology acceptance by older adults. Gerontechnology 10(1):1–12

Chilana P, Singh R, Guo P (2016) Understanding conversational programmers: a perspective from the software industry. In: Proceedings of the 2016 CHI conference on human factors in computing systems (CHI 2016), pp 1462–1472

Chuttur M (2009) Overview of the technology acceptance model: origins, developments and future directions. Sprouts: Working Papers on Information Systems, vol 9

Code Week (2018). http://codeweek.eu/. Accessed 20 Nov 2018

Comunello F, Mulargia S, Belotti F et al (2015) Acceptance of ICTs by older adults: a review of recent studies. In: ITAP (international conference on human aspects of IT for the aged population), pp 239–249

Davis FD (1986) A technology acceptance model for empirically testing new end-user information systems: theory and results. MIT Sloan School of Management, Cambridge, MA

Díaz P, Pipek V, Ardito C et al (2015) End-user development. Springer, Cham

Dougherty D (2012) The maker movement. Innovations 7(3):11–14

Guo P (2017) Older adults learning computer programming: motivations, frustrations, and design opportunities. In: Proceedings of the 2017 CHI conference on human factors in computing systems (CHI 2017), pp 7070–7083

Kafai Y, Burke Q (2014) Connected code: why children need to learn programming. The MIT Press, Cambridge, MA

Kaptelinin V, Nardi B (2006) Acting with technology: activity theory and interaction design. The MIT Press, Cambridge, Massachussets

Lindtner S, Bardzell S, Bardzell J (2016) Reconstituting the utopian vision of making. In: Proceedings of the 2016 CHI conference on human factors in computing systems (CHI 2016), pp 1390–1402

Marangunić N, Granić A (2015) Technology acceptance model: a literature review from 1986 to 2013. Univ Access Inf Soc 14(1):81–95
Meissner J, Vines J, McLaughlin J et al (2017) Do-it-yourself empowerment as experienced by novice makers with disabilities. In: Proceedings of the 2017 conference on designing interactive systems (DIS 2017), pp 1053–1065
Montfort N (2016) Exploratory programming for the arts and humanities. MIT Press, Cambridge, MA
Peek S, Wouters E, van Hoff J et al (2014) Factors influencing acceptance of technology for aging in place: a systematic review. International Journal of Medical Informatics 83(4):235–248
Rogers E (2003) Diffusion of innovations. Free Press, London
Rogers Y, Marshall P (2017) Research in the wild. Morgan & Claypool, USA
Shein E (2014) Should everybody learn to code? Communications of the ACM 57(2):16–18
TIOBE index (2018). https://www.tiobe.com/tiobe-index/. Accessed 10 Nov 2018
TRA (2018). https://en.wikipedia.org/wiki/Theory_of_reasoned_action. Accessed 10 Nov 2018
Venkatesh V (2012) Consumer acceptance and use of information technology: extending the unified theory. MIS Q 36(1):157–178
Venkatesh V, Davis FD (2000) A theoretical extension of the technology acceptance model: four longitudinal field studies. Manag Sci 46(2):186–204
Venkatesh V, Morris MG, Davis GB et al (2003) User acceptance of information technology: toward a unified view. MIS Q 27(3):425–478
Wang Q, Sun X (2016) Investigating gameplay intention of the elderly using an extended technology acceptance model (ETAM). Technol Forecast Soc Chang 107:59–68

Sergio Sayago (Ph.D., Human-Computer Interaction/Computer Science, Universitat Pompeu Fabra, Barcelona) has been conducting HCI research with older people since 2004. He has conducted long-term ethnographic, participant observation and co-design studies of real-life web accessibility (WCAG) and technology use, mostly communication and digital games, in different cultural settings. His current research focuses on long-term empowerment and democratization, addressing making, programming, and (embodied) conversational interfaces, with older and adult people with low levels of formal education.

Angel Bergantiños (BSc, Computer Science with a minor in Mathematics, Universitat de Barcelona) is a computer engineer. He has worked on a number of small projects on machine learning and gamification. He participated in the AGORA 4.0 project (2017–2018), funded by the Barcelona City Council. He developed the accessible website of the project and ran courses on programming for older and adult people with low levels of formal education.

Paula Forbes is a post-doc researcher in the School of Design and Informatics at Abertay University (Scotland). Her main interests are user research and user experience. Paula has participated in a number of interdisciplinary projects across the field of HCI, older people, sustainability and e-health. Paula has several years of experience of working with older people to support their technology learning, after setting up the Dundee User Centre.

Part VI
Conclusion and Future Perspectives

Chapter 16
Editorial Conclusion—Where Do We Go from Here?

Sergio Sayago

16.1 Main Objectives and Summary of Key Findings

To wrap up this book, I recap its two main objectives and present a succinct summary of the key findings.

One of the objectives of this book was to promote a critical reflection about the research conducted in HCI with older people thus far. This book does not intend to provide a full, comprehensive and systematic review of the field. Although this can be seen as limitation, the analysis presented in the editorial introduction, which cites exemplary previous publications of the several issues discussed, indicates that a strong focus on age-related changes in functional abilities, help and health characterizes contemporary older-adult HCI research. On the whole, the research conducted until now has not kept up with changes in paradigms of HCI, which have been prompted by, and aligned with, the evolution of digital technologies, and changes in technology use. The complexity, diversity and richness of old age and ageing have yet to be fully addressed, as current research focuses mostly on the individual, social and negative side of ageing. This current state, which might be accounted for by the fact that older people—as opposed to other 'ordinary' user groups, such as undergraduate students—have been overlooked in HCI research until relatively recently, does not help us understand, appreciate, and design the relationship between older people and digital technologies to maximise potential in the early 21st century. Several examples have been provided in the editorial introduction.

Another objective of the book was to introduce a new (or different) perspective on HCI research with older people. Much as there are a number of aspects of the current perspective that warrants more research, as the different chapters show, this book has been less concerned with providing new answers to questions of digital technology and older people that have driven the field since the 2000s (e.g. How do we design

S. Sayago (✉)
Universitat de Barcelona, Barcelona, Spain
e-mail: ssayago81@gmail.com

S. Sayago (ed.), *Perspectives on Human-Computer Interaction Research with Older People*, Human–Computer Interaction Series,
https://doi.org/10.1007/978-3-030-06076-3_16

UI that make up for age-related changes in functional capabilities?) than introducing a new, or different, perspective that aids in taking older-adult HCI research forward. On the whole, the perspective that emerges from the chapters, whose contributors come from different research areas, is interdisciplinary, and has three key elements:

(i) To address topics that include, but also *go beyond* age-related decline, health, help and isolation, such as leisure, fun and culture, to delve into the role of digital technologies in multiple facets of older people's lives.
(ii) To focus more on doing research and designing technologies *with* and *for* older adults, and their local communities, to avoid and fight against negative social conceptions of ageing, such as ageism.
(iii) To examine older people's *life course (and transitions)*, *strengths*, *interests*, and *values*, as well as their limitations and needs, to design technologies that not only help older people do something but also empower them.

These elements are put into practice, in different ways, in several chapters of this book.

16.2 A Few 'Final' Words About the New (Different) Perspective

The perspective introduced in this book sheds new light on HCI research with older people. Within this perspective, older people are much more than a set of 'human factors'. They can be seen as Human/Social Actors. The topics addressed go beyond social isolation, independent living and health. Digital technologies are not only designed for helping them to do something but also to *empower* them. The notions of empowerment (Schneider et al. 2018) of this perspective can be characterised in terms of (a) power-to (i.e., extending abilities), (b) feel, know and do (i.e., feel empowered, acquire new skills and a better understanding of issues that matter to older people, and behave differently), (c) persistent (i.e., empowerment lasts beyond technology use), and (d) participatory (i.e., HCI research with older people). This view is more aligned with the current or third wave of HCI research.

The perspective introduced in this book is interdisciplinary. The chapters of the book are written by scholars working in Sociology, Communication, Psychology, Information Studies, Information Design, and Computer Science. This interdisciplinary aspect, which is an important aspect in research but not easy to achieve,[1] reinforces the perspective introduced in the book.

The perspective introduced in this book aims to widen and deepen the current research, not to ignore it. We should obviously take notice of the importance of designing technologies that make up for age-changes in functional abilities. We should not underestimate the importance that health, socialisation and living (not

[1] See, for instance, a special issue in Nature devoted to the topic "Interdisciplinarity"—nature.com/inter.

surviving) as independently as possible for a large number of (older) people. Also, important open questions about the decline of functional abilities should be addressed. For example, virtually all we know about cognitive aging was learned from studies conducted on persons born in the early part of the last century (Hofer and Alwin 2008). Whether (and how) this current knowledge will be applicable to the next generation of older people (aka "Baby Boomers"), who tend to have higher levels of formal education and more experience of using digital technologies than do the current generation of older people, is—probably—an important topic to further investigate.

The perspective introduced in the book is an invitation to keep reflecting on, and pushing boundaries in HCI research with, and for, older people. It is my hope that this perspective and book stimulate further research. Working towards this end, I summarize a number of future research opportunities. Some of these opportunities are prompted by the issues discussed in several chapters of this book, and this adds extra value to them. Others, however, are more related to my own and steady reflection on this field, and research I have been conducting since the 2000s. How to address these future opportunities and where doing so will take us are open questions, which, perhaps, could be discussed in a second edition of this book.

16.3 Future Research Opportunities

16.3.1 Towards Strengthening the Theoretical and Interdisciplinary Aspect

A great deal of HCI research with older people—and this book included—has hitherto been performed in a rather descriptive fashion, without strong integration of interdisciplinary theories of ageing, despite their importance and apparent connection, hindering systematic and cross-disciplinary knowledge development. For instance, the third (most recent) edition of the *Handbook of Theories of Aging* (Bengston and Settersten 2016) with 35 chapters addresses theories and concepts built on cumulative knowledge in Biology, Psychology, Social Sciences, Policy and Practice. It is beyond the aim of this editorial conclusion to discuss how and why several theories of ageing help us explain, predict and inform HCI research with older people. However, in this final chapter aim to reflect on the need for strengthening the theoretical (and interdisciplinary) aspect of older-adult HCI, a need also highlighted in (Barbosa and Vetere 2019).

Much as theories help us avoid highly descriptive papers with little interpretation as to why the results occurred or why they matter beyond mere description, theory development within HCI research with older people (and in other HCI areas, such as speech (Clark et al. in print)) is not a top priority. However, this fact seems to contradict the hallmark of HCI, "importing and adapting alternative theories from other areas to address new concerns in HCI continues to be a staple of HCI research"

(Rogers 2012, p. 14), and the well-known importance of theory in advancing knowledge in any scientific field. HCI research with older people is at an early stage of development, and most of us might be either unaware or have not paid enough attention to theories of ageing in our work thus far. There is an opportunity to improve this aspect in the near future, wherein interdisciplinary research is likely to play a very important role, as the relationship between older people (and ageing) and digital technologies is so complex that it cannot be adequately addressed by people from just one discipline.

16.3.2 To Know Our Research Methods Better

Within HCI, "we borrow research methods from a number of different fields, modify them, and create our own "standards" for what is considered acceptable research" (Lazar et al. 2017, p. 1). Within HCI research with older people, we are no different. Yet, we still know little about how to conduct research methods which are suitable for older people and practical to research/ design purposes in a rigorous way. Chapter 13, for instance, points out that some usability testing methods are very difficult to carry out with older people. Chapter 13 also shows that experts adapt these methods to effectively conduct usability evaluations with older adults. This resonates with (Franz et al. 2015) and (Dickinson et al. 2007), where it is argued that "the elicitation of high-quality data from these participants (older people) requires alterations in research methods" (ibid, p. 343). This need for adapting research (and design) methods has also been identified in HCI research with children (Alan et al. 2012). How does this adaptation of methods affect reliability, i.e., the extent to which a study can be replicated, and validity, i.e., the extent to which a study 'measures' what it is supposed to measure? If two studies conduct the same research methods, but they adapt/ conduct them in different ways, to what extent are their results comparable if the studies do not report on the adaptations carried out? What are the "standards", or, perhaps, guiding principles, for what is considered acceptable HCI research methods with older people? Do we need guidelines for methods, or will they be too strict?

16.3.3 The Next Generation of Older People

Following up on methodological aspects, how valid will our results be when the next generation of older adults—that is, most of today's ICT-literate adult people—grow older? Do we need to adapt our research methods to them too—and if so, how, and why? The current generation of older people is by and large characterized by little or moderate previous experience of using digital technologies. However, the next generation of older people will probably exhibit much more experience with digital technologies than do today's older adults. That said, they—the next wave of older adults—are also likely to find themselves using technologies they are not familiar with. Digital technologies evolve quickly. What interaction issues are due to ageing and which to technology experience? Some previous research has partially addressed this question (Hanson 2009; Sayago et al. 2011), showing cognitive-related issues are time-persistent, while others, such as those brought about by previous experience with technology, are overcome overtime. However, much more research is needed.

16.3.4 More Digital Empowerment and Democratization of Technologies

While older people tend to be seen as passive users of digital technologies, there is a growing transition in HCI to seeing them as digital content creators and exploring their digital practices (Guo 2018; Ferreira et al. 2017; Brewer and Piper 2016). Chapters of this book (namely, Chaps. 11, 12 and 15) are examples of this transition. In light of recent socio-technological trends, such as computer programming for all (e.g., Code Week[2]) and the digital making movement (or culture) (Dougherty 2012), there is room for thinking that in years to come, we will explore and take this transition one step forward: from creating digital content to building, programming or modifying software and tangible digital artifacts. Chapter 15 is a step towards this transition and opens up a number of unanswered research questions. In my view, the key question is not whether older people are or are not able to program and to use technologies related to digital making. Previous research has shown that older people are indeed able to learn to use technology—not without difficulties, though. The key question seems to be how to find meaningful ways to empower them effectively and to make these technologies more democratic, because, as Chap. 15 shows, these computing revolutions are nowadays very far removed from most older people, even those who are active computer users. The notion of empowerment (Schneider et al. 2018) that meets better older people's interests, aspirations and needs in a making and programming context is another future research aspect.

16.3.5 Age as a Property of Individuals and Society Too

Much HCI research with older people sees age as a property of individuals or groups. A noteworthy example is chronological age, which serves as a gauge to know where we are in life. Three chapters (Chaps. 2, 3, and 9), however, touch upon ageism (Nelson 2002), which is a different way of seeing age: as a property of society (Settersten and Godlewski 2016). As stated by the World Health Organization, "ageism is the stereotyping, prejudice and discrimination against people on the basis of their age (…) For older people, ageism is an everyday challenge (…) ageism is everywhere, yet it is the most socially normalized of any prejudice, and is not widely

[2]http://codeweek.eu/.

countered".[3] Ageism, to the best of my knowledge, is not a core topic in older-adult HCI. However, if we assume that one of our (perhaps, most important) goals as HCI researchers is to have a positive impact on people's lives, and in light of its pervasiveness and strong negative effects on older people (Nelson 2002), it is clear that more HCI research on ageism, and other (negative) ways of seeing age as a property of society, is needed. Rephrasing Laura Cartensen in (2011), "new longevity (*HCI research with older people*) is about the young at least as much as the old" (p. 10).

References

Alan J, Leigh M, Druin A (2012) Methods and techniques for involving children in the design of new technology for children. Found Trends Hum Comput Interact 6(2):85–166

Barbosa, B, Vetere, F (Eds) (2019, in print) Ageing and digital technology: designing and evaluating emerging technologies for older adults. Springer

Bengtson V, Settersten R (eds) (2016) Handbook of theories of aging. Springer, New York

Brewer R, Piper AM (2016) "Tell it like it really is": a case of online content creation and sharing among older adult bloggers. In: Proceeding of the 2016 CHI conference on human factors in computing systems

Carstensen LL (2011) A long bright future. Happiness, health, and finanicial security in an age of increased longevity. Public Affairs, New York

Clark L, Doyle P, Garaialde D et al (in print) The state of speech in HCI: trends, themes, and challenges. Interact Comput. https://arxiv.org/pdf/1810.06828

Dickinson A, Arnott J, Prior S (2007) Methods for human-computer interaction research with older people. Behav Inf Technol 26(4):343–352

Dougherty D (2012) The maker movement. Innovations 7(3):11–14

Ferreira SM, Sayago S, Blat J (2017) Older people's production and appropriation of digital videos: an ethnographic study. Behav Inf Technol 36(6):557–574

Franz R, Munteanu C, Neves BB et al (2015) Time to retire old methodologies? Reflecting on conducting usability evaluations with older adults. In: MobileHCI, pp 912–915

Guo P (2018) Older adults learning computer programming: motivations, frustrations, and design opportunities. In: CHI 2017, Denver, Colorado, p 7070

Hanson V (2009) Age and web access: the next generation. In: W4A 2009 proceedings of the 2009 international cross-disciplinary conference on web accessibililty (W4A), vol 44, pp 7–15. https://doi.org/10.1145/1535654.1535658

Hofer S, Alwin D (2008) Handbook of cognitive aging. interdisciplinary perspectives. Sage, USA

Lazar J, Heidi J, Hochheiser H (2017) Research methods in human-computer interaction. Morgan Kaufmann Publishers, US

Nelson T (ed) (2002) Ageism: stereotyping and prejudice against older persons. The MIT Press, London

Rogers Y (2012) HCI theory. Classical, modern, and contemporary. Morgan & Claypool, USA

Sayago S, Sloan D, Blat J (2011) Everyday use of computer-mediated communication tools and its evolution over time: an ethnographical study with older people. Interact Comput 23(5):543–554

Settersten R, Godlewski B (2016) Concepts and theories of age and aging. In: Bengtson V, Settersten R (eds) Handbook of theories of ageing. Springer, New York

Schneider H, Eiband M, Ullrich D et al (2018) Empowerment in HCI—a survey and framework. In: Proceedings of the 2018 CHI conference on human factors in computing systems—CHI 2018, pp 1–14

[3]http://www.who.int/ageing/ageism/en/.

Sergio Sayago (Ph.D., Human-Computer Interaction/Computer Science, Universitat Pompeu Fabra, Barcelona) has been conducting HCI research with older people since 2004. He has conducted long-term ethnographic, participant observation and co-design studies of real-life web accessibility (WCAG) and technology use, mostly communication and digital games, in different cultural settings. His current research focuses on long-term empowerment and democratization, addressing making, programming, and (embodied) conversational interfaces, with older and adult people with low levels of formal education.