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Design Considerations for Human-Robot-Interaction in Older Adults' Living Spaces

DISSERTATION

zur Erlangung des akademischen Grades

Doktorin der Technischen Wissenschaften

eingereicht von

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an der Fakultät für Informatik

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Erklärung zur Verfassung der Arbeit

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Hiermit erkläre ich, dass ich diese Arbeit selbständig verfasst habe, dass ich die verwendeten Quellen und Hilfsmittel vollständig angegeben habe und dass ich die Stellen der Arbeit – einschließlich Tabellen, Karten und Abbildungen –, die anderen Werken oder dem Internet im Wortlaut oder dem Sinn nach entnommen sind, auf jeden Fall unter Angabe der Quelle als Entlehnung kenntlich gemacht habe.

Wien, 19. April 2022

Isabel Schwaninger

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Kurzfassung

Assistive Technologien wie Roboter werden auch als Antwort auf die alternde Gesellschaft entwickelt. Die Art und Weise, wie Roboter im Alltag potenziell Einzug finden können, ist - neben Fragen der technischen Machbarkeit, welche im Bereich der Mensch-Roboter-Interaktion (MRI) häufig untersucht wird - sehr komplex, nicht zuletzt, da diverse Stakeholder diese Technologien nutzen und entwickeln. Trotz intensiver Forschung im Bereich der assistiven Technologien seit 30 Jahren finden diese nur begrenzt Einzug im Alltag, was auch für nächste Generationen von assistiven Technologien (z.B. Roboter) antizipiert werden kann, und was auch mit einem mangelenden Verständnis des Kontextes, in dem ältere Menschen leben und potenziell Roboter nützen sollen, zusammenhängt.

Ziel dieser Dissertation ist die Erforschung von Bottom-Up-Ansätzen ausgehend von den Lebenswelten älterer Menschen und ihres erweiterten sozialen Umfeldes, um diese Menschen im Alltag zu unterstützen. Dies beinhaltet i) die Untersuchung von Langzeiterfahrungen älterer Menschen und ihres sozialen Umfeldes mit assistiven Technologien, um daraus für die Weiterentwicklung von Roboteren zu lernen; ii) die Untersuchung der Einbindung älterer Menschen in die Gestaltungsprozesse von Robotern. Um im Kontext älterer Menschen und ihrer Lebensräume anzusetzen, präsentiere ich zwei Langzeitstudien mit Fokus auf die Erfahrungen älterer Menschen und von Pflegekräften, sowohl in privaten Haushalten, als auch in institutionellen Pflegeheimen, wobei ich auch auf den Einfluss von COVID-Erfahrungen auf die Technologienutzung eingehe. Zudem präsentiere ich zwei Studien zur Einbeziehung älterer Menschen in die Gestaltung von Robotern. Diese beinhalten Untersuchungen zu gegenwärtigen Herausforderungen im Zuge dieser partizipativen Gestaltung von Robotern, sowie auch die iterative Entwicklung eines Werkzeugs zur Unterstützung von Co-Imagination von Robotern in privaten Haushalten mit älteren Menschen als Antwort auf diese Herausforderungen. Im Zuge der gesamten Forschung wende ich qualitative Methoden an, d.h. qualitative Interviews und eine Tagebuchstudie. Sämtliche Ergebnisse dienen als Fundament für Überlegungen zum Design, um ältere Menschen mit Robotern im Alltag zu unterstützen.

Diese Doktorarbeit bietet drei Hauptbeiträge zur Forschung. Erstens präsentiere ich Langzeiterfahrungen älterer Menschen und von Pflegekräften mit assistiven Technologien in verschiedenen Lebensräumen, was auch zu einem Verständnis des Kontextes beiträgt, in dem Roboter verwendet werden könnten. Wesentlich ist bei der Entwicklung von Robotern für ältere Menschen, Bedürfnisse rund um Selbstbestimmtheit (engl. self-determination

needs) zu verstehen und zu fördern, wie z.B. das Bedürfnis nach Beziehung oder Autonomie. Diese Bedürfnisse sollten innerhalb von sozio-technischen Netzwerken gedacht und gefördert werden, anstatt nur auf der individuellen oder zwischenmenschlichen Ebene. Wesentlich ist dabei auch die Förderung von Reziprozität in Beziehungen. Da solche sozio-technischen Netzwerke komplex sein können, erwiesen sich Langzeiterfahrungen mit kommerziell erwerbbaren assistiven Technologien als nützlich, um Überlegungen für die Gestaltung von Robotern anzustellen, die derzeit noch erforscht und entwickelt werden. Zudem braucht es ein Verständnis und eine Gestaltung der Arbeit, die geleistet werden muss, um Technologien in der Praxis zu nutzen. Denn diese Arbeit hat auch gezeigt, dass besondere Situationen wie die Pandemie neue Möglichkeiten eröffnet hat, um zwischenmenschliche Beziehungen mithilfe von Kommunikationstechnologie zu fördern, was allerdings auch zu einem vermehrten Arbeitsaufwand geführt hat und demnach eine Neugestaltung von Arbeitsrollen erfordert. Zweitens präsentiere ich methodische Herausforderungen für das partizipative Design (PD) für Roboter mit älteren Menschen. Zentrale Herausforderungen im PD in multidisziplinären MRI-Teams sind Wissenstransfer, Grounding, und Terminologie. Innerhalb solcher Teams empfiehlt sich eine Person, die eine moderierende Rolle innehat. Zudem sollte zu Beginn des PD-Prozesses der Begriff "Roboter" mit Vorsicht verwendet werden, um Erwartungen unter teilnehmenden älteren Menschen nicht zu verzerren. Um Herausforderungen im PD weiter zu erforschen bzw. zu begegnen, wird auch ein methodischer Beitrag präsentiert, um das Verständnis vom Alltag älterer Personen unter MRI-Team-Mitgliedern, die in der Entwicklung tätig sind, zu fördern. Die Verwendung des methodischen Werkzeugs liefert auch einen Beitrag zum Thema Vertrauen als situierte Erfahrung an spezifischen Orten. Anforderungen an Roboter für ältere Menschen müssen unter der Berücksichtigung von Orten, an denen sie potenziell genutzt werden, spezifiziert werden. Drittens präsentiere ich Überlegungen zum Design, um ältere Menschen und deren Umfeld mit assistiven Technologien wie Robotern zu unterstützen. Wesentlich ist bei der Entwicklung von Robotern die Gestaltung von Beziehungen in Gemeinschaften (z.B. für eine gemeinschaftliche Nutzung und Reziprozität), Personalisierung (z.B. in Bezug auf Zugang zu Technologien, soziales Umfeld, Privatsphäre), Lernen (z.B. in Bezug auf Learning Environments oder für Mutual Learning), sowie die Gestaltung für Werte (z.B. Autonomie oder Privatsphäre, wobei auch mögliche Spannungsfelder berücksichtigt werden sollten), und spezifische Orte und Arbeitspraktiken (z.B. hinsichtlich sich ändernder Konfigurationen, Arbeitsaufgaben und -rollen).

Die Beiträge sind gleichermaßen für Forschende aus dem Feld der MRI relevant, für Forschende aus dem Feld Mensch-Computer-Interaction (MCI) und Computer-Supported-Cooperative-Work (CSCW), sowie für Forschende im Feld der Gerontechnologie.

Abstract

Assistive technologies like robots are intended to solve various problems associated with the ageing population. However, previous Human-Robot Interaction (HRI) research has predominantly focused on technology-driven top-down approaches, not so much taking into account the complexity of stakeholders that are actually involved in making use of technology, in putting technology to work, and in the design and development of these systems. Further, despite research on Active and Assisted Living (AAL) since 30 years, there are still challenges with uptake and use, which is critical also for the next generation of AAL like robots, and which may be also due to a lack of understanding of the everyday life and challenges in the field.

The aim of this PhD thesis is to explore bottom-up approaches for supporting older adults with robots in living spaces, taking a predominantly user-driven perspective. This involves i) understanding longitudinal experiences with AAL systems in the field, and ii) engaging older adults in the design of robots. To start with the context of people's living spaces, I present two longitudinal studies on older adults' experiences with AAL systems. One study was conducted with older adults in private homes, the other one in institutional care homes, also focusing on the impact of COVID-19 experiences on technology usage. To engage older adults in the design of robots, I present challenges that I explore for participatory design (PD) for robots involving older adults, and subsequently the design of a card-based tool to co-imagine robots in older adults' living spaces to respond to the challenges. Throughout the research studies, I focus on the use of qualitative methods, including interviews and a diary study. The findings across all case studies are then a basis to present (design) considerations for supporting older adults with robots.

This thesis offers three main contributions. The first contribution is an understanding of older adults' and their care networks' longitudinal experiences with assistive technology, and therefore, the context in which robots are envisioned to be used. In order to design robots for older adults, it is important to understand and promote self-determination needs (e.g. relatedness or autonomy) in socio-technical networks rather than for individuals or on the interpersonal level only. This also includes the need to design for reciprocity in relationships. Given the complexity of these socio-technical networks, there are also advantages of learning from long-term experiences with off-the-shelf technologies for designing robots. Also, the way technology is put to work in practice needs to be understood and designed for, as the use of technology in the care context has opened

up ways of promoting connectedness in special circumstances during the pandemic, but the changing work configurations also require the a potential re-definition of work roles. The second contribution provides an understanding of methodological challenges when engaging older adults in the design of robots. Key PD challenges for robots include knowledge transfer in multidisciplinary HRI teams, grounding, and terminology. A recommendation is to include a moderator role in HRI teams; and to use the term "robot" with caution in ideation phases to not skew participants' expectations. To further explore and address PD challenges, a methodological tool is presented for engineers to get a feeling of older adults' everyday life. The use of this tool also provides a contribution to trust research, where inverted trust can be used for the elicitation of needs of assistance to guide conversations. Furthermore, spacial requirements need to be specified for robots in order to be perceived trustworthy. The third contribution provides design considerations for supporting older adults with robots. These include the need to design for relatedness in communities (e.g., in families, for collaborative use, and for reciprocal relationships), for personalization (e.g., with regards to accessibility issues, social environments, privacy, or companionship), learning (e.g., concerning learning environments in project meet-ups, or mutual learning in PD), values (e.g., autonomy, connectedness, and privacy; where possible value tensions also need to be considered), and the need to design for specific places and work practices (e.g., changing spatial configurations, work practices, and desired work roles of people making use of robots).

The contributions are relevant for researches in the field of HRI, however, also Human-Computer Interaction (HCI) researchers and Computer-Supported Cooperative Work (CSCW) researchers, and researchers working in the field of Geront(echn)ology benefit from the insights provided in this thesis.

Contents

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CHAPTER 1

Introduction

Robots and artificial intelligence (AI) are being developed in an expectation to solve various problems that our societies currently face. One of those problems are associated with the ageing population. The demographic changes are pressing to care systems [World Health Organization, 2020b], as people live longer, and often with chronic diseases. In order to support people's independent daily living, there is a trend to see systems for Active and Assistive Living (AAL) as a possible solution to also meet the increasing demand of caregivers and for ageing in place [Johansson-Pajala and Gustafsson, 2022]. Robots[1] are a particular example of AAL systems [Blackman et al., 2016], where studies have already shown positive effects of robots on people's health and wellbeing in people's living spaces [de Graaf et al., 2015, Klamer and Allouch, 2010, Tsiourti et al., 2014, Wada et al., 2005, Wada et al., 2004, Broadbent et al., 2016].

However, despite technical advancements in many years of research in the field of AAL [Haslwanter et al., 2020], there is still a limited uptake of assistive technology on the market [Haslwanter and Fitzpatrick, 2017] and by the care sector and in private households, and a low adoption rate [Pirzada et al., 2022]. This is important as robots can be seen as a next generation of AAL. Out of an estimate of 10.000 social robots on the market, they can be rarely found in homes [Dereshev et al., 2019]. In relation to digitalization, previous research also suggests that older adults use a language of distrust [Knowles and Hanson, 2018], where trust is also a critical topic in Human-Robot Interaction (HRI) [Billings et al., 2012, Schaefer, 2016, Mcknight et al., 2011]. A lack of trust has been also identified as a barrier of older adults using health information technologies [Fischer et al., 2014], engendering a mismatch of AAL systems and people's actual needs and desires, which can be anticipated also as a challenge for robots in the future. When it comes to robots however, they are often imagined in a dyadic

[1] Note, what constitutes a robot is not clear cut, especially in comparison to other assistive technology. Robots are often characterized as embodied agents [Feil-Seifer and Matarić, 2009]; and they are also treated as separate entity in academic disciplines, see e.g. https://humanrobotinteraction.org

human-robot constellation [Schneiders, 2022, Schneiders et al., 2022, Hornecker et al., 2020] to provide either functional or social assistance to people [Feil-Seifer and Mataric, 2005], with little work on what is needed to develop and integrate robots in complex socio-technical networks.

The development and integration of robots depends much on design choices, where these choices are certainly not limited to technology itself. When developing robots in a top-down manner[2] however, a lot of these opportunities for design are potentially being missed. Besides the replication crisis that has been identified in HRI [Chrysostomou et al., 2017, Ullman et al., 2021, Belpaeme, 2020] (i.e., the lack of ability to reproduce results from controlled studies), challenges of both studying and integrating robots in real-world settings are also unlikely to be revealed in laboratory HRI studies or in observations of short-term interactions [Gallego-Perez et al., 2013, de Graaf et al., 2015]. For example, while technical readiness is a key requirement for robots, it is also necessary to understand processes in the real world that robots are intended to assist with, such as the way people live and work, the relationships they are in, or the issues that people raise in relation to trust or distrust. Furthermore, as robots could assist in various types of homes, there is an opportunity to conduct studies in different types of living spaces (e.g., private homes or institutional care homes). A more bottom-up approach[3] engenders an earlier engagement with people and their context [Broadbent et al., 2016], and this can potentially clarify these sorts of problems earlier to save time and costs later. Here, different approaches have been proposed, such as a focus on people's social practices [Wulf, 2009, Wulf et al., 2011, Kuutti and Bannon, 2014, Ganglbauer et al., 2013] and longitudinal studies, or participatory approaches [Lee et al., 2017a, Lan Hing Ting et al., 2018, Frennert et al., 2012, Weiss and Spiel, 2021]. Participatory design foregrounds the democratic ideal that those people who will be predominantly using a technical artifact should be also able to decide on the design of it [Joshi and Bratteteig, 2015], which also requires to acknowledge the expertise of representative end users [Bratteteig and Wagner, 2014]. Taking such approaches then turns out complex in itself, as the design of robots requires people collaborating across disciplines and with different worldviews [Šabanović et al., 2007, Weiss, 2012, Bratteteig and Wagner, 2014] in order to design, implement and evaluate systems [Axelsson et al., 2021], where the researchers involved could be also regarded as part of the extended care network of older adults.

This PhD thesis explores ways of understanding and designing robots to support older adults in their independent daily living. To understand current issues bottom-up and to not re-invent the wheel, I propose to learn from people's longitudinal experiences with current assistive technologies in different types of living spaces where robots are intended to be used, to understand the challenges and to provide lessons learned for designing robots for this context. Furthermore, I propose to explore the design of robots by engaging with older adults, first reflecting on current challenges in participatory design,

[2]i.e., taking a deductive approach, providing a robot in studies conducted to test in predefined (and often short-term) scenarios

[3]i.e., taking an inductive approach, grounded in case studies, and being primarily people-driven rather than technology-oriented

and subsequently developing a tool to engage older adults in conceptualizing robots in older adults' living spaces, where challenges that were identified can be addressed.

1.1 Aims and Research Questions

The aim of this thesis is to provide an understanding of aspects to consider for supporting older adults with robots, taking a bottom-up approach. The following research question will be answered:

What are the main factors for understanding and designing robots to support older adults?

To answer this main question, two sub-questions need attention. First, I propose to gain an understanding of older adults' longitudinal experiences with off-the-shelf assistive technology (RQ1), where the aim is to learn from longitudinal studies for how to support older adults with the next generation of AAL/robots. Second, I propose to gain an understanding of challenges that occur in the design of robots involving older adults in a participatory way (RQ2), where the aim is to provide lessons learned for understanding and designing robots to support older adults. Therefore, this thesis will answer the following sub-questions:

RQ1: How do older adults and their care networks experience the use of AAL systems in private homes and in institutional care homes?

RQ2: What are current methodological challenges for engaging older adults in the design of robots?

To answer the research questions, I present four case studies in chapters 4, 5, 6, and 7. I focus on user research with older adults and their care networks (where this applies) in different types of living spaces, on one hand, investigating the longitudinal use of current AAL and deriving lessons learned for the next generation of assistive technologies, i.e., robots. On the other hand, I investigate design approaches for robots, reflecting on current challenges in participatory design (PD) for robots, and subsequently, proposing a tool to co-imagin robots in living spaces informed by participatory design challenges together with older adults. The findings of the four research studies conducted to answer the two sub-questions will be also used to derive design considerations that I discuss. An overview of the studies conducted in relation to the two sub-questions is presented in figure 1.1.

1.2 Contributions of this Thesis

Overall, this thesis makes a number of contributions (for an overview of the contributions in relation to the thesis chapters and research questions, see Table 1.1). What is new first

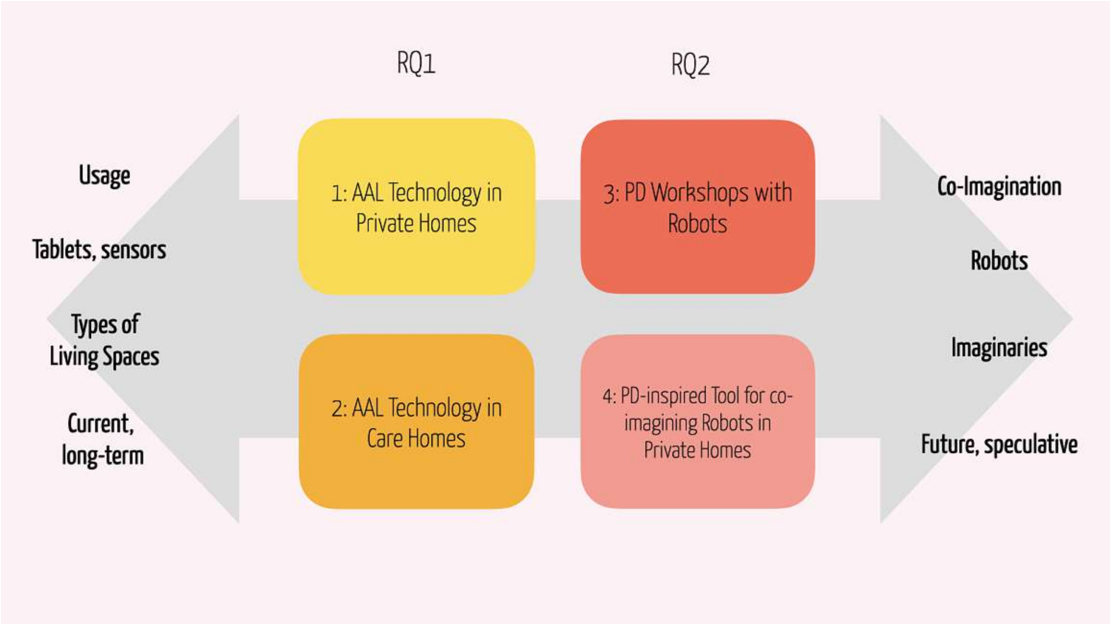

Figure 1.1: The four studies in relation to the research questions.

of all, is to take an exploratory approach by understanding older adults and their care networks experiences with AAL bottom-up, not starting with technical readiness, but with gaining an understanding of the context and current challenges there. Specifically, my approach goes beyond mere stakeholder needs, also taking into account relational qualities between stakeholders, and the work that is needed to make these work. This also involves studies in diverse and potentially changing living spaces, i.e., in private homes, where older adults live more independently, and in institutional care homes, where they require more assistance. The aim of this is to get a more nuanced understanding of the problem from various perspectives of the people in the field, and subsequently, to provide lessons-learned for understanding and designing robots to support older adults. As this specific approach of learning from older adults' and care workers' longitudinal experiences with off-the-shelf systems for robots has not been taken previously, it will also be critically reflected on.

A second contribution is the exploration of methodological challenges when co-designing robots for and with older adults. Extending previous PD research for robots [Lee et al., 2017a, Šabanović et al., 2015, Weiss and Spiel, 2021] and given the design of robots is complex as it requires people to collaborate across disciplines, I first identify current challenges in the process of conducting PD for robots. Potential challenges are related to the multidisciplinary way of conducting participatory design for robots [Rogers et al., 2021], on how to engage older adults effectively in this (collaborative) design process given that robots are more complex to prototype compared to traditional UI design (to be described in more detail in Chapter 6), and around mutual learning between researchers and older adults involved in co-design activities [Sakaguchi-Tang et al., 2021]. Here, the focus is also on the process rather than only on the outcome, taking a holistic perspective beyond individual attitudes of older adults, also taking into account researchers working across disciplines. Subsequently, I further explore and address the challenges identified with a methodological tool for engineers (i.e., people working in multidisciplinary HRI teams) to engage older adults. This contributes to the repertoire of tools for PD in HRI, and to a situated understanding of trust in private spaces as facilitated by the use of the tool, also providing a basis for main factors to consider for understanding and designing robots to support older adults.

A third contribution is the presentation of design considerations derived from across the four research studies, also discussed against the HRI literature. These are new, as they foreground relational qualities discussed, a holistic perspective to the context and design space studied, and emphasizing a situated understanding. The design considerations are also new in a way that they are developed from an exploratory bottom-up approach, providing specific aspects to consider for supporting older adults and grounded in these case studies.

1.3 The Context in which this Thesis has been written

While this thesis reflects my interest in the intersection of people and technology (broadly) and the issues of boundaries across disciplines, it also reflects the context and conditions under which the work has been done. First of all, this thesis has been written as part of a doctoral college on Trust in Robots[4] which I took as an incentive to explore the topic of trust in different ways, i.e., on a conceptual level [Schwaninger et al., 2019], in an experiment conducted together with fellow PhD students from the doctoral college [Zafari et al., 2019], and with the use of a method informed by participatory design [Schwaninger et al., 2021].

Moreover, through working and conducting studies in several projects to understand the role of technology and care in the home (e.g., WAALTeR, RoboGen, Got-IT, and a project on Telemonitoring) throughout the time of working on my PhD, I also had the opportunity to gain an understanding of different applications of AAL and Health ICTs [Schwaninger et al., 2020, Bieg et al., 2022] (and other unpublished work).

The context of this thesis work also included dealing with the implications of a global pandemic, which had an impact on the opportunities and what has been possible in practice. Because of my interest in working in the field and using ethnographic methods [Schwaninger, 2014], and to gain an understanding of current issues around the use of actual robots in the field, I had a longitudinal study planned that involved a Pepper robot in a care home in a collaboration with the University of Siegen (Germany). The study has been conducted with significant delays [Carros et al., 2022], however it could not take place as planned at first due to several forms of restrictions which impacted our work in the care context and possibilities to travel. Because the unexpected

[4]http://trustrobots.acin.tuwien.ac.at

outbreak of the pandemic seemed to affect the context of older adults severely (especially people living and working in care homes), I also took these changes as an opportunity to gain further insights about technology usage in response to the pandemic in the care context [Schwaninger et al., 2022].

1.4 Publications associated with this Thesis

Several chapters of this thesis are based on and extended from publications, i.e., Chapter 4,5, and 7. Other publications are closely related to this work, but are not explicitly represented as core chapters. The publications associated with this PhD thesis are listed in the following.

Journal Articles

- **I. Schwaninger**, F. Carros, A. Weiss, V. Wulf, G. Fitzpatrick (2022): Video connecting families and social robots: from ideas to practices putting technology to work. Univ. Access Inf. Soc., 1–13. doi: 10.1007/s10209-022-00901-y.
- T. Bieg, C. Gerdenitsch, **I. Schwaninger**, B. Kern, C. Frauenberger (2022): Evaluating Active and Assisted Living technologies: Critical methodological reflections based on a longitudinal randomized controlled trial. Computers in Human Behavior, 133, 107249. doi: 10.1016/j.chb.2022.107249.
- **I. Schwaninger**, F. Güldenpfennig, A. Weiss, G. Fitzpatrick (2021): What Do You Mean by Trust? Establishing Shared Meaning in Interdisciplinary Design for Assistive Technology. Int. J. Social Rob., 1–19. doi: 10.1007/s12369-020-00742-w.

Conference Proceedings

- F. Carros, **I. Schwaninger**, A. Preussner, D. Randall, R. Wieching, G. Fitzpatrick, V. Wulf (2022): Care Workers making Use of Robots: Results of a 3 Month Study on Human-Robot-Interaction within a Care Home. In CHI Conference on Human Factors in Computing Systems (CHI '22), April 29-May 5, 2022, New Orleans, LA, USA. ACM, New Orleans, LA, USA, 23 pages. https://doi.org/10.1145/3491102.3517435
- **I. Schwaninger** (2021): Design Considerations for Trust in situated Human-Robot Interaction. In: Proceedings of the 19th European Conference on Computer-Supported Cooperative Work: The International Venue on Practice-centred Computing on the Design of Cooperation Technologies, (ECSCW), Zürich, Switzerland; 2021-06-07 - 2021-06-11. doi: 10.18420/ecscw2021_dc003
- **I. Schwaninger**, Ch. Frauenberger, G. Fitzpatrick (2020): Unpacking Forms of Relatedness around Older People and Telecare. In: Proceedings of the 2020 on Designing Interactive Systems Conference (DIS '20) – WIP EA, July 25–30, 2020, Eindhoven, NL.

- **I. Schwaninger** (2020): Robots in Older People's Living Spaces: Designing for Trust in Situated Human-Robot Interaction. In: 2020 15th ACM/IEEE International Conference on Human-Robot Interaction (HRI), May 23-26, 2020, Cambridge, UK.

- S. Zafari, **I. Schwaninger**, M. Hirschmanner, C. Schmidbauer, A. Weiss, S. Koeszegi (2019): "You Are Doing so Great!" - The Effect of a Robot´s Interaction Style on Self-Efficacy in HRI. In: Proceedings of the 28th IEEE International Conference on Robot and Human Interactive Communication, New Delhi, India.

- **I. Schwaninger**, G. Fitzpatrick, A. Weiss (2019): Exploring Trust in Human-Agent Collaboration. The 17th European Conference on Computer-Supported Cooperative Work, Salzburg; in: "Proceedings of 17th European Conference on Computer-Supported Cooperative Work", European Society for Socially Embedded Technologies (EUSSET), Proceedings of 17th European Conference on Computer-Supported Cooperative Work, ISSN: 2510-2591.

Workshop Papers (juried)

- **I. Schwaninger** (2021): Design Considerations for Trust in situated HRI. Doctoral Colloquium at INTERACT 2021, Bari, Italy.

- **I. Schwaninger**, G. Fitzpatrick (2020): Exploring the Concept of Relatedness to understand and design for older People's Needs in Telecare. CHI 2020 Virtual Workshop Designing Interactions for the Ageing Populations - Addressing Global Challenges, Hawaii; 2020-04-24

- **I. Schwaninger**, G. Fitzpatrick (2020): Exploring the Concept of Relatedness for Technology Ecosystems around Older People. CHI 2020 Virtual Workshop Technology Ecosystems: Rethinking Resources for Mental Health, Hawaii; 2020-04-24

- **I. Schwaninger**, A. Weiss, Ch. Frauenberger (2019): Qualities of Trust: Caputuring Aspects beyond System Reliability. In: Ro-Man 2019 Workshop „Trust, Acceptance and Social Cues". The 28th IEEE International Conference on Robot Human Interactive Communication, New Delhi, India.

- **I. Schwaninger**, G. Fitzpatrick (2019): Exploring Care Networks with Senior Citizens in Vienna. ECSCW 2019 Workshop "Who Cares? Exploring the Concept of Care Networks for Designing Healthcare Technologies", Salzburg, Austria.

- **I. Schwaninger** (2018): On the Interplay of Psychological Safety and Trust in Long Term Human-Robot Collaboration. Human Agent Interaction (HAI) 2018 Workshop „Designing and Measuring Trust", Southampton, UK.

Workshops

- J. de Pagter, G. Papagni, L. Crompton, M. Funk, **I. Schwaninger** (2020): Trust in Robots and AI. in: Robophilosophy 2020 Workshop Trust in Robots and AI". Robophilosophy Conference 2020, Aarhus, Denmark; 2020-08-18 - 2020-08-21;

1.5 Thesis Overview

The overview of this thesis is as follows. After this Introduction (Chapter 1), Chapter 2 presents the relevant related work. The Related Work Chapter gives an overview of robots, AI and assistive technology, relevant building blocks such as conceptualizations of ageing, the home, and stakeholders living and working in home environments. I also present an overview of bottom-up approaches that are relevant to consider, including longitudinal studies with robots and recently emerging participatory design approaches. The aim is to give an overview of the landscape of robotics and assistive technology and the context in which robots are intended to be used, and to support the proposed bottom-up approaches that I explore across this thesis.

Chapter 3 presents the methodology, starting with the research questions (as already described in this chapter), followed by a discussion of the methodological approach which is predominantly qualitative. The qualitative approach is described in more detail also in contrast to a (post-)positivist approach, given its potential value for a more nuanced understanding of the socio-technical network (i.e., providing lessons learned from current technologies and to explore participatory design). The methods chosen are then presented, which is followed by an elaboration of the research studies in more detail that I propose to conduct also to answer RQ1 and RQ2. I close the chapter with a set of ethical considerations.

After setting up the introductory part (i.e., Introduction, Related Work and Methodology), the case studies are presented. These involve long-term studies using current off-the-shelf AAL technologies (i.e., commercially available systems such as tablets) in private homes (Chapter 4) and in care homes (Chapter 5), and case studies that focus on exploring and addressing challenges when engaging older adults in the design of robots (Chapter 6 and 7).

Two case studies are presented to gain an understanding older adults' experiences with current AAL technologies in private homes (Chapter 4) and in care homes (Chapter 5). While both studies focus on people's long-term usage of current off-the-shelf technology, the studies also take into account perspectives of other people who are involved in using AAL technology besides older adults (i.e., care workers in the context of care homes). Both studies involve qualitative interviews, and in the case of the care home context which has been conducted mostly remotely, a diary study.

In both the study in private homes (Chapter 4) and in care homes (Chapter 5), I take a socio-technical lens. In the case of Chapter 4, I unpack forms of relatedness, and I present a discussion on individual differences and opportunities for personalization. In the case of Chapter 5, I present findings on communication technology usage that has been triggered by experiences of the pandemic, with a discussion on values and work configurations. Both chapters also present initial investigations on older adults' attitudes towards robots (without people actually having seen them), as well as lessons learned for future generations of AAL, i.e., robots. As the two chapters (i.e., Chapter 4 and 5) focus on older adults' and their care networks' experiences with AAL in private homes and in care homes, these chapters mainly serve to answer RQ1.

In the next two chapters (Chapter 6 and 7), I engage with robots from a design point of view. As a starting point, participatory design workshops are presented in Chapter 6. The aim of this chapter is to explore challenges when designing robots with older adults through participatory design. I unpack challenges related to multidisciplinary collaboration in HRI teams, expectation management and language around robots.

After setting out current PD challenges, these are addressed and further explored in the subsequent Chapter 7 with a study on the design and use of elicitation cards. The design and use of these cards further tackles the topic of trust and robots in people's living spaces. I present this tool and findings on trust and conceptualizations of robots in the home, and I discuss implications for future research based on the design and use of the cards. As the two chapters (i.e., Chapter 6 and 7) focus on participatory design challenges for robots, these chapters mainly serve to answer RQ2.

After presenting the four case studies, the research is revisited and critically reflected on in Chapter 8. Here, I provide answers to the research questions: (1) I reflect on older adults' and their care networks' longitudinal experiences with AAL and lessons learned from the use of current assistive technology for robots, such as taking into account individual differences of people and forms of relatedness, values, and work-related implications of increasing technology usage in the care context. (2) I then reflect on the challenges in participatory design for robots and that come with the collaboration in multidisciplinary teams, such as expectation management, language, and roles, and on the co-imagination tool that I propose using elicitation cards to address some of the PD challenges. The discussion chapter also includes a section on design considerations. I follow with limitations and future work sections.

The thesis concludes with Chapter 9, a Conclusion.

An overview of chapters 4, 5, 6, 7, and 8 with respect to answering specific research questions and the contributions is illustrated in Table 1.1.

Chapter	RQ	Contribution
4 Experiences with Assistive Technology in Private Homes	RQ1	Understanding older adults' longitudinal experiences with AAL systems for robots, foregrounding relational qualities in care networks
5 Experiences with Assistive Technology in Care Homes	RQ1	Understanding older adults' and care workers' longitudinal experiences with AAL systems triggered by the pandemic, foregrounding values and work practices
6 Exploring PD Challenges for Assistive Robots	RQ2	Understanding methodological challenges when engaging older adults in the design of robots
7 Addressing PD Challenges with a Methodological Tool	RQ2	Understanding and addressing PD challenges through the design and use of an elicitation tool, also providing a contribution to trust research
8 Discussion	RQ	Design considerations for supporting older adults with robots, based on lessons learned from the field and from design, and foregrounding a holistic approach

Table 1.1: Chapters 4-8 in relation to the research question(s) to answer and contribution.

CHAPTER 2

Related Work

This chapter gives an overview of the relevant literature. The overall aim is to discuss previous work on assistive technology, several building blocks for HRI research in home environments to support older adults, and related work on bottom-up HRI research. As part of the literature, I also open up several gaps that I aim to close with the work presented later.

The area of interest requires related work from multiple disciplines. Given the focus on HRI and robots, the core literature is presented from HRI; and the field of AAL is represented in HCI, CSCW, and Gerontechnology. A relevant body of literature is also represented in gerontology / ageing research. Not core, but also worth mentioning at this point is that bottom-up research can be applied in multiple disciplines, where example literature is briefly presented from areas like from within Informatics (other than HCI) and Global Health Studies.

2.1 Assistive Technology for Home Environments

2.1.1 Technology for Active and Assisted Living

AAL technologies have been promoted for many years [Haslwanter et al., 2020, Choukou et al., 2021] as a way to meet the desire among older adults to stay healthy and live autonomously in their homes for as long as possible [Peek et al., 2015, Liu et al., 2016, Bloom and Luca, 2016, Pirzada et al., 2022]. Their goals are among others, to enable an independent, active, and self-determined life [Vimarlund et al., 2021, Brauner and Ziefle, 2021, Nilsson et al., 2021, Dupuy et al., 2016], stay socially connected [Schomakers et al., 2018, Blackman et al., 2016], or to feel safer in everyday life at home [Turjamaa et al., 2019, Pirzada et al., 2022]. Relevant assistive technologies include safety systems, systems for security, monitoring the health status [Lussier et al., 2020, Pirzada et al., 2022], communication, and entertainment, and home automation [Turner and McGee-Lennon, 2013, Haslwanter et al., 2020]). The aspect of promoting an active and autonomous life of people is also highlighted by the shift of the term from "Ambient Assisted Living" towards 'Active and Assisted Living" within the scientific community [Aumayr, 2016]. It should be further noted that the term AAL - given its broad scope - overlaps with related terms such as smart home technologies or gerontechnologies, and a distinction between these terms is not clear-cut.

AAL technologies are either implemented as individual services or comprehensive systems that combine a number of different services (i.e., multi-service systems). While specific contexts of application, use cases, and desired outcomes regarding AAL technologies are highly diverse, AAL technologies share two general characteristics: Firstly, they are ambient, meaning that they are seamlessly integrated into people's environment, realized through a wide array of different embedded technologies [Schomakers et al., 2018], such as camera and sensor systems integrated into the immediate home environment, wearable devices [Correia et al., 2021], or smart everyday-objects [Cicirelli et al., 2021]. Secondly, they assist people. For instance, the implementation of a voice-controlled smart home environment, designed to support people with visual impairments [Vacher et al., 2015] (where smart homes can also involve robots [Do et al., 2018]; more about this later), or rehabilitation technologies designed to assist people by motivating them, or promoting exercises after a stroke [Axelrod et al., 2009].

A large proportion of AAL technologies is developed to assist people with more specific needs and requirements [Calvaresi et al., 2017], where the particular aims of the different technologies are manifold: There is assistive technology to promote physical, cognitive, and psycho-social aspects of health. Prominent instances include promoting cognitive health, for example in cases of dementia [Gettel et al., 2021, D'Onofrio et al., 2017, Moyle et al., 2021]. Lussier et al. emphasized that these monitoring technologies should report clinically relevant changes of older adults with Alzheimer disease to support medical and care personnel in decision-making [Lussier et al., 2020]. Other work focused on the promotion of physical health, for example heart failure [Saner et al., 2021, Masterson Creber et al., 2016], where telemonitoring has been proposed as a possible solution to assist various stakeholders/users at the same time, including patients, healthcare professionals, and organizations [Boyne and Vrijhoef, 2013]. Other systems aim to monitor people's mobility, sleep, outings, cooking, and hygiene-related activities [Lussier et al., 2020].

2.1.2 Robots as a recent Instance of Assistive Technology

A recent instance of AAL are assistive robots, who are embodied agents[1]. The variety of tasks such assistive robots are envisioned to take over is manifold. In the broader scope of healthcare, application areas include medical robotics. These are increasingly being used, for example, to support surgical procedures [Nwosu et al., 2019]. There exist robots for pain relief [Azeta et al., 2018], and other work proposed assistive uses of

[1] Note, what constitutes a robot is not clear cut, especially in comparison to other assistive technology. Robots are often characterized as embodied agents [Feil-Seifer and Matarić, 2009]; and they are also treated as separate entity in academic disciplines, see e.g. https://humanrobotinteraction.org

robots in dementia or care of older adults [Nwosu et al., 2019, Ghafurian et al., 2021]. They are also proposed to provide health [Breazeal, 2011], including mental health of people in general and older adults in particular [Gallego-Perez et al., 2013, Gallego-Perez et al., 2015], for example, by providing companionship [Cifuentes et al., 2020]. There is existing work on robotics for tele-health [Azeta et al., 2018], for instance providing assistance and being remotely operated by a doctor [Martinez-Martin and del Pobil, 2017]. Health-related applications also include robots for rehabilitation (e.g. Auto Ambulator), including neuro-rehabilitation [Krebs et al., 2021, Kubota et al., 2020] and cardiac rehabilitation [Céspedes et al., 2021, Irfan et al., 2020]. Other work has proposed mobile robots to aid physiotherapists in their work [Gerling et al., 2016], or robots for psycho-therapeutic use [Gallego-Perez et al., 2015]. There are also various applications of AI in healthcare, for example, when it comes to processing and analyzing patient data [Amisha et al., 2019]; and while these do not necessarily require robots, they may assist doctors in primary patient care.

Other types of service robots are also proposed for home environments, aiming to support people to live independently [Martinez-Martin and del Pobil, 2017], for example, by assisting with mobility, household tasks, and monitoring safety and health [Martinez-Martin and del Pobil, 2017]. As they need to adapt to the living conditions to some extent, these systems are of a certain degree of complexity [Martinez-Martin and del Pobil, 2017]. Furthermore, they are embodied, as also shown on Figure 2.1, where some example AAL robots are illustrated. They can assist in mobility (such as Friend II), or support in fetching and carrying (such as Boltr). Robots have been designed for personal care, (e.g. Bestic) and for cleaning (e.g. the vacuum cleaner robot Scoooba) [Werner et al., 2015]. AAL robots can be also intended for older adults to feel safer and stay longer in their homes by providing fall prevention measures, as well as emergency detection and handling [Martinez-Martin and del Pobil, 2017, Bajones et al., 2018].

As also illustrated in Figure 2.1, assistive robots could also take over tasks that include social purposes, for example, telepresence robots to connect to other people [Breazeal, 2011] (e.g. Giraff). Companion robots, such as Hector and the seal robot Paro, are intentionally designed as emotional agents [Werner et al., 2015]. The seal robot Paro is also used for pet therapy, and it is the most commonly used robot in dementia care studies, as shown in a recent review [Ghafurian et al., 2021]. Companion robots should proactively assist older adults in everyday tasks, reduce stress and promote well-being, to enhance social interaction and elicit emotional responses [Martinez-Martin and del Pobil, 2017]. Potentially, companion robots also include entertainment robots (e.g. Ifbot) [Werner et al., 2015], or social robots for therapy and care [Cifuentes et al., 2020]. As an example of social robots, pet-like robots are proposed to increase well-being of patients with dementia [Thunberg et al., 2020] or during hospital stays [Cifuentes et al., 2020]. Similarly, baby-type robots are designed for being taken care of an older person requiring nursing care, as part of Babyloid-centred therapies for promoting motivation to older adults [Martinez-Martin and del Pobil, 2017]. Overall, there has been some debate about potential opportunities and risks, however, according to Nwosu et al., the

Figure 2.1: Applications of AAL Robots [Werner et al., 2015].

debate around opportunities and risks of robotics in areas of palliative, supportive and end-of-life care is limited [Nwosu et al., 2019]. They are studied only to some extent, also in home environments. To date, a great majority of HRI research is (post-)positivist and has been conducted in the lab [Rosenthal-von der Pütten et al., 2020], which provides opportunities for also taking into account factors around ageing and home.

2.2 Building Blocks for HRI Research in Home Environments

Robots are embodied agents, and they are designed to be used by specific people and at specific places. I discuss these in the following as relevant building blocks to gain a better understanding of what is required to take into account supporting older adults with robots.

2.2.1 Home Environments

There are different types of living spaces for ageing, such as private homes and institutional care homes. Home then may be a culture-specific term. It can be regarded as an abstract concept related to a wide set of associations and meanings, and it is both a physical space and it has a symbolic meaning [Moore, 2000]. The multifaceted aspects of home can be described as “a place, a relationship and an experience” [Gillsjö et al., 2011]. In a study with older adults in particular, home has been conceptualized as a place that has been built together for a long period of time, a relational place, a place “closest to the heart" [Dahlin-Ivanoff et al., 2007], as an experience. It has been associated with security (due to neighborhood, memories and functionalities), and freedom (being a place for reflection, a social meeting-point, and leaving your own mark) [Dahlin-Ivanoff et al., 2007]. Associated with belonging, the experience of home of older people in particular has been associated with a movement between the well-known present and the unknown future (i.e., as there may be a day where one has to leave home) [Gillsjö et al., 2011]. Moore also pointed out that the following basic terms have been frequently associated with home: privacy, security, family, intimacy, comfort, and control [Moore, 2000]. There have also been research studies concerning changes of home due to relocation, ageing or physical or/and cognitive frailty [Leith, 2006, Renaut et al., 2015, Case, 1996].

The very way in which technology is envisioned to be used at home can have an effect on design choices. Innovations may have changed the way one perceives home, as well as the physical quality of the home itself. For example, stationary telephones used to be an important spot at home, often situated in an easily accessible place. This communication spot at home has now become more dynamic or literally mobile, through the use of mobile or smartphones. When looking at technology that is installed for telehealth, earlier research suggests that rehabilitation technologies can have an impact both on physical arrangements of the home and on how home is perceived and felt, which needs to be taken into account when designing these technologies [Axelrod et al., 2009]. With more and more digital applications to be used at home, the quality of the home as a place can change. As health-related applications are increasingly used, home can be perceived as extended care facility [Boyne and Vrijhoef, 2013]. A potential risk is also that technical artifacts are designed in a way that they proscribe fragile, home-bound users, where older adults are envisioned to be bound to their physical homes through the use of devices [Aceros et al., 2015]. In contrast, people may want to maintain their social networks also in places outside the home [Aceros et al., 2015]. If robots are designed for home environments, home as a place and associated home practices need to be taken into account. For example, home organization is relevant to consider for HRI [Cha et al., 2015], and so are power relations within the home [Lee et al., 2017b]; where data collection in homes may require a specific choice of methods (e.g., previous research has focused on ethnographic methods or collaborative map making [Cha et al., 2015, Lee et al., 2017b]).

2.2.2 People/Stakeholders living and working in Home Environments

Given that assistive robots are mostly also intended to be directly interacting with people, it is certainly worth outlining the people who live and work in different types of home environments. AAL technologies are intended to support older adults in ageing in place [Choukou et al., 2021]. The group of older adults is, however, quite diverse in itself and people can have very different needs in the same age cohort. Therefore, technological solutions aim to either target a broad spectrum of people, resulting in rather complex systems with a high degree of functionalities, or people with very specific needs (e.g., to support or promote physical or psycho-social health). The target group is also often referred to as primary users [Werner et al., 2015]; the term "user" has been however debated in previous research [Bannon, 1995].

Besides this group of older adults, there are certainly other people involved in the interaction with assistive technologies, as mentioned above in the case of telemonitoring for patients with chronic heart failure [Boyne and Vrijhoef, 2013]. Even if older adults live on their own, they may not necessarily be isolated, which brings in other potential user groups. These – often called secondary users [Werner et al., 2015] – include all kinds of peers, extended family, or care workers, such as informal or formal care workers, sometimes also referred to as caregivers. There exists work on proposing robots to support secondary users, such as formal care workers in institutional settings [Johansson-Pajala et al., 2020], or informal care workers (where some work also involved long-term co-design activities [Moharana et al., 2019]). Some work has aimed to design trustworthy *care robots* [Stuck and Rogers, 2018], also emphasizing the role of robots as care workers (interestingly, rather than the robots' potential for supporting the work of human care workers, for example).

The profession of caregivers is relevant for envisioning robots in home environments, especially when it comes to institutional care homes. Recently, workers have been confronted with a growing number of challenges, including low recognition of one's contribution, inadequate pay and workload, strong emotional experiences and increasing work-related stress, and burnout [Foà et al., 2020]. In contrast, working autonomy, professional growth, positive relationships with colleagues and older adults increase job satisfaction [Foà et al., 2020]. Many care homes, however, do not have enough staff, and this situation forces caregivers in Europe again to do overtime work [Foà et al., 2020], as it is also the case for hospital nurses [Griffiths et al., 2014], with a reported decrease in patient safety and quality of care, or even care left undone [Griffiths et al., 2014]. Missed care in the medical context again not only leads to decreased patient satisfaction, but it can also lead to medical problems like medication errors, urinary tract infections, patient falls, pressure ulcers, care quality and patient readmissions [Recio-Saucedo et al., 2018]. A response to these professional burdens is to support care workers in providing healthcare assistance, in performing daily tasks, or in the increase of self-management [Martinez-Martin and del Pobil, 2017]. Despite the obvious role of care workers especially in institutional home settings, the role of care workers has been rarely considered in action in HRI. Few exceptions include Hornecker et al. who have referred to the triadic interaction between a robot, a care worker and an older person and hence constitutes one of the very few multi-actor approaches [Hornecker et al., 2020]. They argue that such interaction can only be satisfyingly designed when all parties are taken into account [Hornecker et al., 2020].

Similarly, tertiary users have been hardly addressed in relation to assistive robots [Weiss and Spiel, 2021,Werner et al., 2015]. Tertiary users include, for example, service providers, installation and maintenance technicians, insurance companies, municipalities, architects, social agencies, and guarantors of privacy, safety, and ethical procedures [Johnson et al., 2014]. Certainly, their needs and preferences can be very different from the needs of primary or secondary users. For example, a need includes cost efficiency, and long-term studies on positive impacts are still rare [Werner et al., 2015], despite evidence of heterogeneity and contradictions in stakeholder perspectives that affect the usage and deployment of assistive technologies [Vaziri, 2018].

2.2.3 Perspectives on Ageing

There are multiple people/stakeholders living and working in home environments and subsequently involved in the process of ageing, and it is clear that AAL does not only target older adults. However, the ageing population is a key argument to conduct research and development in this area. While systems aim to target older adults, there is no universal agreement on what ageing and age (in particular old age) actually mean. There are also various perspectives across cultures and generations [Palmore, 1999], and across research disciplines. Broadly, the different approaches and understandings of ageing can be found under the umbrella term 'gerontology'. Different conceptualizations of ageing can be either implicitly or explicitly embodied into technology design [Harley, 2011, Fitzpatrick et al., 2015], which is why I aim to reflect on these.

When looking at the policy level, there are different definitions of ageing in use. The World Health Organization (WHO) has promoted Active Ageing [World Health Organization, 2002]. Here, ageing is seen as the process of optimizing opportunities for health, participation, and security in order to enhance quality of life over time [World Health Organization, 2018, Foster and Walker, 2015]. Active Ageing applies to both individuals and groups such as populations [World Health Organization, 2018]. Another term used by the WHO is Successful Ageing [Bowling and Dieppe, 2005], which also has a proactive, but rather normative approach. It consists of three elements, including the reduction of disease and disability, maintenance of high cognitive and physical functioning, and active engagement with life [Rowe and Kahn, 1997]. A term that is being used also by the WHO more recently is Healthy Ageing, which puts a focus on "creating the environments and opportunities that enable people to be and do what they value throughout their lives" [World Health Organization, 2020a]. Not having any physical or mental diseases is not a requirement for healthy ageing, as it is more about how these conditions are handled in order to support well-being, to enable older adults to remain a resource (e.g., to their families, communities and economies); with a particular focus on creating environments such as minimizing the exposure to health risks, access to quality health and social care, and a focus on the opportunities that ageing brings [World Health Organization, 2020a].

While these perspectives on ageing on a policy level seek to promote a rather active lifestyle, participation and quality of life, other perspectives on ageing have a different focus. A dominant view trends to conceptualize ageing from a bio-medical point of view [Rose et al., 2012], or from a social point of view. Here, ageing is also associated with an accumulation of loss and decline [Harley, 2011, Tournier, 2020, Fitzpatrick et al., 2015]. From a bio-medical point of view, ageing is reflected in physical, biological and cognitive aspects of ageing, and it is also addressed through various types of healthcare services [Harley, 2011]. It is seen irreversible, progressive and cumulative functional decline, along with a reduction of adaptation capacities of older adults [Tournier, 2020].

An example of a person's cognitive performance changes over time are the losses of cognitive capacity like memory [Harley, 2011, Fitzpatrick et al., 2015]. It comes then with no surprise that ageing is also associated with perceived undesirable changes of personal, social, and cognitive characteristics [Nikitin and Freund, 2019]. Apart from these bio-medical models, there are social models of ageing: Activity theory is intrinsically linked to a loss of participation in society and in social roles beyond retirement [Harley, 2011, Fitzpatrick et al., 2015]. According to this perspective, ageing adults who engage in daily activities that they perceive productive age successfully. They may, for example, engage in volunteering, care-giving and self-development [Karim et al., 2018]; there is furthermore a value of social interactions. According to this perspective, people's level of activity is further linked to life satisfaction, which also affects a person's view on themselves (self-concept) [Diggs, 2008]. Another social model of ageing is disengagement theory. From this point of view, disengagement is seen as an adaptive response to ageing, and increasing social withdrawal with age is seen as normal and healthy. Older adults voluntarily transfer the power to younger generations; which is even seen as beneficial for both the ageing society and individuals [Diggs, 2008]. Both bio-medical models and social models of ageing put emphasis primarily on deficits of ageing [Harley, 2011, Fitzpatrick et al., 2015], and they see older people as rather passive recipients of social and medical intervention. They ignore the subjective experience and individual adaptations made in day-to-day life. This is especially paradox, as older adults do tend to report good levels of wellbeing and life satisfaction in research (despite "declines"), which is also known as the "age invariance paradox" [Tournier, 2020].

In contrast to a focus on decline, ageing as adaptation is emphasized in other work. Adaptation is generally referred to as making (behavioral) adjustment to changes that occur, including environmental changes [Tournier, 2020]. Rather than aiming for a lack of disease, for example, the focus is on psychological or behavioral adaptations to life changes [Reichstadt et al., 2010]. The relevant related literature sees ageing as a positive developmental lifespan process [Erikson and Erikson, 1998]. The model of Lifespan Development postulates eight successive stages of individual human development that are influenced by biological, psychological and social factors throughout the lifespan [Orenstein and Lewis, 2020]. A person's identity is then adapted in line with one's life stage. Middle and late adulthood in particular are also seen as relevant, because active and significant personality development also takes place here. Further, the stage of old age is concerned with a conflict between integrity and despair or disgust, where the individual looks back and reflects, also gaining wisdom [Erikson and Erikson, 1998]. Tornstam [Tornstam, 2005] extends Erikson's lifespan development with an additional stage in life, Gerotranscendence. In this additional stage, individuals tend to become less self-occupied, increasingly feeling of affinity with past generations, and decreasingly interested in superfluous social interaction. They may also experience a decreased interest in material things, and positive solitude becomes increasingly important to people [Tornstam, 2005].

Another perspective suggests that developmental opportunities of "successful ageing" take place when there is a compensation for age-related declines by developing other capacities, namely by selectivity with optimisation and compensation [Baltes and Baltes, 1990]. From this point of view, older adults can promote their quality of life by choosing a set of significant activities over others, according to personal interests or needs. They can acquire and coordinate personal resources for selected goals, enhancing their abilities (optimisation). They can also make use of resources (their own or others' resources) to reach a certain goal (compensation) [Tournier, 2020, Harley, 2011], where this active engagement can also enhance older adults' wellbeing [Carpentieri et al., 2017]. According to Socio-emotional Selectivity, perceived proximity of death can affect older adults' selectivity. The perspective is based on the assumption that social contact is motivated by a range of different goals, ranging from basic survival to psychological goals. The importance of these goals fluctuates depending on age, in particular, emotion regulation increases with older age, while the acquisition of information, and the desire to affiliate with unfamiliar people becomes less important. Therefore, socio-emotional selectivity triggers increasing emotionally meaningful and socially-oriented goals [Carstensen, 1992, Carstensen et al., 1999], where older adults tend to invest more in what is most important to them at a present time, and less in acquiring in skills or knowledge that could be relevant on the long-term [Tournier, 2020]. Regarding social connections, older adults further tend to avoid superficial social contact and seek deepening intimacy [Carstensen, 1992, Carstensen et al., 1999]; where meaningful social contacts are known to be increasingly important at older age, preventing health physical and mental health injuries [Faraji and Metz, 2021]. As reduced social contact can also enhance resilience at older age, recent measurements of "social distancing" due to the outbreak of the COVID-19 pandemic were also found to decrease resilience, which is a new challenge on top of isolation that some older adults experience [Faraji and Metz, 2021]. When having access to resources to make adaptations - which can be technology, for example -, previous research sees older adults as "technogenearians" or adaptive agents, who are not passive consumers, but who creatively utilize and adapt technological artefacts to fit their needs [Joyce and Loe, 2010]. Changes in information processing capacities, for example, can be supported using ICTs [Tournier, 2020]. An important aspect is that available resources (i.e., physical, psychological, social, and economic resources) are essential to adapt to age-related changes that people experience [Tournier, 2020].

2.3 Bottom-Up HRI Research

As shown above, a variety of assistive technologies has been developed since the 1990s for ageing at home, including robots as a recent instance. Furthermore, there are different types of living spaces that involve different people/stakeholders; and different perspectives on home and ageing that are reflected in technology design and may open up design spaces. For example, a robot could prescribe a home-bound person that is ill, or it could promote a more active lifestyle and choices to be made that support adaptations.

In the light of this complexity, research needs to engage with older adults and their social and spacial environment to understand people's needs and values, especially as robots are intended to be used in these contexts. To do so, a variety of bottom-up approaches (i.e., mainly driven by people's perspectives rather than technical readiness) to HRI and HCI have been proposed in previous work. Some of these include putting a focus on people's social practices [Wulf, 2009, Wulf et al., 2011, Kuutti and Bannon, 2014, Ganglbauer et al., 2013, Schmidt, 2018, Entwistle et al., 2015], participatory approaches [Lee et al., 2017a, Lan Hing Ting et al., 2018, Frennert et al., 2012, Šabanović et al., 2015, Weiss and Spiel, 2021], or long-term studies with assistive assistive technology and also, specifically, with robots [Bajones et al., 2019, Irfan et al., 2019, Irfan et al., 2021, de Graaf et al., 2017, de Graaf et al., 2018].

In Human-Computer Interaction (HCI), a shift from interactional research to practice-based research in the everyday is also reflected in the *turn to practice* [Kuutti and Bannon, 2014]. While early methods in HCI were inspired by psychological sciences involving controlled short-term, lab-oriented studies, which are according to Kuutti & Bannon [Kuutti and Bannon, 2014] embedded in the *Interaction paradigm*, this is not the case in the recently emerging *Practice paradigm*. In previous practice-oriented work, the practical accomplishment and "dynamic and situated 'interactional' aspects [...] to be accounted" [Fitzpatrick, 2003, p. 91] was highlighted. Generally speaking, practice approaches explore "[...] historical process and performances, longer-term actions which persist over time, and which must be studied along the full length of their temporal trajectory[,][...] situated in time and space" [Kuutti and Bannon, 2014, p. 3543]. Further, the broader context is taken into account, and it is "intervowen within the practice" [Kuutti and Bannon, 2014, p. 3543].

Long-term approaches towards ageing at home with robots either focus on older adults living in private homes [Bajones et al., 2018, de Graaf et al., 2015, de Graaf et al., 2017] or on the residents living in care homes [Carros et al., 2020]. For example, de Graaf et al. have provided insights on people's attitudes and relationship-building with or towards robots in private homes [de Graaf et al., 2015]. A few number of studies that have taken place in institutional care homes suggest that social robots have a positive impact on the residents [Carros et al., 2020], and they could show that care workers facilitate the interaction between robots and residents [Kidd et al., 2006, Carros et al., 2020]. A study has used a NAO robot to evaluate the effects of its use on care workers [Melkas et al., 2020]. Another longitudinal study has involved deploying a robot in a care home as an information point to adapt the robot to the information needs of people [Hanheide et al., 2017]. Other research work places more emphasis on the sociality of robots (e.g. [Sabelli et al., 2011, Šabanović and Chang, 2016]), in one case assessing conversational elements, with input from an operator, and including care workers in the analysis [Sabelli et al., 2011]. Given this body of existing research, there is a need for conducting longitudinal field studies with assistive technology in people's diverse and potentially changing living spaces. This bottom-up research promises to yield an understanding of people's situated experiences and the dynamic process that are inherent. Given social environments may play a key role in these situated experiences, it is promising to also take into account actors that also play a role in older adults' lived experiences (e.g., friends or families, care workers, etc.), instead of conducting dyadic HRI research between one person and one robot. Bottom-up HRI research would then provide an understanding of what factors matter in the first place from the perspective of older adults and their care networks, who would contribute with their expertise on what they need in order to be supported with assistive technology.

Throughout the design lifecycle, there is also a need for methods to design and evaluate assistive robots with target stakeholders [Werner et al., 2015], and for participatory research, there is a need for methods to involve older adults e.g. into the design of robots [Šabanović et al., 2015]. People need to be involved in all steps of research to fit their real needs, especially in the light of complex health or social challenges [Tournier, 2020]. For HRI, then, it is important that people who are intended as users are involved in the conceptualization, development and testing [Johansson-Pajala et al., 2020, Flandorfer, 2012, Weiss and Spiel, 2021]. Involving people at an early stage of design and conducting research in real-world settings is also of crucial importance in user-centered (UCD) and participatory design (PD).

When it comes to robots however, co-creation is more challenging to accomplish with traditional UCD/PD methods, given that building prototypes of robots requires a lot of technical expertise and decisions about which lay people have no familiarity (as also argued in the literature [Weiss and Spiel, 2021]). Designers and engineers of robots who do make these decisions, on the other hand, most likely experience life from a different perspective than their target group of older people [Güldenpfennig et al., 2016]. This multidisciplinary aspect has been stressed [Weiss, 2012], however rarely taken into account practically (with few exceptions [Axelsson et al., 2021]) with concrete methodological tools which enable grounding among stakeholders in PD. A benefit of bottom-up HRI research is that it could help to understand specific methodological challenges in co-design for HRI, such as around grounding. Subsequently, it would be possible to extend the repertoire of HRI tools to engage older adults in co-design by also taking into account a more holistic perspective on stakeholders (including researchers) in HRI teams.

For older adults and robots, some recent projects have involved people in research at an early stage of developing robots, i.e., through PD [Frennert et al., 2013b, Lee et al., 2017a, Lan Hing Ting et al., 2018, Bråthen et al., 2019]. Among the recent work on PD for robots, with older adults, Lee et al. focus on the support of mutual learning between researchers and participants, and on promoting active participation of older adults in design [Lee et al., 2017a]. Lan Hing Ting et al. [Lan Hing Ting et al., 2018] use ethnographic methods to explore the co-design and evaluation process of a mobile social robotic solution for elders following a living lab approach. Multiple perspectives of people are involved in design: the people who are considered the primary users, sociologists, designers, and engineers. In prototyping workshops, Brathen et al. [Bråthen et al., 2019] found that developing a story about a robot in the context of older people's homes and in the daily life of older adults is essential for successful design and prototyping. We lack methods for designing and evaluating assistive robots in HRI research [Werner et al., 2015], also in terms of how robots could actually provide good care. Further, as described above, there is a need take into account stakeholder needs also within HRI teams, e.g., with regards to managing disciplinary boundaries. Therefore, there is a need to extend PD approaches for assistive robots in HRI, taking a holistic perspective and carefully taking into account challenges of conducting PD as a way of approaching HRI bottom-up.

2.4 Summary

Assistive technologies of various kinds have been developed since the 1990s as possible solutions to the problems associated with the ageing population. Application areas include healthcare, systems to promote safety and independence, communication and entertainment. They are designed as individual services or as multi-service systems, targeting specific needs of people or multiple needs at once. While the distinction is not always clear-cut, assistive robots can be considered as the next generation of AAL. They broadly have similar application areas, but can offer different functionalities, also due to their embodiment. Robots can provide assistance with mobility, they can fetch-and-carry objects, or potentially even provide companionship through displaying social cues and emotional responses. All of these assistive technologies are designed to be used in home environments by target users, often older adults. This context and target group constitute relevant building blocks for designing future interactions with assistive robots.

There are different kinds of living spaces and home environments, where home can have a physical, symbolic, and even a culturally situated meaning. Time plays a role when looking at the meaning of home, and it is also important when looking at ageing throughout the lifespan. Different people who are living and working in home environments include primary and secondary users, and there are tertiary user needs to consider. While older adults are not necessary the only people who engage with assistive robots, ageing can be still reflected in design choices. Taking a perspective that focuses on biomedical or social aspects of ageing, and when picturing ageing either as decline or as process that involves adaptation can make a difference. Both adaptation processes and the meaning of home are specific and situated. For future assistive robots, it is important to design them in a way that they fit people's situated (and changing) needs that are also connected to ageing and home.

One possible way of designing for people and their needs is by taking a bottom-up approach driven by the people and their social environments. This can involve practice studies and/or longitudinal studies with older adults and their social environment, or approaches to co-creation like participatory design. The engagement with older adults and other relevant stakeholders, experiences of ageing and home, and a focus on appropriate methods to do so throughout the research is promising to support developing more successful robots as the next generation of AAL in the future.

CHAPTER 3

Methodology

3.1 Chapter Overview

The aim of this chapter is to provides an overview of the methodological approach (such as paradigms) and methods (including the actual methods used to collect empirical data) in this PhD research. I start with the guiding research questions (i.e., the main question and sub-questions), followed by situating this work within a constructivist worldview. I then contrast research traditions of conducting user research (in HCI/HRI) inside the lab and in the wild, which sets the basis for the following sections on the chosen methods. In the respective section on methods, I also argue for the choice of qualitative methods to study aspects to consider for supporting older adults with robots. After this theoretical overview, I present the four research studies and discuss the qualitative methods used for data collection and analysis, which is followed by ethical considerations. Finally, this chapter concludes with a summary on the specific perspectives and methodological approach I bring to this thesis.

3.2 Guiding Research Questions

The aim of this thesis is to present main factors to consider for supporting older adults with robots. The following main research question is answered:

RQ: *What are the main factors for understanding and designing robots to support older adults?*

To answer this main question, I draw attention on several sub-questions. These concern a detailed analysis of longitudinal experiences with current off-the-shelf AAL technologies in private homes and care homes (RQ1), and the engagement with design for robots and older adults (RQ2). Therefore, this thesis answers the following sub-questions:

RQ1: How do older adults and their care networks experience the use of AAL systems in private homes and in institutional care homes?

RQ2: What are current methodological challenges for engaging older adults in the design of robots?

The subquestions are answered with four case studies. Before outlining the chosen methods and planned studies, I want to include a section on the the methodological approach of this thesis in the following.

3.3 Methodological Approach

While this thesis is written as part of an interdisciplinary doctoral college, disciplinary, inter- and transdisciplinary approaches to research can also be embedded in different worldviews. Research at the intersection of people and technology can be interdisciplinary, and disciplines are historically grown entities with their own cultures and sub-cultures. However, different schools of thought have implications on how we view very fundamental epistemological and ontological questions of our research. Worldviews are reflected research paradigms, where a paradigm can be viewed as "a set of *basic beliefs* (or metaphysics) that deals with ultimates or first principles. It represents a *worldview*" [Denzin and Lincoln, 1994, p. 107].

In order to better understand worldviews, it makes sense to revisit (post-)positivist approaches, followed by constructivist approaches on research in the everyday of people.

3.3.1 Revisiting (Post-)Positivist Research

In the field of Human-Computer Interaction (HCI), a (post-)positivist lens has been dominant for some time. The ontology of positivism and post-positivism is realism, with a major difference that in a positivist worldview, the reality is apprehendable, where in post-positivist worldview, it is only imperfectly and probabilistically apprehendable. Concerning the epistemology, findings are true or probably true in a positivist or post-positivist worldview, because of the epistemology being dualist/objectivist. The inquiry aim is explanation as prediction or control [Denzin and Lincoln, 1994].

(Post-)positivism is also reflected in lab studies as an approach that have been adopted from research methods in psychology [Blandford et al., 2008] and cognitive sciences [Crabtree, 2003]. In HCI research, they have been used in the context of evaluating systems or interfaces and style of interactions. Most commonly, they have been used to test technology in different conditions, where they would answer questions of the type: "does making a change to the value of variable X have a significant effect on the value of variable Y?" [Blandford et al., 2008, p. 1] For example, variable X would be an interface or feature of a robot, and variable Y might be number of errors, people's satisfaction or trust. When designing experiments, several factors need to be considered. These include participants, ethics, dependent and independent variables, study design, etc. [Blandford et al., 2008]

Participants are the people to take part in a study. They represent a population (i.e., a "user group" [Blandford et al., 2008] or "all the people who might use an idea" [Purchase, 2012, p. 8]). For example, if a study concerns older people using a certain device or interface, it is important to involve older people as study participants. However, recruiting the right "target" population or a representative sample might not always be feasible. Further, a user population may belong to a vulnerable group which may cause ethical challenges. This might be the case also when studying the effect of a robot on older people's trust. However, a non-representative sample of users may challenge the outcome of the research, where it may not be guaranteed to what extent the results are also applicable to the user population.

A controlled experiment usually tests a hypothesis, typically concerning the effect of a change on some measurable performance indicator [Blandford et al., 2008]. For example, an experiment may concern the effect of robot related design cues on people's trust. The aim of a classical experiment is further to reject the null hypothesis, where the null hypothesis is an assumption stating, for example, that there will be no difference between two designs or conditions and hence no measurable difference in the effect of a variable X on a variable Y [Blandford et al., 2008]. In the example of trust, a null hypotheses may be: *there will be no difference in the effect on people's trust when using two different robots*. By failing to prove this null hypotheses, it can be shown that a specific robot has an effect on the independent variable, i.e., on people's trust. In designing an experiment, then, it is important to vary the independent variables in a known manner, to measure the effect, i.e., the dependent variables, and to minimise confound variables that would bias the outcomes [Blandford et al., 2008].

An important factor of experiments is to be aware of individual differences between people. These may include differences in personality, sensibilities, gender, cognitive skills, physical differences, etc. While it is impossible to control for all of these differences in experiments - and indeed to identify what differences might matter -, research suggests to control for the most likely factors that might influence the outcome of the study and that can be controlled to some extent. In a population sample, Blandford et al. suggest to be aware of factors like age, gender, education level, etc., and to avoid putting people with common selection criteria into one group and compare it to the other group, unless it would be an independent variable [Blandford et al., 2008].

Experiments can be also designed differently when it comes to the conditions. It is possible to conduct experiments within subjects and between subjects. A within-subject experiment involves each study participant to take part in all conditions. A between-subject experiment involves each participant to take part in only one condition [Blandford et al., 2008]. In a study on the effect on using a Pepper robot [Robotics, 2021] against a Buddy robot [Bud, 2021] on people's trust, it is possible to design a between-subject experiment, where each participant would test only one robot. Or, in a within-subject experiment, all participants would test both robots. The question which study design to choose depends on the type of question, duration of the experiment, potential biases when being exposed to one condition after the other, the difficulties in recruiting participants (i.e., a within-subject experiment may require less participants), etc [Blandford et al., 2008].

Overall, a controlled experiment comes with a couple of advantages such as that it can give confidence in the findings if the experiment is both well designed and executed. Experiments are well suited to study details of the perception of a system, of cognition or interactive behavior [Blandford et al., 2008]. For example, the effect of robot related design cues on people's trust in the robot may be suitable to be studied to some extent if trust is well defined. However, every approach also has its weaknesses: The causes of success or failure related to the use of a system/robot are commonly not to be found in the details of the system, but in the broader context of activity [Blandford et al., 2008]. These more situational aspects cannot be analysed well in controlled experiments, because it is impossible to isolate and control all variables and to isolate all confounds. Another risk is that the experiment measures something other than the researchers think, and that the data is misinterpreted [Blandford et al., 2008]. Participants may further behave according to the expectations of researchers, which can cause additional biases [Rogers et al., 2017].

While experiments have been a common approach to conduct empirical studies in HRI for some time, there is also increasing critique to using this approach too predominantly. For example, Rosenthal von der Pütten et al. [Rosenthal-von der Pütten et al., 2020] have called for inclusion of people who happen to be in coincidental presence with robots, such as in public spaces and outside of the lab [Rosenthal-von der Pütten et al., 2020]. Other work has called for participatory methods [Lee et al., 2017a] to design robots. Concerning experiments themselves, reproducibility and replicability of studies and results have also increasingly become a topic of concern recently in HRI [Chrysostomou et al., 2017, Ullman et al., 2021, Belpaeme, 2020]. Perhaps, the challenges with reproducing results also provides opportunities to invite a constructivist lens in HRI [Lee et al., 2022].

3.3.2 Taking a Constructivist Lens

In HCI and HRI, certain problems of interest are more socially embedded and complex to explore to be studied in controlled settings [Adams et al., 2008]. This is especially the case as problems that we encounter as researchers are not merely technical (e.g., how to design a specific algorithm that can fulfill certain pre-defined quality criteria), but also social [Fitzpatrick, 2003] (e.g., what are needs of people and how do we build robots that meet these needs).

Because this thesis deals with complex problems in the social world, the methodological approach is a constructivist one. In contrast to positivism and post-positivism, it is situated in relativism [Guba and Lincoln, 1994], meaning that realities are "apprehendable in the form of multiple, intangible mental constructions, socially and experientially based, local and specific in nature, and dependent for their form and content on the individual persons or (although elements are often shared among many individuals and even across cultures), and dependent for their form and content on the individual persons or groups holding the constructions" [Guba and Lincoln, 1994, p. 110f.]. However, while realities are specific and contextual [Braun and Clarke, 2019], they are often shared among individuals and across cultures [Guba and Lincoln, 1994]. A constructivist worldview is epistemologically transactional/subjectivist, and the findings are assumed to be created/generated rather than true. The inquiry aim may also be rather an understanding or reconstruction [Denzin and Lincoln, 1994].

In constructivism, the knowledge is created by the knowledge generator to a certain context. Hence this type of research is not uncovering objective facts (like discovering diamonds [Braun and Clarke, 2016]), because this approach assumes that objective facts do not exist. Rather, knowledge is generated and to be interpreted from complex data in a specific context [Boeije, 2009]. Because within a constructivist perspective, the knowledge is so strongly related to the interpreter, multiple "knowledges" can co-exist [Denzin and Lincoln, 1994]. In HRI, several work has also taken and argued for a constructivist worldview, e.g. [Šabanović, 2010, Suchman, 2006], while a great majority of research is (post-)positivist and has been conducted in the lab [Rosenthal-von der Pütten et al., 2020].

To a certain extent, research paradigms are also reflected in the type of methods chosen, e.g., the choice of qualitative vs. quantitative methods [Todd and Nerlich, 2004]. As described above, (post-)positivist worldview would tend to favor experimental or manipulative approaches to falsify hypotheses (with the difference that Postpositivism may also include qualitative methods in contrast to Positivism which would strictly use quantitative methods). Constructivism would tend to favor hermeneutical/dialectical approaches [Denzin and Lincoln, 1994]. The tendency to choose different methods over others may also have implications on collaboration between researchers who approach their work from different perspectives [Šabanović et al., 2007], e.g., (post-)positivist or constructivist.

In HCI and HRI, researchers have been increasingly going into settings of the home [de Graaf et al., 2015, de Graaf et al., 2018], public spaces [Rosenthal-von der Pütten et al., 2020, Dobrosovestnova et al., 2022], or other locations outside the lab [Rogers et al., 2017]. In HRI, this has been also called for lately, given a strong focus on research conducted in experimental settings in the past [Rosenthal-von der Pütten et al., 2020]. In HCI, a shift from more interactional research to practice-based research in the everyday is also reflected in the *turn to practice* [Kuutti and Bannon, 2014]. Further, Šabanovic (2010) has also emphasized the dynamic co-construction of robots and society in contrast to a technology-deterministic view [Šabanović, 2010]. Methodologically, research in everyday life is also reflected in recent steps towards participatory design research in HRI [Lee et al., 2017a, Frennert et al., 2013b, Lan Hing Ting et al., 2018].

The umbrella term 'research in the wild' (RITW) is also used to refer to research in the everyday: "Its overarching goal is to understand how technology is and can be used in the everyday and real world, in order to gain new insights about: how to engage people/communities in various activities, how people's lives are impacted by a specific technology, and what people do when encountering a new technology in a given setting" [Rogers et al., 2017, p. 1]. The results of RITW can yield new understandings, theories, or concepts. This approach can also be useful to generate situated understandings of certain phenomena, and to take into account ecological concepts and socio-cultural aspects [Rogers et al., 2017]. Concerning the chosen methods, Rogers et al. (2017) state that it is "agnostic", where it does not follow one kind of methodology, but may combine different ones depending on the problem or opportunity. Multiple decisions need to be taken [Rogers et al., 2017], as research and findings can be emerging. Greenhalgh & Russel (2010) suggest to take this into account, and to build theory from emerging data and to explore links between issues by observing social practices [Greenhalgh and Russell, 2010]. Because the research is conducted in the everyday and in more "naturalistic" environments, a particular context and specific setting is of importance [Rogers et al., 2017].

In situ studies are likely to give researchers access to the problems and needs people actually have in their everyday life, such as when using technical devices [Rogers et al., 2017]. Compared to a lab study, it is more likely to gain understanding of the complexities of people's needs in their homes, for example, where people may take different decisions on where to place a device, how to use it if at all, etc. As in-situ research provides the opportunity to focus on longitudinal experiences of people, this is certainly beneficial for answering certain types of questions, such as when designing robots to support older adults' psychological wellbeing [Gallego-Perez et al., 2013] (i.e., where a short-term study in a controlled setting would not yield any relevant insights for the question how a robot is able to support people, and what people experience and gain from using a robot). Compared to a lab experiment with pre-defined usage scenarios, a study in the wild may then also come with unexpected results of a study [Rogers et al., 2017]. This is also reflected by the nature of the types of problems that researchers are likely to encounter in RITW. These problems are often also social (i.e., not merely technical) and with non-deterministic solutions that are situated and co-evolving with the problem space, such that they can be characterized as *wicked problems* [Rittel and Webber, 1973, Fitzpatrick, 2003].

However, the advantages of research in everyday life may also come with downsides. Researchers can lose control over how a system is used in an in-situ study [Gallego-Perez et al., 2013]. A less systematic approach in terms of studying how a device or system will be used may be also harder to conduct. Here, it can be challenging to study whether a certain system is actually useful, usable, or whether it can potentially support people [Rogers et al., 2017]. For example, testing a robot's functionalities with regards to how it affects people's trust may be much harder to conduct in everyday life, given that researchers are not always present, and that not all actions can be predicted. Otherwise, the very values of older adults in their everyday life may be too complex to be only understood through controlled settings. When aiming to design robots that people actually perceive useful or giving an added value to their life, it is certainly necessary to conduct studies on people's engagement with technologies in real life, conducting in-situ studies. In a constructivist approach, the data is interpreted by a specific person having a specific background and experience, cultural membership, and theoretical assumptions [Braun and Clarke, 2019]. As it is the case in all scientific approaches, it may not be possible to fully erase biases that come with the approach, where in qualitative research, researcher subjectivity is seen as a resource [Braun and Clarke, 2019], such as the findings interpreted from interview data with older adults in chapters 4, 5, and 7. Therefore, a reflection on the own role may be useful, where Greenhalgh & Russel suggest "a balance between critical distance on the one hand and immersion and engagement on the other" [Greenhalgh and Russell, 2010, p. 4]. I as a researcher would not consider myself as part of the heterogenic group of older adults. However, I may share certain notions of technology, I may share socio-cultural understandings of technology and ageing, experiences in relation to gender or citizenship. As a PhD student at a technical university in an HCI research group coming from both a Social Sciences oriented field and an Engineering field, I may however have a more abstract perspective on assistive technology and on potential issues related to their role and usage compared to other people e.g. older adults. Bringing older adults' perspectives into research is a good reason to conduct in-situ studies to learn from these perspectives.

While the individual positioning against research and data may be useful to increase transparency, the absence of objective truth does not imply that results are arbitrary or without any criteria. (Post-)Positivism, for example, draws on benchmarks of rigor, such as internal and external validity, reliability, and objectivity [Guba and Lincoln, 1994]. In contrast, quality criteria in constructivism are trustworthiness and authenticity [Guba and Lincoln, 1994]. In the following, I describe how I accounted for the most relevant quality criteria for for this type of research [Guba and Lincoln, 1989, Guba and Lincoln, 1994].

- *Credibility* is a trustworthiness criterion in constructivism [Guba and Lincoln, 1994], which concerns the research against the setting or topic. Across the studies, I explain the methods used, and I provide evidence from the data (such as using quotes). I also discuss the overall approach, findings, and limitations in a critical manner to provide trustworthiness in my research.

- *Transferability* is another trustworthiness criterion [Guba and Lincoln, 1994]. It describes the ability to transfer insights or concepts from the context studied to other contexts. I provide information about the research context (e.g., location, participants, or time) [Guba and Lincoln, 1989], and further, I discuss the research against other literature, so that readers can judge the applicability of the research and findings to their respective setting. I also describe more explicitly in Chapter 8 how some of the findings can be potentially transferred to other contexts (e.g., to HRI research in public spaces).

- *Dependability* is another trustworthiness criterion [Guba and Lincoln, 1994]. I describe the area, participants, and setup of each study. Doing so, I account for the context in which the overall research has taken place.
- *Confirmability* is another trustworthiness criterion [Guba and Lincoln, 1994]. I describe the study procedures including the interview guides and technologies used (if any). This should enable other researchers to confirm and/or expand on the knowledge that I present.
- *Fairness* is an authenticity criterion [Guba and Lincoln, 1994]. Throughout the data collection and analysis, I included a variety of views and perspectives. I did so by defining diversity criteria, by conducting studies in different settings of the home (i.e., private homes and care homes), and also by including care workers' perspectives. I further discussed the data with fellow collaborators, which is a form of including multiple perspectives.
- *Ontological Authenticity* is accounted for by developing a more sophisticated understanding of older adults' longitudinal experiences with off-the-shelf AAL systems and design challenges for robots. This is especially done with a presentation of the contributions and the design considerations that are based on the entire research studies.
- *Educative Authenticity* is accounted for in the setup in Chapter 4, which has included regular social meet-ups by older adults. By voluntarily attending these meet-ups, participants also had the chance to exchange and learn about each others' viewpoints. Learning was also a key part of engaging in conversations using the elicitation cards in Chapter 7.
- *Catalytic and Tactical Authenticity* is accounted for by stimulating older adults to reflect on their experiences, which could be regarded as a form of empowerment. During the pandemic, older adults were given diaries to fill out regularly and reflect, cf. Chapter 5. Participants were also provided the opportunity to access AAL systems as part of the study presented in Chapter 4, which can be interpreted as a form of empowerment.

While this thesis predominantly reflects a constructivist worldview, it also involves a study using participatory design. It is therefore worth mentioning that some researchers argue for a participatory paradigm (which is different from a constructivist paradigm): According to Heron (1997), practical knowledge plays a primary role in this worldview, which they argue that constructivism does not acknowledge [Heron and Reason, 1997]. Further, "within the participatory paradigm, practical knowing is of central intrinsic value[...][and] the intrinsic value of the researchers' own practical knowing" [Heron and Reason, 1997, p. 288] is of importance.

3.4 Chosen Methods

While this thesis also concerns empirical work in home environments, the "where" of empirical research does not necessarily imply any specific methods to use per se, e.g., interviews or surveys. Therefore, the subsections below will give an overview of the chosen methods applied in this thesis. As noted above, the paradigmatic worldview underlying this thesis is constructivist, meaning that the knowledge is created by interpretation [Denzin and Lincoln, 1994, Braun and Clarke, 2019]. This implies to a certain extent that the predominant choice of methods is qualitative, which I will elaborate on in more detail in the following subsection.

3.4.1 The Stance of this Thesis: Choosing Qualitative Methods

This thesis is based in complex, socially embedded phenomena around older adults and their living spaces. The main research question starts with "How" and is open-ended (cf. also [Braun and Clarke, 2019]), and it is a typical example of a wicked problem with no pre-defined solutions. To name only a few of the key properties of wicked problems, there is no definitive formulation of such a problem, every instance of such a problem is essentially unique, each of the multiple stakeholders who are interested in how a wicked problem is solved could define the nature of the problem and the solution differently, and problem definitions and solutions co-evolve [Rittel and Webber, 1973]. While a great part of science relies on quantitative and experimental methods, these complex and socially based phenomena cannot be easily quantified or experimentally manipulated [Adams et al., 2008]. People's emotional or social drives, trust or their expectations are complex and they may be even more complex when they are related to social structures and work practices, organisational, political and economic factors [Adams et al., 2008]. Hence a more naturalistic, contextual and holistic understanding of human beings in society and their needs also requires methods that are more suitable to capture these aspects, where qualitative methods can be more suitable to deal with these open-ended questions [Todd and Nerlich, 2004] and with wicked problems in general. Because the chosen methods and the kind of data collected must be appropriate to answer a given question [Purchase, 2012], this thesis is predominantly based on the use of qualitative methods.

An essential part of qualitative research is the subjectivity of the researcher [Adams et al., 2008]. This includes their subjective experience and situatedness. While this may also be the case in quantitative research, it appears to be much more obvious in qualitative research. In quantitatve research, methods are adopted with the aim to allow reproducibility, such that manipulations can be repeated by any researcher, and that the influence of the researcher on the research is reduced where possible [Adams et al., 2008]. Quantitative data is typically represented by numbers (e.g., number of errors, degree of trust,...) [Purchase, 2012]. In qualitative research however, findings to be identified are interpreted by one or more researchers [Braun and Clarke, 2016, Braun and Clarke, 2019], who actively *identify* patterns of meaning across datasets in the interpretation process, i.e., rather than reporting on *emerging* results [Braun and Clarke, 2019]. The findings then are also connected to the researcher's subjective experience. Hence the criteria for choosing a sample of participants cannot be generally determined as it would be required from the view of (post-)positivism [Braun and Clarke, 2016, Braun and Clarke, 2019]. Braun and Clarke (2019) also stress that in qualitative research, depth of engagement with the data is important, along with an open-ended and flexible stance of researchers, and the foregrounding of researcher subjectivity and reflexivity [Braun and Clarke, 2019].

Qualitative research may concern data collection and analysis. This concerns the literature as well as empirical data collection and analysis [Boeije, 2009]. Data can be represented by verbal or written descriptions of an experience, a video, any artefact, etc. [Purchase, 2012]. In the following, I outline the methods used in this thesis for data collection and analysis, which reflect the qualitative stance that I bring in this thesis.

3.4.2 Applied Methods in this Thesis

Data Collection

This thesis uses different types of qualitative interview techniques, including individual and and group interviews. In addition, I used diary studies as a remote data collection technique. An overview of the methods used is also presented in Table 3.1.

Interviews are generally useful to obtain more detailed and thorough information on a problem or topic (e.g., compared to questionnaires) [Adams and Cox, 2008]. It is often guided by pre-defined questions, where interviews can be generally either more or less structured [Adams and Cox, 2008]. In this thesis, I focused on semi-structured interviews, which would give the interview conversation a basic structure, but would also allow me to be flexible enough to jump between questions or to explore topics of interest more in depth, depending on the conversation flow and the topics emerging during a conversation [Adams and Cox, 2008]. E.g., if an interview partner raised privacy concerns in the very beginning, then I would explore the topic further, even if I had a question prepared on this topic later in the guideline.

Interviews can be conducted either with one person or with or with groups. In any case, conducting interviews requires a certain degree of trust between the researcher and the people who are being interviewed. I aimed at establishing trust by sticking to formalities like the assurance of confidence and of the conversation and collected data. I also focused on establishing a relationship with interview partners from the very beginning of being in contact with them (e.g., by using their preferred way of contacting them, such as via telephone or via email; and being polite), and during the conversation. During the interviews, I aimed at interacting spontaneously and naturally, as in a more casual conversation, and showing my interest in the conversation and topics that the interview partners raised.

I conducted interviews both in-situ and remotely, e.g., via telephone or video, as has been the case in the study during the COVID-19 pandemic. The setting for the interview however can also affect the conversation and atmosphere, and more natural settings may also increase the likelihood for naturalistic responses [Adams and Cox, 2008]. Therefore, where possible, I aimed at conducting the interviews in naturalistic settings like people's homes. If both the researchers and interview partners are comfortable meeting there, they may be able to relate better to daily experiences. However, where possible, I also gave the interview partners the choice to state where the interviews should be conducted (see e.g. interview locations in Chapter 4).

Group interviews can be further useful to stimulate discussions with and among participants [Frey and Fontana, 1991], and they have been also associated with marketing research [Denzin and Lincoln, 1994]. I used group discussions as part of participatory design workshops. The evolution of group dynamics can be useful to explore the characteristics of a group, such as shared attitudes or differences in people's attitudes on robots, for example. I also aimed at balancing the participants' voices in the interviews, as more dominant participants may take more time to speak, which is important to counteract to some extent to engage and make use of the group as a whole [Adams and Cox, 2008].

Another data collection method that I applied in this thesis is a qualitative diary study. Diaries can be used either with pen and paper, or in an electronic format [Janssens et al., 2018], where I aimed at the version with paper and pen given this appeared more accessible to residents of care homes who did not all have access to electronic devices. The diaries allowed for repeated engagement with topics and questions, i.e., on a regular basis and over time [Hyers, 2018]. This comes with the potential to stimulate a deeper reflection, as I aimed for in the diary study of my thesis. The method has been found particularly useful for psychological measurements (like symptoms) that require longitudinal and regular assessment [Janssens et al., 2018]; where in my case, it allowed me to engage older adults with a repeated reflection on longitudinal experiences of the pandemic in care contexts. Another advantage of diaries is that they allow remote data collection, which has been in particular required during the restrictions of the pandemic. As diaries are filled out remotely, i.e., without researchers present, they can be also used in a particular context and time, potentially drawing attention to the context-specific experience [Hyers, 2018] (such as living in a care home during a pandemic). I decided on the overall duration and the number of questions per day in order to balance opportunities for reflection and workload for the participants, and the time-points (i.e., daily questions) [Janssens et al., 2018].

Data Analysis

To analyze qualitative data, many methods have been proposed across disciplines, e.g. [Braun and Clarke, 2006, Charmaz, 2014, Froschauer and Lueger, 2003]. While qualitative data can be analyzed in an inductive manner or in a deductive manner [Braun and Clarke, 2019], given the constructivist stance of this thesis, I analyzed data inductively. A popular way of analyzing qualitative data in HCI (perhaps, given its intersection with Psychology) is through Thematic Analysis (TA) [Braun and Clarke, 2006]. This approach is an umbrella term [Braun and Clarke, 2019], and Braun and Clarke distinguish between 'coding reliability', 'codebook', and 'reflexive' approaches that have been used in previous years, the latter reflecting their own stance [Braun and Clarke, 2016]. They aim for an "[...]open exploration of ideas, understandings and constructs" [Braun and Clarke, 2016, p. 740] to identify patterns of meaning across qualitative datasets [Braun and Clarke, 2016, Braun and Clarke, 2019].

Braun and Clarke identify a reflexive and recursive six-phase approach to qualitative data analysis [Braun and Clarke, 2019], which I used throughout the process as follows.

Familiarization with the data. First, I familiarized myself with the data, e.g., by listening to audio recordings, and reading notes that I had collected. At times, I took or added casual notes. As some of the data has been also analyzed collaboratively (e.g., in Chapter 5 and 7), I met with other researchers involved over lunch, or in virtual meetings, to debrief and discuss first impressions in a more informal manner.

Generation of initial codes. Subsequently, I generated codes, which is a more systematic engagement with the datasets. I did so by organizing the data, either in tables, or using the MaxQDA[1] software. In one case (cf. Chapter 7), I printed out the text-based data and organized it on a large table in the office. With an inductive orientation of coding, I started with the meaning-making from the data (rather than from existing concepts/theories). In the case of Chapter 7), I was also interested in analyzing specific cards that were part of the elicitation method, which is why I also grouped codes in accordance with the respective cards (inspired by [Froschauer and Lueger, 2003][2]).

Generation of themes. From the codes, I constructed themes, unifying initially disparate data [Braun and Clarke, 2019]. I constructed these themes in an iterative process to ensure that they are more than domain summaries (cf. [Braun and Clarke, 2019]). I did so either by grouping codes that I identified, or using the Miro software in one case (cf. Chapter 5), as this work has also involved collaborative data analysis.

Review of themes. I used several iterations to explore connections between themes, reviewing them, where in this process, I also went back to the codes and the data at times. Here, initial candidate themes were also refined and/or replaced by others; where it is important not to get too attached to initially crafted themes right away in order to let go of them if they do not fit [Braun and Clarke, 2019].

Definition and naming of themes. In this phase, I created the final version of themes, so that they clearly represent a shared aspect across the dataset. In this phase of the interpretation, theme names could also change to become even clearer, reflecting an actual interpretation that tells a compelling story.

Production of the report. This final phase was a next important step as part of the data analysis, which happened especially as part of discussing the work in publications ([Schwaninger et al., 2020, Schwaninger et al., 2021, Schwaninger et al., 2022]) and in this thesis, namely the sections on Findings in the case study chapters, and the Discussion

[1]https://maxqda.de

[2]Note, according to Braun and Clarke [Braun and Clarke, 2016], TA allows for a combination with other analysis approaches, if stated transparently

chapter. Part of this final creation of themes has also involved slight adaptations of research questions [Braun and Clarke, 2019].

3.5 Research Studies

The main research question along with the two subquestions are answered with several case studies (see also overview Table 3.1). The subquestions (RQ1-RQ2) further accomplish one objective each (O1-O2), providing building blocks for the overall objective (O) to answer the main question (RQ).

O1 provides an understanding of older adults' longitudinal experiences with current off-the-shelf AAL systems in private homes and in care homes (RQ1). O2 provides an understanding of methodological challenges when designing robots by engaging older adults, and addressing these challenges with methodological explorations to co-imagine robots in living spaces. The main objective of this thesis (O), then, is to derive lessons learned from O1 and O2, which are needed to identify main factors for understanding and designing robots to support older adults (RQ).

I will describe the studies to be conducted to answer the research questions below, where I will also give an overview of the methods used. Further details on the methods and approach (e.g., choice of participants, exact procedure) will be elaborated on in the respective chapters on the research studies.

RQ1: Understanding Older Adults' Longitudinal Experiences with Assistive Technology

There are still many challenges with AAL systems that are currently on the market, such as a lack of uptake or complex stakeholder needs. However, given there are various off-the-shelf systems available, these can be used to learn from longitudinal in-situ experiences with older adults for supporting them with robots. Therefore, I present two case studies that focus on older adults' experiences with current systems, also taking into account their care networks where applicable, and different types of living spaces.

First, I present a long-term study with older adults using commercially available devices and AAL systems in private homes. In the study, several devices (including tablets, fall detection sensors, safety watches) were deployed to over 80 households for over 18 months [Ates et al., 2017]. I present the results of 20 qualitative interviews with 15 older adults in two phases (i.e., after 12 months and after 18 months) which I conducted. Understanding people's longitudinal experiences in private homes will provide a lessons learned from older adults from for robots that are not yet on the market.

Second, I present a long-term study with 10 older adults and 10 care workers using current AAL technologies in two different institutional care homes. The fact that this study has been conducted at times of COVID restrictions provided an opportunity to also investigate experiences of using devices as triggered by experiences of the pandemic. In the context of this thesis, this study provides insights on lessons learned for supporting older adults with robots from an institutional setting and also taking into account the perspectives of care workers, and with insights from special circumstances.

RQ2: Understanding Methodological Challenges when Designing Robots for and with Older Adults

As I am interested in the main factors to consider for understanding and designing robots to support older adults, it is certainly necessary to engage with older adults and actual robots in one or the other way. This is useful to complement longitudinal experiences with current off-the-shelf AAL in the field. However, because AAL robots are not yet on the market, a promising way of engaging older adults with robots is through a design approach. A bottom-up approach which has been proposed recently is engaging older adults through participatory design [Lee et al., 2017a, Lan Hing Ting et al., 2018].

To gain an initial understanding of current methodological challenges of participatory design with older adults and robots, I first present three workshops including group discussions with 17 older adults and commercially available robots by using an open-ended approach. While these workshops complement previous participatory design research in HRI [Lee et al., 2017a], I also aim to identify and reflect on challenges related to the PD process itself. These reflections also feed into the next step, where the challenges are addressed with the exploration of a methodological tool.

As a subsequent step, I present the iterative design of an open-ended co-imagination tool to conduct qualitative interviews, i.e., a deck of elicitation cards. Elicitation tools can be useful to engage with abstract topics [Barton, 2015], and older adults are not yet familiar with actual robots in their homes. This method also aims to address some of the challenges identified in the initial study on PD with older adults and robots (to be explored in more depth in the respective case study). As part of this study, 10 people were involved in designing and assessing the method with additional 10 older adults. While the design of this exploratory method is a contribution in itself, I also provide methodological findings on envisioning robots using it.

Study	Methods	Objective(s)	Participants
Long-term study with older adults using off-the-shelf AAL technologies in private homes	Qualitative Interviews	Identify an in-depth understanding of older adults' experiences with AAL (O1)	15 Older Adults (interviewed in 2 Phases)
Long-term study with residents and care workers using off-the-shelf AAL technologies in care homes	Remote qualitative interviews and diary study	Identify an in-depth understanding of older adults' and care workers' experiences with AAL (O1)	10 Older Adults and 10 care workers
Participatory design workshops with older adults and commercially available robots	Group discussions	Identify methodological challenges of conducting studies with robots and older adults in interdisciplinary research teams (O2)	17 Older Adults
Iterative design and usage of a co-imagination tool to engage older adults in PD, responding to PD challenges identified	Qualitative interviews	Address methodological challenges of conducting studies to design robots by engaging older adults (O2)	10 Older Adults + 10 Informatics Students

Table 3.1: Overview of the studies conducted.

3.6 Ethical Considerations

This research has been conducted with older adults and care workers. All participants were cognitively able. The qualitative research included open-ended questions, which may also cover sensitive and/or personal topics (e.g., trust, social experiences, ageing, autonomy, privacy). Ethical guidelines suggest that it is necessary to make clear that it is technology that is being assessed and not people themselves [Blandford et al., 2008], which I emphasized in the beginning of interviews and the diary study, and whenever people were concerned about their competence in providing "good enough" answers. When asking questions about potentially sensitive topics e.g. in the study conducted at times of the pandemic, I took many interactions preparing the questions (e.g., in the case of the diary), asking older family members for feedback at first, in order for people to feel comfortable with the questions and help them to reflect. I also aimed at making clear that participants should only disclose as much information as they were comfortable with. Throughout the empirical studies, participants were asked for consent[3], and participants

[3]cf. also https://www.tuwien.at/index.php?eID=dumpFile&t=f&f=100923&token=3c852936061a0f75a539328ef90d59dd4b590330 [Online, last accessed: 11 April 2022]

could resign at all time from the studies.

The studies presented in Chapter 4 and 6 were conducted as part of research projects with external partners. In Chapter 4, the data presented was collected as part of a larger AAL project (WAALTeR). Already in the beginning of the project, two internal ethics workshops have been conducted, which applied the MEESTAR framework [Manzeschke, 2015] to identify possible ethical risks. Based on the outcomes, a document with extensive ethics guidelines has been developed [Frauenberger et al., 2017], providing a collective value base to guide actions, and to provide information on how to handle aspects such as the right to privacy, possible exit strategies for participants, protection of vulnerable participants, as well as informed and continuous consent. The information in this document has been also developed because neither the funding body nor the involved research institutions had formal ethics board installed at that time; it is nevertheless similar to what is expected from an ethics document submitted to a formal ethics board [Bieg et al., 2022]. The data presented in this thesis was collected at the end of the project (in 2019), as part of the evaluation phase. In the study presented in Chapter 6, the "Ethikkomission des Evangelischen Krankenhauses Wien" has provided ethical approval, and the procedure has also involved consent forms. The study presented in Chapter 5 has been conducted remotely and in collaboration with the University of Siegen, where the study design has received ethical approval by the University of Siegen, and participants were asked for consent (cf. consent forms in Appendix 9). The study presented in Chapter 7 has been conducted as part of a university course at TU Wien, where at the time of conduction, TU Wien did not have a formal ethics approval process. As part of this study, students were provided with consent forms (cf. Appendix 9).

To respect individuals' privacy and confidentiality [Blandford et al., 2008], the entire collected and processed data has been also fully anonymized. The participation has been voluntary which we made clear throughout the studies; and while participants did not receive any financial reimbursement for participation, in some cases, they received devices (cf. Chapter 4), or at least food and beverages (cf. Chapter 6).

3.7 Summary

In this chapter, I discussed an overview of the methodological approach of this PhD thesis. I presented the guiding research questions with which I address the topic of supporting older adults with robots, taking a bottom-up approach. This includes my main research question and the two sub-questions. I also situated the work within a constructivist worldview, revisiting this worldview both from a philosophical tradition and against previous HCI and HRI literature. I then set a foundation of the different approaches that have been discussed in HRI by outlining the contrast between lab studies and research in the wild in HCI and in HRI. After this foundation, I presented a theoretical overview of the methods that I have chosen as part of this bottom-up approach, where I also argued for choosing qualitative methods, allowing an exploratory approach. I then discussed the qualitative methods used for data collection, including qualitative interviews (individual and in groups, as well as remote interviews); and diary studies. For data analysis, I presented an overview of the Thematic Analysis approach [Braun and Clarke, 2006, Braun et al., 2018, Braun and Clarke, 2019]. After this methodological overview, I presented the four case studies, including how they aim to answer the respective research questions. This was followed by ethical considerations which focused mainly on research ethics.

CHAPTER 4

Experiences with Assistive Technology in Private Homes

4.1 Chapter Overview

The work presented in this chapter is based on and extended from the previously published Designing Interactive Systems (DIS) conference paper "Unpacking Forms of Relatedness around Older People and Telecare" [Schwaninger et al., 2020]. The aim of the chapter is to provide one of two building blocks for understanding older adults' long-term experiences with off-the-shelf AAL in living spaces (contributing to answer RQ1 and the main research question). It involves a longitudinal study that was conducted with older adults and simpler AAL technologies like tablets and sensors in private households, which was conducted as part of the evaluation phase of the WAALTeR project[1]. As a key aim of AAL is to support independent living at home, I also draw on Self-Determination Theory (SDT) [Ryan and Deci, 2000] from psychology to map out self-determination needs across the findings. I provide insights into how these needs are also relevant for care / AAL with robots.

The overview of this chapter is as follows. The Chapter Introduction section sets the context and key aims of AAL as relevant to this chapter. I then describe the research project, data collection and analysis, along with results from 20 qualitative interviews with older adults using AAL technologies. Subsequently, I introduce the concept of relatedness, which provides a conceptual basis to unpack forms of relatedness throughout the findings. I then discuss how the findings are relevant for care networks with robots in living spaces. The chapter closes with a summary.

[1] http://waalter.wien [online; last accessed: 1 Dec 2021]

4.2 Chapter Introduction

AAL Technology has been promoted since many years for ageing in place [Haslwanter et al., 2020], where robots are a relatively new instance of AAL. Blackman et al. [Blackman et al., 2016] identified three generations of AAL. The first generation of AAL technologies include community, social, and personal response systems, mostly designed as a wearable device that can be used to trigger an alarm to contact a person in a 24-h call center. A benefit is potentially decreased stress levels among older adults and their family and caregivers; and the ability to live at home longer; while a disadvantage is that the person actually needs to wear the device also in high-risk situations such as when getting up at night. The second generation of AAL technologies are characterized by integrated electronic components which not only respond to, but also detect emergencies with sensors [Blackman et al., 2016], such as a fall or environmental hazards [Sixsmith, 2000]. These technologies are used within the home only, and they may feel intrusive. The third generation of AAL technologies combine the benefits of earlier technologies, aiming to detect and report problems and also prevent them. By integrating computing systems and assistive devices such as wearable and environmental sensors into living spaces, they monitor the environment and the older person. A potential benefit is also reduced stigma associated with monitoring and assistance by embedding technology within everyday objects and hiding them [Blackman et al., 2016]. While the paper by Blackman et al. includes robots as within the three generations, the majority of studies with robots in living spaces have been conducted with prototypes [Bajones et al., 2018, Bajones et al., 2019, de Graaf et al., 2018, de Graaf et al., 2018], and given that robots are not commercially available for the most part, they could also be seen as a next generation.

AAL technology types can be classified as activity monitoring, alerts, communication, emergency, feedback support, health monitoring, navigation, recreation, social support, standards, and specialized user interfaces [Blackman et al., 2016]. Assistive robots often have similar aims and they offer functionalities similar to other AAL systems, especially when it comes to monitoring, emergency detection and handling, or supporting safety [2]. Service type robots also aim to support basic activities like bathing, eating, toileting and getting dressed, and mobility [Martinez-Martin and del Pobil, 2017, Bajones et al., 2018, Broekens et al., 2009]. Further, companion type robots are social robots that provide companionship, also to enhance health and psychological well-being of older adults [Broekens et al., 2009], or for entertainment and "leisure" [Dautenhahn et al., 2005]. These social type robots offer an additional functionality compared to other AAL systems. Besides their embodiment and the expectation that robots are able to communicate with non-experts in an intuitive way [Dautenhahn et al., 2005], robots also come with a certain degree of autonomy (e.g., in their navigation or communication).

However, AAL robots are not widespread to date, but under development, making requirements for robots critical. Hence there is an opportunity to gain an understanding of the integration of current AAL technology into everyday life and issues that are relevant

[2] Does safety exist? Is it the absence of 'danger', providing there is an idea of danger or risk?

to learn for HRI. To do this, I conducted a longitudinal study with older adults using devices that have been on the market for some time [Ates et al., 2017]. The focus here is on AAL technology that is used for communication, social support, emergency, and monitoring, and it is mostly of the first and second generation of AAL. This includes community, social and personal response system. At a later stage in the project, some participants were also given monitoring systems that automatically detect alters.

4.3 The Research Project

In an AAL project in Vienna [Ates et al., 2017, Bieg et al., 2022], over 80 households of people at the age of 60+ were provided with smartwatches and tablets to use for 18 months. The system has been developed based on a a user-centered design approach as part of a joint project[3], involving public stakeholders, research organizations, and technology providers. Even though the applications were tailored to the target group as part of the project, they were also mundane and provided a variety of functionalities that have been also on the market for some time. Devices used were a smartwatch and a tablet with apps of various categories.

The smartwatch came with basic functionalities of a watch (i.e., display of date and time), and an additional calendar integration from the tablet and an emergency call function. The tablet offered five categories of applications, which were displayed on the main menu screen (see Figure 4.1[4]): *News and Events*, *Health*, *Communication*, *Mobility* and *Other applications*. The *News and Events* category included a news application, a local event application for the city, and a calendar. The latter two were connected, allowing a transfer of events in the city to the calendar. The *Health* category included a list of online resources for health and age-related information, e.g., an application to locate nearby pharmacies. The applications in the *Communication* category aimed to foster and facilitate social connections with other people. This included staying in touch with friends and relatives as well as making new acquaintances. Video calls and message applications, as well as a neighboring platform application were provided. The *Communication* category further included a photo cloud to store pictures and directly share them via the integrated message or e-mail application. The *Mobility* category included a route planner. The *Other Applications* category included external applications, including a selection of popular applications that were available in a regular app-store (e.g., a standard web browser, an e-mail program, communication applications such as WhatsApp and Skype, public transport applications specific to the city, a weather application and games like Solitaire and Mah-Jong. A more detailed description of the system can be found in [Bieg et al., 2022].

For the last six months of the research project (i.e., after 12 months of using tablets and smartwatches), a number of the over 80 participants were also given additional

[3] http://www.waalter.wien

[4] While the devices were provided and used in German language, the illustration of the main menu presented in this work is in English to make it better understandable by the readers.

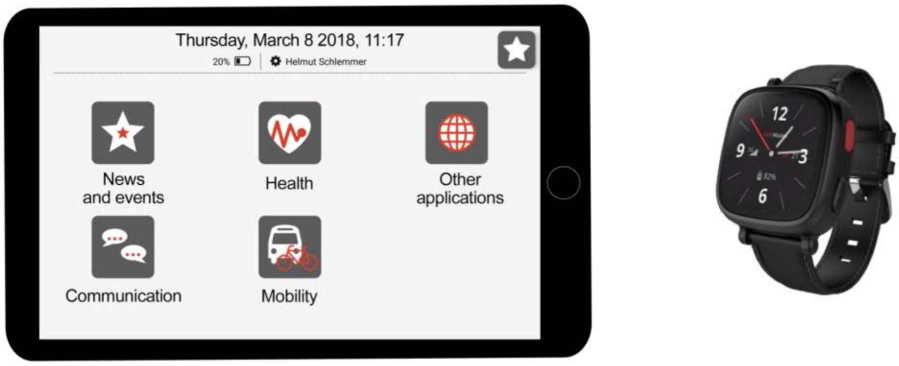

Figure 4.1: An illustration of the main menu of the tablet (left) and the smartwatch (right) used by the participants for 18 months.

applications to use for additional 6 months. They could choose between either a safety package with fall detection sensors installed in a room of their choice, or tele-health applications with a smartwatch for counting steps paired with an app for collecting data on blood pressure.

To support the uptake of AAL technologies, the project also set up a social infrastructure. The participants were offered monthly social meet-ups and information events, run by care facilitators. These were also used for social exchange, and to ask project-specific questions. From the side of the project, these were also planned to provide an additional incentive for the participants and prevent high dropout rates of the project [Bieg et al., 2022].

4.4 Data Collection and Analysis

I conducted 20 qualitative interviews with 15 older adults in two rounds, after 12 months and at the end of the project (i.e., after 18 months). I chose our interview partners based on diversity criteria (i.e., to obtain a diverse sample), taking into account their flat size, area of Vienna, household size, gender, technical affinity, age, and additional applications to be received later in the project[5]. Among our interview partners, 10 people were female, 5 were male, and the mean age was 72.6 (SD = 7.5; Min = 61, Max = 86). The interviews lasted 30-60 minutes each, and the participants could choose the location for their interview. An overview of the interview partners including their gender, age, and the interview location is presented in Table 4.1. The interview questions covered topics around self-determination and autonomy, design and transparency, perceived safety and

[5]Note, in the recruitment process, a few participants were also invited not taking into account all of these criteria, such as household size. Therefore, not all information is available (see Table 4.1 indicating n.a.). The recruitment was facilitated by a project partner who provided contacts to candidates who had expressed their interest, and overall, there were time constraints.

privacy, an outlook into the future (e.g., asking about the idea of robots as a next step), and a final reflection. The interview guideline is presented in the Appendix (9).

ID	Gender	Age	Area	H Size	+Appl.	Interview Location
IP1	female	77	15	1	S	home
IP2	male	74	14	2	S	home
IP3	male	73	19	1	-	university
IP4	female	82	2	4	-	home
IP5	male	78	11	2	H	home
IP6	female	70	21	1	H	university
IP7	female	62	21	n.a.	H	café
IP8	male	75	12	n.a.	-	home
IP9	female	65	1	2	S	café
IP10	female	69	8	1	-	home
IP11	female	68	n.a.	n.a.	-	university
IP12	female	86	22	1	H	café
IP13	female	61	17	2	-	café
IP14	male	67	18	1	S	café
IP15	female	82	22	1	S	café

Table 4.1: Overview of interview partners and their gender, age, home district (i.e., suburb/area in Vienna), household size (referred to as "H size" in the table), additional packages where applicable (S = safety, H = health, referred to as "+Appl" in the table), and the location of the interview as chosen by each participant.

I transcribed the audio recordings of the interviews, anonymized the recordings, and subsequently coded the transcribed text. The qualitative data was analyzed with a reflexive thematic analysis approach [Braun et al., 2018, Braun and Clarke, 2019] by inductively clustering topics. I generated initial themes, reviewed them, and defined a final set of themes to interpret results that I present below.

4.5 Results

4.5.1 Experiences with current AAL

In general and in line with the diversity of features offered by the technical system, AAL technology was seen as a tool for multiple purposes. Examples included: to facilitate connectedness with other people (e.g., via messaging with family members or photo sharing), to support independent living and to handle potential emergencies (e.g., with the smartwatch), to help others or to support with care-related work (e.g., by having access to information about current and future AAL application in the project), or to get help or access information (e.g., searching for online health information, or everyday life issues: "*she can search [online] for who does this who could repair it*" (IP14)). Regarding the quantitative evaluation of functionalities, gaming apps were the most used [Bieg et al., 2022]).

Participants were especially curious about new technology-related opportunities that could support them in an older age. By participating in the project, they aimed to learn "*what there is to offer for ageing besides care homes*" (IP1), which was seen as a must: "*because you have to [learn about this topic]*" (IP1). Participants wanted to engage with technology related to AAL "*because as a 75, 70 year-old, I won't get anything like this into my house anymore*" (IP11). Some participants described a particularly positive attitude towards receiving new technology in the context of the study: "*A neighbor of mine also joined, [...] she was impressed [by the project] and she was happy to receive an iPad*" (IP6). Participants were also motivated to make use of technology to support themselves, even if only in the future ("*I don't really need it yet, however, I might be able to prolong living alone a bit longer*" (IP6)). This was also connected to the idea to be able to live independently.

Participants expressed proactive engagement also as they generally wanted to improve their skill-set and their digital competencies to keep up with the latest technologies. "*I want to be more literate, I want to better understand the latest technologies*" (IP13), illustrating this. However, some participants were missing support in learning how to use the technology ("*I need better enrollment*", i.e. support (IP12)). Improving skill-sets was also a motivation to join the social meet-ups, and so was learning: "*all the meet-ups have been really interesting*" (IP12). A participant expressed how she was particularly curious about exploring the technology in detail: "*I even went into the operating system to change all kinds of things*" (IP7).

However, some participants also described a lack of motivation to engage with technology, either because of a lack of time, usefulness, the availability and use of other (or better) technology, or fit. One participant felt she did not have time: "*I think it is somewhat interesting but [...] I am very busy and I don't have so much time for it*" (IP13). Another participant expressed that - from her personal perspective - she had better things to do than reading or watching news online: "*I don't want to watch nonsense every morning*" (IP5). Further, people also stated they already had many friends in their closer social environment and were not in need to make new contacts. Some participants expressed that they preferred to use specific external applications (e.g., commercial messenger apps like WhatsApp) over tools developed in the project (e.g., the internal messenger app) as the external applications were also used by people in their closer social environment. While participants engaged with technology, they could also not relate to the content of several apps, or they did not see themselves belonging to the target group ("*Look, birth preparation [...], I am a great grandmother now*" (IP4)).

Experiences with technology also brought upon the topic of vulnerability, as AAL technology was seen as either stigmatizing or it could cause rather unpleasant situations when not working reliably. For example, "*the emergency watch [...] I felt a bit uncomfortable wearing it [...] I've seen there is also a necklace to wear but this one is just a bit...ok, if you are home alone, then it would be okay. But...look if you find anyone of age 62 on the* *street wearing it this is not really common...*" (IP13); or it was not seen as pretty. In cases of emergencies, the smartwatch had breakdowns, which created unpleasant situations. A person told us how she was embarrassed when she needed help but couldn't get help because of a technology breakdown: "*I hope it [i.e., the battery] will not be empty next time so that I stand there and it is then very embarrassing, it is unpleasant, it is vital actually. Because last time I fell I had to call for half an hour, 45 minutes until anyone could hear me. This is of course very unpleasant*" (I15).

Furthermore, there was also skepticism of using technology at home because of a lack of privacy or safety regarding the own home. For example, the neighboring platform was rejected by the interview partners as they were sceptical about data security and integrity on the platform (i.e., the risk of information disclosure to people in the neighborhood via an application). Participants also had privacy concerns around technology in general ("*big brother is watching*" (IP3)). For the smartwatch, relationships with care facilitators and the values associated institutions such as the EU also facilitated trust in technology to some extent.

4.5.2 Social Aspects of AAL

While the intention of setting up the social infrastructure may have been mainly to support the uptake of technology, we found people found them most useful for feeling connected with other people in the community. This was a value in its own right; with a few side effects. Participants joined the meet-ups for social reasons, where they could meet old friends or new peers. Some participants had been friends for several years ("*I've met that other colleague three or four years ago, but this other colleague, I've known her since my youth*" (IP1)), and they found it "*nice meeting there*" (IP2). Others were interested in meeting up with new peers ("*it is really all about the contacts you can make*" (IP7)). Further, some participants enjoyed meeting people across generations. The context of the study also provided new insights about others, e.g., "*I find it interesting to see how others experience technology in relation to their life, in relation to age, in relation to ideas*" (IP7). However, this very same aspect was not always appreciated: "*I have enough to do, should I also deal with a whole lot of other people who need an even longer spoon for their yoghurt glass or what?*" (IP6).

Participants valued the opportunity of helping each other, and of receiving some degree of training by the facilitators of the meet-ups, which has been useful but could be even more personalized. Participants were solving issues together: "*we also tried to help each other in smaller groups*" (IP7), offering help: "*if there is anything you want to know you can ask me [...], I am more experienced as I know these things from my job*" (IP14). However, social exchange also resulted in people comparing themselves with others: Some found they were "*maybe not as talented*" (IP12) as other people, where the oldest interview partner said, "*I need more personalized training*" (IP12). As such, some participants wished for additional support in regard to using the technology ("*I could have asked, maybe...although I can see I am one of the last ones needing help...as far as I can see,* *the others already know pretty well how to use the devices*" (IP2)). In contrast, others stated the technology seemed too easy ("*this is like pre-school*" (IP8)).

People who volunteered to participate in the project were not only concerned about their own future or skill-set, but it turned out in the interviews that the participants were also interested in helping others, either professionally or informally. Among our interview partners, three people worked in a professional sector related to AAL (IP3, IP13). At least two people worked as caregivers on a voluntary basis (IP4, IP6), and one person was living with a person in need of care (IP9) who participated in the project to support her husband. As these participants were working in the (health-)care sector or living with (older) partners, they were hoping to enhance their skill-set and learn about technology that might be useful for care work. A participant who was working as an occupational therapist (IP13) was optimistic and eager to learn about research and development in the field of healthcare, specifically related to her profession. During the interviews, she also asked us about our work and opinions towards technology for therapy.

Some participants joined the project to care for others informally, where technology would facilitate connectedness between participants and their partners or patients. When asking participants why they were taking part in the project, one answer was: "*because I can help people*" (IP4). It referred to doing care work (*"I work a lot with older people [...] we visit those people aged 75+, I think I can pass something on to them"* (IP11)), or sharing experiences and information. People stated that they would pass on the news to their friends, e.g., "*the group of retired people, they benefit from the information and experience we pass on to them, it's good to pass on experiences*" (IP1). Participants did not want to be dependent on their family when facing problems with technology ("*I rather wait for asking him for help when I actually need it*" (IP1)).

Actively shaping the future and making a contribution to research was also important for the interview partners. Participants stated that they wanted to share their experiences because they wanted to help the researchers (IP7). Especially those who had experience working in the healthcare sector stressed how they wanted to contribute to research. For example, one person had worked in a position where he was also responsible for international projects related to AAL (IP3). During the interviews, he shared his opinion about different parts of the technical system (e.g., the watch and various apps). Another participant working in the healthcare domain had expected more questions related to her professional expertise in the interview to be able to contribute more actively to research (IP5).

While a crucial role of AAL is to support people, participants described that it was important to know that people or trustworthy institutions were *behind* technology. The project itself, also represented by care facilitators from the perspective of the participants, had a crucial role in facilitating older people's feeling of support. Multiple participants also expressed that - from an individual perspective - they perceived the technical infrastructure as helpful in facilitating social contact and safety, for example regarding the smartwatch: "*if anything happened to me I would rely on it to call for help, easier and quicker*" (IP5). They also enjoyed talking to the care facilitators when they accidentally triggered the alarm, or reminded them to be on the ball in cases of an actual emergency (IP5). Knowing there were people to contact was important, i.e., "*this is what I prefer, there are people behind the technology*" (IP1). Furthermore, the funding institution was sometimes mistaken for the European Union (EU), which some people felt supported by ("*one can trust more in the European Union*" (IP14)).

4.5.3 Attitudes towards next Generations of AAL

When asking questions about people's perceptions of the future and more advanced assistive technology like robots, there were participants who rejected the very idea of robots ("*No robot will ever enter my house!*" (IP5)). They expressed the fear of isolation through robots, and skepticism of robots as not being able to provide good care: ("*do you want to be stroked by a robot?*" (IP5). In contrast, and as described in the previous section, social contact showed very important in the project, and participants were also hoping for more personal patient-doctor relationships. It can be interpreted that the idea of an autonomous system in the home without people in the loop was rather rejected, as participants valued "*people behind the technology*" (IP1).

Even though AAL systems could promote interpersonal relationships, possible dangers were discussed that could happen in the future. Participants were concerned that in the future, the deployment of such systems could either enhance loneliness, or create dependency relations. For example, "*if one was totally engineered / mechanized, one would grow totally lonely*" (IP6). Further, dependency relations could be reinforced through unequal access to technology: "*Telling people they need it if they really don't [...] they actually want to create dependencies. [...] Because if people don't have much knowledge, they are dependent*" (IP3). Further, control was also an issue between people and technology, as one could become totally dependent on devices: ("*someone has to tighten the robot's goose*" (I14)). Related to this, a participant (at the time of the interview living with an older partner) also envisioned a person being in control of another one, when living together, as one person could control the access to a house, potentially locking the other person in or out (IP9).

On the other hand, the notion of robots as possibly being able to stroke people (IP5) carried the idea of some degree of personal contact with technology, were AAL systems were also imagined of having an actual role of an entertainer or companion. A participant expressed that a device could say "*how are you, haven't heard from you in a while [...] may I tell you about a couple of things you are interested in?*" (IP15). Such a companion could "*give me the feeling I am less isolated than when it [i.e., the device] is mute*" (IP15). Technology was also imagined to support people who had a lack of social contact, "*if I have the feeling a person might need support or feels left alone, then one could recommend something like this*" (I6), however participants were usually not referring to themselves when painting such scenarios. In a state of vulnerability, receiving help by a device would also be a better option than being all alone: "*Of course I rather have a computer bring me what I want than nobody, although I don't really like a computer*" (I6).

4.6 Discussion

The findings presented in this chapter are nuanced, pointing to socio-technical aspects that provide important lessons learned for future generations of AAL like robots. Before unpacking these socio-technical aspects, it is however worth first introducing the concept of relatedness from psychology [Ryan and Deci, 2012], facilitating a lens for conceptualizing needs that can be unpacked from older adults' experiences in these these socio-technical networks.

4.6.1 Introducing the Concept of Relatedness

The findings of the study point to *relatedness* running through people's accounts. Relatedness is a key concept of Self-Determination Theory (SDT) [Ryan and Deci, 2000, Ryan and Deci, 2006]. Before unpacking forms of relatedness by discussing the findings against the concept and illustrating how it applies in a care network, I first explain the concept iteself in more detail.

Relatedness in Psychology

AAL systems often aim to promote self-determination of older adults [Dupuy et al., 2016], also given that the feeling of self-determination becomes particularly important with higher age [Peek et al., 2015]. According to Self-Determination Theory (SDT) [Ryan and Deci, 2017], the need for relatedness concerns a feeling of belonging and of being significant or mattering in the eyes of others, of feeling connected and supported by others. Ryan and Deci [Ryan and Deci, 2017] argue that people's behavior is situated in a social context not only for people to survive and because they require others' care or help, but "[t]here is a basic need to feel responded to, respected, and important to others, and, conversely, to avoid rejection, insignificance, and disconnectedness" [Ryan and Deci, 2017, p. 96]. People's need to relate is shown also in the tendency to internalize cultural values and behaviors [Ryan and Deci, 2011]. The need to feel connected may also explain why people behave in ways that ensure involvement, where this need will only be fulfilled when people feel that they are accepted for who they are [Ryan and Deci, 2017].

Cultural, political, and economic systems can also play a role in whether people can experience satisfaction of their basic needs, such as relatedness. According to Ryan and Deci [Ryan and Deci, 2012], cultural and economic systems set affordances, constraints, and boundaries, which may affect people's pursuit and attainment of need satisfactions. While some systems may promote extrinsic aspirations or life goals that focus on accumulation, personal gains, and recognition, these may be in opposition to goals for community [Ryan and Deci, 2012].

Social connectivity is further reciprocal and grounded in a two-way nature [Fitzpatrick et al., 2015]. Being only in a receiving position of care may increase a person's feeling of dependency, and it may undermine self-worth and independence [Fitzpatrick et al., 2015]. Reciprocity is also known to predict better mental health and life quality among older adults, rather than being in an unbalanced position to only receive or give [Fyrand, 2010].

Along with relatedness, autonomy and competence are two additional basic needs in SDT, where the need for autonomy is in an interesting relationship with the need for relatedness. Autonomy and relatedness satisfactions are not antithetical, but “[...] intricately connected with one another[,] “[...] the fulfillment of each need is intertwined with the fulfillment of the other” [Ryan and Deci, 2017, p. 293]. When helping another person, for example, this other person may feel cared for and related to. However, if the helper was not autonomously motivated to help (but instead helping for rewards or complying with pressures), the relatedness of the person being cared for would be undermined [Ryan and Deci, 2017]. Furthermore, receiving autonomy support from a relational partner may facilitate the receiver’s need satisfaction, and giving autonomy support to close others may satisfy a giver’s basic needs [Ryan and Deci, 2017].

In summary, relatedness is defined as a basic need of people in SDT (together with autonomy and competence), also explaining our behavior, where cultural, political and economic systems also play a role for need satisfaction. Along with its interwovenness with other needs (such as autonomy), reciprocity is a key factor here. I unpack various forms of relatedness that I identified across the data in the following.

Unpacking Forms of Relatedness

The findings presented in this chapter provide an understanding of older adults’ experiences with AAL in a socio-technical context, answering RQ1 on older adults’ experiences with long-term use of AAL in private homes. In this specific study, explaining their experiences also involved the concept of relatedness which I identified with a bottom-up approach. By reflecting on the findings, it turns out that relatedness provides an interesting lens for explaining the findings, especially when expanding the concept of relatedness to a socio-technical configuration.

As we know from the literature, digital environments (like socio-cultural environments) can support needs such as relatedness [Calvo and Peters, 2017]. In SDT, relatedness applies to the interpersonal, which is also reflected in the findings of the study. Participants described interpersonal relatedness with people from their communities, friends, family members, and other people in the research project. They were eager to make use of technology to connect with family members, and to care for others. They also helped each other (i.e., other participants) in the project. In the study however, there were also other forms of relatedness: relatedness with institutions and technology. Participants described expected support by institutions, such as from the European Union, the project (also represented by care facilitators); and from the health care system; for example, one motivation to participate in the project was to see what the care system had to offer for older adults. A lack of relatedness with technology was described as participants could not relate to the content of several apps, or as they were expecting support from AAL technology as such (even if – sometimes – representing a care system or people from the project who they could talk to). Relatedness also played out in a reciprocal way, as participants wanted to contribute to research (i.e., not only being in the role to receive), or care for other people in the community. This points to relatedness between people and multiple other actors in a care network.

Furthermore, relatedness in a care network also points to complex *interwoven* forms of relatedness. For example, interpersonal relatedness and institutional values shaped how people felt more supported by technology (and trusted it, such as in relation to privacy). Along with interpersonal relatedness, a lack of relatedness to how the technology itself was designed also mattered for whether people felt they were belonging to the target group. Support in enhancing digital competences may be connected to how people feel supported by technology itself. Feelings of support relate to aspects of accessibility and privacy, where privacy was also shaped by how people associated institutional values with the project and with technology.

By exploring interwoven forms of relatedness with multiple actors in care networks and further expanding the concept to sociotechnical actors beyond the interpersonal, I painted a picture with different forms of relatedness between older people and various sociotechnical actors, and in a reciprocal way. Applying the concept of relatedness to care networks and hence expanding it to human and non-human actors like robots may be also a contribution to the theory itself in return [Schwaninger et al., 2020]. Furthermore, a relatedness lens also offers lessons learned to take into account for AAL and care networks with robots. These are presented in the following.

4.6.2 Relatedness & HRI: Lessons Learned for future AAL

Based on the overall approach of investigating older adults' experiences with AAL systems in private homes, and subsequently, unpacking forms of relatedness in a sociotechnical context, I point out several lessons learned for HRI and future applications of robots. Providing lessons learned for the design and use of robots constitutes a key part of answering the main research question on the main factors for understanding and designing robots to support older adults (RQ).

Current AAL systems have similar functionalities as robots (e.g., monitoring, emergency detection, promoting social connectedness), and it is practical to learn from the long-term use of these off-the-shelf systems for robots, especially as not all needs are technology-specific nor can all needs be tackled with technology.

Forms of relatedness in AAL appear to be not only a matter of a specific technology (i.e., whether to have a tablet or a robot). For example, as shown in this study and in previous HRI research [Neven, 2010], a sense of belonging to the target group of users has been a concern of older adults who participate in a study. This is related to the fact that people did not consider the technology to fit their needs or day-to-day routines. People experienced technology to be meant to serve younger people (e.g., like with events that clearly target people of younger generations); or to assist people who are older, potentially even stigmatizing them as 'old'.

It is certainly useful to learn from current AAL for robots also because of similar functionalities, and to make decisions on what is worth to continue with robots. The devices offered were not perceived personalized enough and this is an opportunity for AI algorithms that could be also used with robots. At the same time, there were privacy concerns and concerns about integrity in the home that need to be taken into account also for next generation AAL, possibly personalized. Regarding personalization, a critical part that also came out of this study is that participants asked for various levels of training and help in digital competence, which could be tailored more to individual differences.

The individual differences in the experiences with the technology and in the project also provides an opportunity for personalization and adaptation [Pirzada et al., 2022]. As stated, participants could not relate to the content of several apps, such as for events or information. As a consequence, there is clearly an opportunity for personalization and/or adaptation with regards to content. Furthermore, there were differences in accessibility, also influenced by digital competence. While some participants found the technologies "like pre-school", others asked for more training. This leads to the opportunity for more personalized training of older adults as part of projects.

While there is clearly an opportunity to start with simpler functionalities before conducting more extensive (and expensive) studies with robots, there is however also a need to conduct studies with robots (and especially, longitudinal studies) as these are being developed. One reason is that there is a symbolic meaning that a robot carries [Sundar et al., 2016, Schwaninger et al., 2021, Störzinger et al., 2020], and that a smartwatch does not, for example. This may be linked to terminology (i.e., the symbolic meaning that a "robot" carries [Schwaninger et al., 2021]), and potentially to its embodiment and the technical opportunities that a robot can offer. For example, robots can be designed to adapt to living conditions, which comes with a certain degree of complexity [Martinez-Martin and del Pobil, 2017].

Relatedness needs are important from the perspective of older adults, and these needs should be approached in a socio-technical network rather than focusing on individual users only, which includes the need to design robots for communities.

A key aim of AAL is to promote an independent, active and self-determined lifestyle of older adults living at home [Vimarlund et al., 2021, Brauner and Ziefle, 2021, Nilsson et al., 2021, Dupuy et al., 2016], and to stay socially connected [Schomakers et al., 2018, Blackman et al., 2016]. In this study, AAL technology was also a key topic of interest for people to gather socially and to exchange. As shown in previous HRI research, robots can also promote social communities, also acting as proxies in social environments [Dereshev et al., 2019]. Jeong et al. [Jeong et al., 2018] proposed a robot for activity sharing among people who live alone, and they found increased social interactions among people who lived alone used a robot in their homes. Technology can promote relatedness, especially if it is embedded in social context and happenings around the technology that are used to introduce it, to support in learning, helping and exchange. Based on this work and in support of the literature [Joshi, 2019], it is important to consider the benefits of communities forming around technology in research projects.

Given the critical role of communities, robots and HRI need to be also *designed* for communities instead of individual people. The community perspective is also one way of looking beyond dyadic human-robot constellations, and expanding the concept of relatedness to socio-technical networks provides a lens to do this. In contrast, a dominant way of studying HRI puts of focus on interactions between one human and one robot [Hornecker et al., 2020, Schwaninger et al., 2019]. There are a few exceptions, however more loosely calling for looking beyond the dyadic, such as in specific care scenarios [Hornecker et al., 2020], for human-robot teams [Jung et al., 2018], or for trust [Schwaninger et al., 2019]. Exceptions also include HRI research in groups and teams [Jung et al., 2018, Sebo et al., 2020], e.g., in relation to team dynamics [Tennent et al., 2019], fairness considerations and group performance [Claure and Jung, 2021], or group trust [Strohkorb Sebo et al., 2018, de Visser et al., 2020], and in military research [Lakhmani et al., 2020], however, not necessarily conducting research in everyday life. The socio-technical perspective for relatedness proposed here then also has implications for conceptualizing various users of a system (i.e., instead of a single person), for example, or moderator roles [Lahtiranta, 2017, Carros et al., 2020, Carros et al., 2022, Schwaninger et al., 2022]. Previous HCI research has also emphasized the role of care *networks*, aiming for technology to support older adults' entire support networks [Consolvo et al., 2004] (e.g., rather than individuals only). A qualitative evaluation of the AAL study presented in this chapter therefore aimed to look at people's long-term experiences with AAL by also extending the unit of analysis to socio-technical networks, as it is currently critical to move away from dyadic interactions between a person and an AAL system only. The importance of communities around technology are therefore relevant for both projects with current AAL technology (as shown in this work [Schwaninger et al., 2020]), and they are also important for future generation AAL like robots.

On an interpersonal level, technology can mediate social *connectedness*, which is a key part of the relatedness concept [Ryan and Deci, 2017]. In support of previous research [Hsu et al., 2016], interpersonal relatedness was demonstrated as an important need in this work with older adults. According to previous studies, it is not limited to AAL but has also been shown as crucial in research on social play [Harris and Hancock, 2019], multiplayer games [Horton et al., 2016], photo sharing [van Dijk et al., 2010], or social media [Ma et al., 2019]. Given these features could also be included into AAL solutions, there are opportunities to design HRI to promote interpersonal relatedness. Examples include the connection with family members or to gather in groups of people around robots [Dereshev et al., 2019, Carros et al., 2020].

When promoting social connectedness with a robot, trust is certainly important. Robots could facilitate connectedness between people with entertainment features, and also by connecting people with their social environment in a meaningful way. This is important especially according to Socio-emotional Selectivity Theory [Carstensen, 1992, Carstensen et al., 1999], suggesting that older adults increasingly seek meaningful connections rather than superficial ones. Regarding connecting to other people, then, boundaries need to be set. Older adults were very skeptical when connecting to people in their neighborhood, also talking about potential pitfalls when disclosing too much information about their own homes. It is important to design for trust when robots should be used in a home, to ensure control of the information that is disclosed, and to whom.

Relatedness with technology played a role in this study to the extent that older adults expected support of the technology and they could not relate to the content of apps, for example. Relatedness with technology is relevant for HRI, in particular with regards to social robots and companion robots (e.g. [Breazeal, 2011] for health applications). In HRI, it is often argued that robots can offer features that allow more autonomous interaction and "intuitive" communication with (companionable) systems [Dautenhahn et al., 2005]. In previous work, social bonding and intimacy between a person and a social robot was studied by manipulating a robot's affective and social expressions [Koyama et al., 2017]. While the study by Koyama et al. [Koyama et al., 2017] has not included older adults or longitudinal experiences, the aspect of relatedness between a person and a robot may be potentially relevant for care contexts as well. In previous research, long-term users also reported the *social* value of a robot as one of its key values [Dereshev et al., 2019], and as proposed in earlier research, companion robots could provide assistance as a nanny, a friend, or a butler in domestic environments [Dautenhahn et al., 2005]. Thinking about robots in human roles has a longer tradition when it comes to replacing workers, for example. As shown in this study however, replacing human care is also linked to skepticism by older adults [Schwaninger et al., 2020]. While robots could be designed to take these roles that are informed by human roles, I argue that it is important to be open about possible new roles, not necessarily thinking about replacement of people but to put desired roles of *humans* and their needs first.

Focus on psychological needs in addition to changing technology and digital competence.

Participants were interested in proactive engagement in enhancing their skill-sets, which is important to take into account especially given different professional and socio-economic backgrounds, and as one could argue for the current generation of older adults in the Global North. Digital competence of older adults may however change over time, and so does technical readiness and opportunities that come with (cheaper) technology (where affordability of technology and in particular care has been also a concern of older adults in this study).

In contrast to changing technology readiness and digital competence, relatedness needs are psychological needs that are very likely to also matter in the future. It is important to take these needs into account early on. Technical solutions provide new opportunities, as also seen in the different generations of AAL technology [Blackman et al., 2016]. Furthermore, older adults of the next generation are likely to have different skills. Skills also depend on socio-economic status and professional backgrounds (as visible in this study). As also demonstrated, individual differences in literacy are important to consider, and therefore it is important to consider these differences even when new opportunities are being developed. Here, it is important to carefully re-evaluate the opportunities (both from a technical point of view and according to literacy) to design for psychological needs.

The insights on relatedness needs as presented in this chapter are also relevant to contextualize older adults' attitudes towards robots. As shown in the work presented in this chapter, robots for care also provoke skepticism among older adults, and there is a doubt that robots are able to provide good care (i.e., in *contrast* to humans). Related fears, such as that technology could promote "inhuman" care, also threatening the relationship between care workers and people in need of care are also known from the literature [Frennert and Östlund, 2018]. Loneliness (linked to perceived social isolation) is a growing issue among older adults in post-industrial societies [Cacioppo and Cacioppo, 2018], and other research has emphasized the opportunities or benefits of technology to decrease social isolation [Feldmann et al., 2020, Gallistl et al., 2021]. Given that relatedness needs appeared very important, a focus on these needs is even more essential to consider when designing robots for older adults, and it could be tackled within a network, i.e., in communities. However, these relatedness needs also need to be linked to other needs in design decisions, such as autonomy and competence, as these self-determination needs are not antithetical but connected according to the literature [Ryan and Deci, 2017] and to this study.

Consider reciprocity in interpersonal relationships and forms of giving as a need of older adults.

There are certain negative social repercussions being in a vulnerable position [Torrey, 2008], and participants also expressed how AAL technology either stigmatized them as 'old' or they were ashamed when they were in need and technology did not respond. Older adults who participated in this study were also keen on providing care and support to other people rather than only receiving care. Previous research suggests to design for reciprocity in AAL [Fitzpatrick et al., 2015], and this work also points to the relevance of giving such as helping others or providing care, contributing to research or helping the researchers, i.e., in contrast to not only being in a position to receive help.

The aspect of reciprocity also points to the motivation of the so-called "target audience" of older adults. In this study, various participants were eager to enhance their skillset also to care for others, either professionally or informally. It is therefore important to take this motivation into account from a research point of view when developing solutions and testing them with a group of people who want to learn, help others or contribute to research.

In interactions between humans and companionable robots, the aspect of reciprocity could be tackled with robots that need care (instead of providing assistance only), which has been already proposed and studied with robots and older adults [Lammer et al., 2014], or with voice assistants to be used in domestic environments [Ostrowski et al., 2021b]. Pet robots or baby robots (es described in Chapter 2) are also a way of designing robots in a way such that people provide care to it. While such features of robots in need of assistance or care could promote giving to another (robotic) entity, this study has also highlighted forms of relatedness that were experienced in a network, i.e., as part of a community. While helping a robot could be useful for other means (e.g., keeping people active by requiring some degree of assistance [Lammer et al., 2014]), relatedness between one person and one robot that needs care is likely to not fulfill these relatedness needs in the way they were expressed by participants of this study. While there is certainly an altruistic element in people's motivation to give or help (as also described in [Warneken et al., 2021, Michael et al., 2016]), and empathy is connected to helping behavior [Bohns and Flynn, 2021], in the case of helping robots, other elements were found crucial that also point to a community perspective. Even though a social value was found in the use of social robots by expert users in a post-acceptance face [Dereshev et al., 2019], a semi-ethnographic study with a service robot at a café also pointed to the relevance of community aspects when helping a robot: People helped a robot for various reasons, not including empathy with the robot but curiosity, willingness to help people behind the robot, and be perceived ethical by other people [Fallatah et al., 2020]. As proposed by Kim et al. [Kim et al., 2017] in a study with a bot, a robot could be potentially used to practice caring for other people, as helping people with illnesses like depression can be sometimes very overwhelming; and based on the findings of this work, there is an opportunity to also include a community perspective when designing a robot that needs help or assistance when designing for self-determination needs like relatedness.

A robot could be designed to provide opportunities to help other people, as for example with a bot that helps people to practice helping [Kim et al., 2020]. If a robot is designed to need care, this may be an option to carefully evaluate, but it is not an option to replace the need to give such that giving is interpersonally meaningful, or contributing to society (e.g., by contributing to research. This is also in support of recent research suggesting that reasons to help a robot in a real world study are not about the robot as such, but rather about curiosity, willingness to help people behind the robot, and be perceived ethical by others [Fallatah et al., 2020]. For older adults specifically, taking the willingness to give into account could be also in line with framing ageing as adaptation, where older adults could actively take decisions, as this is more obvious with pro-active engagement rather than receiving care. Of course, there are times where people are in need of care, which is important to take into account as well and to promote as much autonomy/choice as possible.

4.7 Summary

In this chapter, I presented a long-term study with older adults and current first and second generation AAL technologies [Blackman et al., 2016] in private households to provide lessons learned for supporting older adults with robots. One aim of AAL technologies is to support self-determined living at home, where relatedness is one key need of people and crucial for self-determination. As part of a qualitative study, I presented findings on older people's experiences with AAL technologies for the duration of 18 months. Doing so, I explored their experiences of the long-term use of AAL systems in private homes (to answer RQ1), and deriving lessons learned to identify main factors for understanding and designing robots to support older adults (RQ). Responding to RQ1, the findings point to positive experiences with making use of technology for learning, promoting safety, for helping and caring for others, and for connecting interpersonally. The study also points to opportunities for personalization and adaptation. Furthermore, by exploring interwoven forms of relatedness with multiple actors in care networks and further expanding the concept to socio-technical actors beyond the interpersonal, I painted a picture showing how different forms of relatedness can facilitate a sense of connectedness, belonging and feeling of support between older people and various socio-technical actors, and in a reciprocal way. Responding to the main research question, I discussed how these forms of relatedness are relevant for robots and HRI to support older adults. Lessons learned for the design and use of robots include the opportunities of learning from off-the-shelf AAL for robots, as not all needs are technology-specific. I also emphasize to focus on relatedness needs from a socio-technical point of view rather than focusing on individual users only, and to design robots for communities. I recommend to focus also on psychological needs rather than on changing needs such as digital competence only; and to consider reciprocity in interpersonal relationships for older adults.

CHAPTER 5

Experiences with Assistive Technology in Care Homes

5.1 Chapter Overview

The work presented in this chapter is based on and extended from the Universal Access of Information Society journal article "Video Connecting Families and Social Robots: From Ideas to Practices putting Technology to Work" [Schwaninger et al., 2022], which has been conducted in collaboration with the University of Siegen in Germany. While the previous chapter (Chapter 4) presented a study on the longitudinal use of off-the-shelf AAL systems with older adults in private homes, foregrounding forms of relatedness in care networks, the aim of the chapter is to provide the second building block for understanding older adults' long-term experiences with off-the-shelf AAL in living spaces (contributing to answer RQ1 and the main research question). It involves a longitudinal study that was conducted mostly remotely with older adults and care workers starting in the beginning of the COVID-19 pandemic in 2020, taking place in institutional care homes. The study involve data collection with several stakeholders, including older adults and care workers (where care workers are key actors of these types of living spaces compared to the previous chapter, which foregrounded the experience older adults in private homes). Given external circumstances of the pandemic, it investigates the effects of experiences of the pandemic on technology usage to draw out lessons learned for care with robots, where the event of such special circumstances is an aspect that the previous chapter did not happen to take into account.

The overview of this chapter is as follows. I present a chapter introduction section, which aims to introduce the context, motivation and circumstances of the study as relevant. I then describe the methodology, including chronological accounts of the study, research setting and participants, and data collection and analysis. This is followed by findings on changing technology usage associated with experiences of the pandemic, especially regarding technology for communication (CT), including experienced isolation and changing work practices associated with increasing CT usage, and mixed attitudes towards future technology like robots. I follow with a reflection on solutions to old problems exacerbated by COVID and new issues, along with a discussion on readiness for engagement with new technology, and lessons learned for supporting older adults and their care networks with robots. While the pandemic has changed imaginaries and it has triggered the use of CT in the care context to some extent, it also requires solutions for new problems associated with increasing workload associated with technology usage, which is one of the issues I propose to also take into account for robots and HRI. The chapter closes with a summary.

5.2 Chapter Introduction

Various types of AAL systems have been proposed since the 1990s to be used in older adults' living spaces [Blackman et al., 2016], e.g., including safety systems, security, monitoring, communication, and entertainment systems, and home automation [Turner and McGee-Lennon, 2013, Haslwanter et al., 2020]. While a key aim of AAL is to allow older adults to age in place, older adults are also a complex group with different needs when it comes to promoting health, safety, an independent lifestyle, or daily life activities needs [Fiorini et al., 2021]. Do date, this is also reflected in the various types of living spaces that allow various levels of support also by professional care workers. Thus, technology usage has been also increasingly proposed in institutional settings, like care homes [Sabelli et al., 2011].

While older adults are often targeted with AAL systems, the complexity of stakeholder needs also needs to be taken into account, especially given technology use as such is a socially embedded process. Not only that, practices of technology usage in this context are both social and collaborative [Procter et al., 2014], also involving secondary users [Werner et al., 2015] such as through informal and formal care [Procter et al., 2014, Tellioğlu et al., 2014, Manuel et al., 2020, Sabelli et al., 2011], inter-generational relationships [Marston et al., 2020] and help networks [Eveland et al., 1994] that are important for the use and uptake of collaborative (care) systems. Technology usage also involves tertiary users [Werner et al., 2015], like institutions. And on top of these complex stakeholder needs between primary, secondary and tertiary users [Werner et al., 2015], older adults as such have heterogeneous needs [Fiorini et al., 2021]. Given the complexity of stakeholder needs, it is worth looking at institutional homes, complementing research with older adults in private homes (as conducted in Chapter 4). Here, both adults and care are represented [Werner et al., 2015], which is promising to provide additional insights for robots and HRI.

Assistive technology has been developed and discussed to support older adults since many years [Haslwanter et al., 2020], where CT is an instance of AAL with functionalities that are also offered by AAL robots: Robots can be designed for interpersonal communication or tele-presence, or they can be designed to be social as such [Werner et al., 2015], for example, by designing anthropomorphic embodiment or with cues for verbal and non-verbal communication.

The care context in central Europe has been however under severe restrictions since the outbreak of the COVID-19 pandemic in March 2020 [World Health Organization, 2020b]. Restrictions may trigger developments and change habits to cope with special circumstances, also depending on the ideas that have been developed and 'lying around' [Friedman, 2002]. The use of CT in particular can be a response to crisis situations [Hagen et al., 2020], and research suggests its potential as a response to isolation in the care context that has occurred since the pandemic [Gallistl et al., 2021]. However, there is still little known about the the actual use of CT at places like care homes during a lasting crisis. The aim of the study presented in this chapter is to get a better understanding of how the experience of the pandemic has affected attitudes and use of CT, and associated processes of social interaction at these places to draw out lessons learned for the next generation of CT and AAL. Given the restrictions in place, the study has been conducted mostly remotely, which is further described in the following section.

5.3 Methodology

5.3.1 Chronological Account and Context of the Study

The data has been collected in two care homes at different time phases (see Figure 5.1). Phase 1 was the strictest phase concerning the COVID restrictions in Western Europe where our study took place, and it included most of the first lockdown (March-May 2020). In this phase, the care homes did not let other people enter, which also resulted in families being torn apart. This phase has been used for method preparation and recruitment. Restrictions to receiving visitors were lifted rather quickly after the first lockdown and and they were not reinstated with the same strictness later. In Phase 2 (from May 2020), visits were allowed under severe restrictions, including window visits[1], or container visits[2]. A limited number of visitors per day were allowed, enhanced hygiene rules like wearing masks, and rapid COVID-19 tests were in place. In Phase 3 (from Sept. 2020), visits were possible under lighter restrictions. Different types of data has been collected in Phase 2 and Phase 3 in the two care homes (see section 5.3.2 and 5.3.3).

5.3.2 Research Setting and Participants

The two care homes that participated in the study are situated in Germany, and they are referred to in this chapter as H1 and H2. H1 is situated in a medium sized city, while H2 is within a big city. H2 has had a regular exchange with the researchers involved in conducting the study until the pandemic. Over a period of the last four years, the care home worked together and experimented with different digital tools like tablets, smart assistants and also social robots.

[1] i.e., visitors communicated with the residents through a window without entering the care home
[2] i.e., containers were installed in front of care homes especially for visits

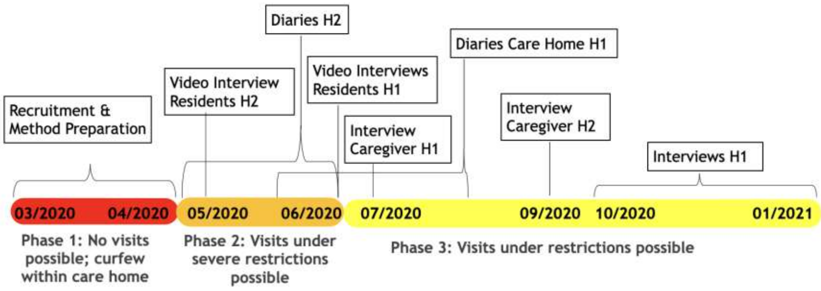

Figure 5.1: A chronological account of the restrictions and data collection phases.

Both care homes have religious roots and belong to catholic institutions. They are both connected to multiple other organisations within their buildings (H1: Monastery, Administration of Organisation; H2: Kindergarten, Residential Assisted Living). H2 is approximately twice the size of H1 in terms of permanent residents (119:49). H1 is connected to a monastery with nuns living within the care home.

The study involved 18 participants: 9 residents and 9 care workers. The residents were all cognitively able. Before conducting the study, ethical approval has been acquired from the University of Siegen. The residents were invited by the care workers, and their participation was based on their willingness and ability to participate. The residents were between 55 and 93 years old, 4 of them male and 5 female. An overview of the participants is presented in Table 5.3.2.

Name	Age	Gender	Facility	Role
R1	55	m	H2	Resident
R2	86	w	H2	Resident
R3	85	f	H2	Resident
R4	85	m	H2	Resident
R5	84	w	H1	Resident
R6	60	w	H1	Resident
R7	86	m	H1	Resident
R8	60	m	H1	Resident
R9	93	w	H1	Resident
C1	62	m	H2	Social Service
C2	54	w	H1	Mgmt Social Service
C3	19	w	H1	Social Service Intern
C4	36	w	H1	Social Service
C5	52	m	H1	Mgmt Care Home
C6	38	w	H1	Mgmt Care Workers
C7	45	w	H1	Social Service
C8	74	w	H1	Social Service
C9	57	w	H1	Social Service

Table 5.1: The participants' names as referred to in this chapter, their age, sex, care home facility (pseudonymised) and role in the respective care homes.

5.3.3 Data Collection and Analysis

We conducted a diary study and interviews with 18 participants (see Table 5.3.2) in the two care homes[3]. In Phase 1, we created paper-based diaries for residents to fill out for four weeks. The diaries (see Appendix 9) included open questions and playful activities, such as story completion and postcards (see e.g. Figure 5.4) to be sent to researchers. For a playful exploration of ideas regarding the next generation of AAL, we also added a postcard in each diary to be sent to a robot. The aim of the diaries was to gather insights on the role of technology in day-to-day activities, on the experience of social contact and the pandemic, and on perspectives on the next generation of CT (i.e., robots). We also took these into account given the aim to provide lessons learned for future AAL (as also done in Chapter 4). The diaries were filled out by nine residents at two care homes (i.e., four and five, where the imbalance of numbers was a result of the voluntary participation). To complement the long-term diary study, the participants who volunteered to fill out diaries were invited to participate in remote interviews with us using a communication medium of their choice (e.g., telephone or video telephone using a videoconferencing software like Skype). Four interviews were conducted with residents of H2 via telephone, and five interviews were conducted with residents of H1 via video telephone, with the assistance of a care worker. The interview guideline can be found in the Appendix 9. To gather insights about care workers' perspectives, we also conducted interviews with nine people working with residents, one from H2 and eight from H1 (based on the workers' willingness to participate). The guideline is presented in Appendix 9.

The interviews were recorded using recording software for audio/video. Subsequently, the audios and videos were transcribed and coded along with the diaries. The data was analysed with a reflexive thematic analysis approach [Braun et al., 2018] with the MaxQDA software by inductively clustering different topics. We generated, reviewed and defined themes to interpret results that we present below.

We collected our data out of interest in the effects on the experiences of the pandemic on technology use, and therefore we did not actively change the environment with our research by asking participants to use technology (this was also not possible because of the restrictions, at least in the beginning of our study). However, both institutions had access to technical devices, even if in slightly different ways: Within the 6-years cooperation with the collaborating university, H2 had received around ten tablets and the residents were trained to use these devices by the university until the pandemic started.

[3]Note, we did not intend for a comparison between the two care homes. However, we had several reasons for inviting two institutions to participate in this study: (1) We were in the middle of a collaboration with the two institutions at the time of the outbreak of the pandemic, (2) we wanted to get a broader view on the topic, (3) the situation and topic was delicate and it required a highly exploratory approach, and (4) only four residents volunteered to participate in our virtual study in H2 who we had invited first. Methodologically, the only difference in approaching the institutions was the slightly different time of data collection (as shown in Figure 5.1). Furthermore, as described earlier, we conducted telephone interviews with the residents in H2 and online video interviews with residents in H1 responding to their preferred medium.

Figure 5.2: A postcard a resident has written to the researchers describing the visits in containers: *"[...] I will be visited by my son Christian today at 4 p.m., the visit will be in front of the home in a container. [...]"*

H1 on the other hand received tablets from a national telecommunication company in Phase 1 and they did not receive any training.

5.4 Findings

Across our data, we identified effects of the pandemic on the care homes, new technology use, and attitudes towards future technology as reported by care workers and residents. In the following, I present the findings on experienced isolation, workers' concerns about residents, and changes in social interaction. This is followed by technology use at care homes, including the use for social interaction and physical activation, associated changing work practices, technical affinity issues, and subsequently, attitudes towards future technology.

5.4.1 Effects of the Pandemic on the Care Homes

Experienced Isolation

Especially in the first phase, visits were forbidden ("*visits = prohibited!*" (R2)), where later, containers were installed in front of care homes dedicated to visits, as shown in Figure 5.2). The restricted visits were difficult for the residents: "*Of course, the [...] people first had to get used to the fact that their people - their relatives - were no longer allowed in the house. That was, I would think, the biggest setback.*" (C2).

Besides the restrictions on receiving external visitors, the isolation of residents was also enforced through restrictions within the care homes. Group activities were reduced: *"Yes, our sports activities and bingo and what we all do. That also has to be cancelled and we can only do it with so much distance you just sit with two men [...] so that we don't get too close."* (C1). Furthermore, it became normal that everybody had to wear a face mask within the care homes at all times to protect others from possible infections. These hygiene rules were intended to slow down a possible infection but also resulted in limiting the residents in understanding other people - since their sense of hearing is quite often limited, they depended on being able to use several senses to compensate: *"They had to keep the minimum distance, they had to keep the mask and I would say, the old person can't hear so well, he can't see so well. And he depends on it, to see the mouth move and also that you can get close to speak loudly and so on, and all that was not possible. That made some residents feel insecure, rather than comfortable, because you couldn't reach the other person, so to speak."* (C2).

The rules also had the consequence that the residents did not receive physical contact unless it was necessary. Before COVID-19, it was normal that a care worker would give them physical contact, like patting the shoulder. Also, visitors normally provided physical contact via hugging or holding hands. All of this was restricted and took away an embodied sensual way of communicating without words.

As the residents are quite a heterogeneous group, not all of them experienced isolation in the same way and they had different perspectives on loneliness. One resident reported to us that: *"sometimes I need the loneliness"* (R2), suggesting that loneliness has positive sides for her. However, this view was not shared by all residents, as another person told us: *"I want my kids to be allowed to visit me again"* (R3).

Workers' Concerns about the Residents

Care workers reported safety concerns regarding the residents. On top of the usual health-related risks (e.g., "*the usual influenza will come additionally in November [...], then we are likely to have our noro-virus in the care home [...], as every winter*" (C1)), workers were concerned about not being tested for COVID-19 in Phase 2 (which changed later): "*great that we are not being tested here. Everyone could be a spreader even without symptoms*" (C1). However, there was also awareness that the residents had gone through several other personal and global crises in their lives, where the pandemic may not be perceived as difficult by some of the residents. One resident compared the experience to that of being a prisoner: "*I am 94 now. Four years of war captivity in Siberia, I survived it all. Now I am locked in like a prisoner. I need to die anyway, I want to be able to move around freely during the last months that I have. Within the remaining months I have left, I expect to be able to move freely.*" (C1).

The care workers recognised that increasing dependency of people as they got older challenged their sense of self-confidence, and the workers would do what they could to try to promote self-confidence: "*in my view, this is the most important, because these people* *that are here, they all have been like us, [...] they were able to do everything like we do and now all they can do is to experience deficiency [...]. I think the most important for them is that they are able to do it on their own, completely and especially to understand on their own. This will promote their self-confidence and a sense of mastery.*" (C2).

Changes in Social Interaction & Communication

Both residents and care workers reported changes in social interaction and communication because of the pandemic. In the care homes, there were fewer group activities happening, and in the beginning of the outbreak they had to eat their food alone in their room ("*lunch is being brought in our room, you know, we don't go into the big dining area downstairs, and in the morning, a plate with breakfast is put here and in the evening as well*" (R1)). This resulted in more monotonous daily routines, and residents wanted to have more activities and see people ("*of course, then there would be more variety*" (R5)). Residents also made efforts to keep physical distance ("*of course I avoid all the people*" (R2)).

The interaction between residents and care workers changed, where the face masks had an effect on communication. For residents who were depending on facial expressions a lot, the workers "*lose their personality, when wearing this thing, in my view, some of the personality is getting lost [...][my fear is that] everything is getting more mechanical, [...] one is nothing but a number*" (R4). Because of the restrictions, there was also a decrease in face to face interaction with people from outside the care home. Residents were however missing their family members ("*I wish that my children are able to come and visit me again*" (R1)).

5.4.2 Use of Communication Technology

Using Communication Technology for Social Interaction and Physical Activation

In response to the restrictions and associated experiences, off-the-shelf technology usage was initiated by care workers at both care homes. These were also used because of fewer visits and to increase safety.

To communicate with people from outside the care homes, both institutions were using video telephone from different corporate technology companies ("*we have used WhatsApp a lot, a lot*" (C1), "*a friend usually comes regularly to visit me, now at times of COVID-19 [we have been using] Skype*" (R1)). However, a care worker also stated that video conferencing platforms were used only by approximately 10% of the residents during the pandemic: "*Those who have been using it appreciated it [i.e., video telephone]. Among over 100 people however, if only ten people were using it, this is not a very good quota, because [compared to]feeling closeness for real, [...], sitting next to a person, [...]*" (C1). However, among the people who were motivated to use communication software, a care worker said: "*We really took our time for every resident who wanted to be able to use it on their own. Skype is always a bit of an obstacle, but WhatsApp, everyone has it, so* *we showed it to everyone, even the relatives, how they could use it, so the relatives can contact the residents on their own or the other way around*" (C2).

Video telephone was appreciated a lot, as care workers tried to "*realize everything as good as possible, to take into account every opportunity and guidelines*" (C2). A care home reported how they got support from a national telecommunication provider with tablets and apps such as Skype or WhatApp which made this even easier (C2), and according to the care home, the use of video telephoning "*has worked out very well*" (C2). The use of video telephone was also perceived useful for the people who were able to use it. As visits became possible with special measurements, if they "*could compare between Skype and original visits, they preferred Skype, because they said: 'What should I sit here, where I can't get close to them and so on, then this is better, I can also hear better etc. when doing it over Skype*!" (C2).

Video conferencing tools were also used by care workers to conduct physical exercise sessions with residents ("*we continued with our program - movement with music. And we had rehabilitation sport twice a week, and we did the same for movements with music*" (C2)). However, this required a lot of space, "*we had the big advantage that we are very spacious here and we could separate people from each other*" (C2). Workers made use of the videoconference tools with screens: "*with bad image quality and bad audio quality, we used the TV in the cafeteria and in the rooms to transfer and show our sports program*" (C2). People were able to gather and still keep the minimum distance from each other. This way, "*they could still see their usual caregiver on TV*" (C2), and another caregiver could still come by to the people and support them physically.

However, the predominant use of tablets for communication required assistance by care workers or relatives. The lack of visits had an effect, as relatives were not able to help with set-ups or maintenance: "*It [video telephoning] is installed on my laptop. When my son comes, he will help me*" (R2). The help of relatives was missing, which required care workers to assist. With the use of tablets, on the other hand, residents also had more "*access to media*" (C2) to access online information. While residents had been less open to use technology for this purpose before, activities had been cancelled or reduced. This also resulted in opportunities for engagement with devices: "*where nothing else was possible, they might have accessed it and say: 'Okay, now I'll give it a try'. This was actually very nice.*" (C2).

Changing Work Practices

The use of technology at the workplace entailed changing work practices, with both positive experiences among workers and challenges, the latter including digital competence, accessibility, and additional workload.

Digital competence was an issue in general. While care workers needed to assist residents in using communication software, they were also in need of guidance: "*This is currently difficult because of Corona, [however] if there were seminars, also for the residents or small videos with explanations...*" (C3). However, following the engagement with videoconference software to enable residents to communicate with people from outside the care homes, the workers started to use video telephone as a new habit in their private lives: "*This [video] telephoning has become a habit at some point. We also used Skype, everyone who had the opportunity to set it up on their phone*" (C2).

The use of CT (i.e., videotelephoning) also increased the workload. Workers assisted residents with setting up conference software: "*We enabled everyone who had the option to have Skype - with their phone. We guided everyone [...] if they weren't familiar with it yet*" (C2). There were accessibility issues that required assistance of care workers: "*most residents are not able to see very well, so with this, let's say, video conference with the outside as one could say, they do need a little help*" (C2). In addition, there was also considerable work involved in setting up appointments for the calls: "*people [i.e., family members] called at least a day before Skype calls should happen*" (C2), and "*some [residents] even booked appointments for the entire week*" (C2) to speak to their relatives or friends. During the virtual conversations with relatives, care workers also reported that they were often directly involved e.g., to support the communication and give short updates to relatives (e.g., regarding the status of the resident).

This increase in workload came on top of an already high general workload, exacerbated by restrictions of other people visiting the residents who would normally help, e.g., with setting up or maintaining devices. On the other hand, the care workers also found it rewarding to use technology. They experienced learning while supporting the residents' needs ("*This was actually great*" (C2)).

Technical Affinity of Care Workers

As care workers were using CT at their work and because they have used video telephone frequently ("*we have used WhatsApp a lot, a lot*" (C1), see also Figure 5.3), their technical affinity appeared to increase. While care workers had not expected to need technology for their work before the pandemic (C2), the experiences of the pandemic triggered the exploration of new possibilities: "*once that nothing else was possible, they might have have accessed the technology, 'okay, now I'll give it a try'. This was actually nice. Also the fact that we have to engage with it – what is possible, what is good for everyone*" (C2).

One care worker expected the new habits to remain at the care homes after the pandemic. Videotelephone "*[...] will not be gone only because of opening steps, instead, this [i.e., videotelephoning] is an additional option now [...] Of course, Skype will play a role in the future, the same goes with WhatsApp calls with video. This will not just disappear because of the opening, but it is becoming an additional option*" (C2).

However, while they accepted that the use of technology would persist, they were also aware of their skills gap. The generally low technical affinity of people working at care institutions (i.e., care workers and people in management positions) was mentioned (C1). Technology usage would mean additional workload. A care worker, however, stated that there were too little offers from the government to promote digital competence (C1).

Figure 5.3: An advertisement at H2 to communicate with relatives via CTs like Skype and WhatsApp.

5.4.3 Attitudes towards Robots

We also asked questions about attitudes towards robots in the interviews and we had robot-related questions in the diaries, and the answers were mixed. Some residents were sceptical about the potential for robots: *"Modern technology can open new perspectives but can never replace human affection!"* (R4). The resident sees technology as not smart: *"Computers don't think by themselves. Everything has to be inputted beforehand."* (R4). This opinion is not shared by everyone though as can be seen in a comment that was made about a Pepper robot from previous experiences at H2: *"Yes, I like him. He is not too tall, he doesn't frighten me and I want to have him with me"* (R3). A resident who had experiences with Pepper wrote postcards to the robot, saying *"I would love that you can pronounce my name [...]"*, and *"[...] tomorrow Pepper should come and visit me"* (see Figure 5.4). One resident who had previous experiences with Pepper even reported that his family was interested in the robot: *"My kids want to get to know Pepper."* (R2).

A care worker on the other hand expected a social robot to be problematic for residents because of their very feeling of deficiency: *"They are likely to build up a relationship right away [...] 'oh he is cute', 'he is so pretty' [...] I believe they wish for too much, even if unconsciously. And if Pepper [i.e., the robot] does not react to what I would be able to provide, a person who is used to bear a lot of deficit may feel deficient again. [...][T]hey will think immediately, 'is it my fault', 'why does he [Pepper] not understand me'..."* (C2).

The residents and care workers had many ideas regarding the functionalities of a robot

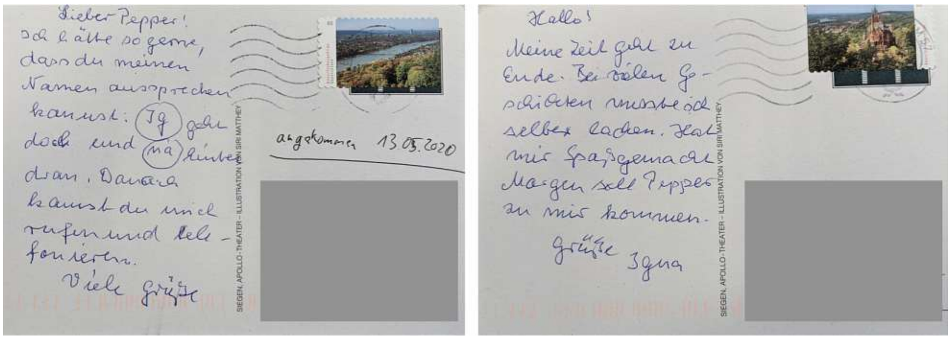

Figure 5.4: Two postcards a resident sent to the Pepper robot.

and the tasks it could do for them. One care worker saw it as something that would be helpful to give orientation to people with dementia: *"For the elderly and demented it could be something to give them orientation. [...] Maybe saying things like: 'At noon we have this and this as lunch' or 'This morning at 10:30 the Bingo game will happen'* (C2). The residents saw several tasks that a robot could do like cleaning or bringing things from one place to another. A resident who had previous experience with Pepper had a specific idea on how he would cooperate with a robot: *"I am taller than him, I will work on the things that have to be done on the wall and he can help me on the ground."* (R3). A resident also thought the robot could measure the temperature of people (R2). One care worker however expected the robot to promote physical contact: *"it is rather perhaps even contact-promoting or also motivates, rather to the participation in groups. And that could be counterproductive, of course, regarding Corona"* (C1).

5.5 Discussion

The aim of the study presented in this chapter is to explore how older adults and their care networks in institutional care homes experienced the use of AAL systems (answering RQ1), and to derive lessons learned for robots (to answer the main research question on the main factors for understanding and designing robots to support older adults (RQ)). Given the circumstances, I focus on how experiences of the pandemic have affected attitudes and use of off-the-shelf CT in institutional care contexts (with CT being one instance of AAL). When looking at the results, many issues that were described by our participants (such as family members living far away, the loss of family members because of death, or low digital competence) were not entirely new but became apparent in a condensed way. CT and its usage at care homes has been an idea 'lying around' [Friedman, 2002] to be exploited, however, it took a pandemic to increase the use of these technologies (even if on a small scale) to respond to these old problems. Furthermore, as CT use has evolved, new issues appeared associated with increasing workload and the configurations in which CT has been put to work, which is something to put into consideration also for care with robots.

The changes in social interaction through the usage of CT are also reflected in values that I identified across different contexts and time phases, which were a key part of experiencing the use of AAL: social connectedness, (a key part of relatedness, as discussed in chapter 4), and autonomy. In the following, I unpack these values and make suggestions how to promote them in the future, potentially useful for the next generation of AAL. Subsequently, I discuss readiness to engage with CT and its relevance for HRI, followed by a section on a discussion on perceptions towards robots. Subsequently, I present lessons learned, where I pull out implications for living and working in the care context where technology is now expected to stay: the need for the acknowledgement of increasing workload and support structures on several levels, and the re-definition of work roles and processes. I discuss how these lessons are particularly relevant for care with robots.

5.5.1 Values in Social Interaction

Social Connectedness

The restrictions of the pandemic [World Health Organization, 2020b] have further reinforced the notion of care homes being isolated in society. As a group prone to higher risks, older adults living in care homes have been experiencing isolation at times during the pandemic, with fewer visits and increased restrictions in mobility at times that have affected social interaction. Experiences of loneliness or solitude were mentioned not only in relation to the restrictions. They were also associated with losses of relatives or partners that residents have experienced previously (i.e., before the pandemic) or with relatives living further away (not caused by the pandemic), as also discussed in the literature [Smith, 2012, Fakoya et al., 2020, Feldmann et al., 2020, National Academies of Sciences and Medicine, 2020, Pirzada et al., 2022]. Further, experiences of loneliness were positively and negatively connoted, where it is important to take into account that loneliness does not simply mean the absence of people, but it has been also described as the absence of context and connectedness (which is not necessarily provided by the presence of people, as one can also feel lonely in groups) [Dahlberg, 2007]. As residents were open to new forms of social interaction and communication that has also involved technology, it is important to aim for promoting relatedness needs, including interpersonal connectedness and context in a meaningful way, rather than simply focusing on providing contact to other people, also when designing to support older adults with robots.

CT was introduced and used for social interaction. It took a pandemic to discover the potential of these devices to facilitate social interaction and for information retrieval. Care workers also reported positive experiences of using tablets in their work, as they described the use of video conferencing tools to promote a sense of community. Residents who have been able to use video telephony to communicate with relatives appreciated it, where the social potential for digital technology for older adults in general has been already highlighted in previous work [Harley et al., 2018]. Advantages were even mentioned compared to face-to-face visits if these visits were restricted: people were able to hear/understand better as compared to visits without being able to touch each other or the wearing of masks. However, digital competence is a requirement, and a lack of it excluded a lot of people (a known barrier for technology use among older adults [Fischer et al., 2014] and care workers [Johansson-Pajala and Gustafsson, 2022], also identified in previous COVID research in the care context [Gallistl et al., 2021]), or they required the help of care workers to make contact with people outside care homes. Digital competence is a key requirement of older adults [Atkinson et al., 2016,Fischer et al., 2014] and of care workers, enabling social connectedness with digital tools. The pandemic has provided an impetus to enhance digital competence. On the other hand, promoting digital competence may be also used to establish social connectedness on an interpersonal level, e.g., by creating social activities around digital competence promotion.

Autonomy

Using CT has the potential to promote residents' autonomy in daily life (e.g., through access to additional information and / or communication). However, as shown in previous work [Hornung et al., 2016], autonomy is a multi-faceted concept [Calvo et al., 2014] and sometimes one facet can be impaired to ensure another one. While some residents interacted with relatives virtually, these modalities of communication also came with new dependencies due to the additional articulation work [Schmidt, 2008] (to be further described in section 5.5.4): Residents required care workers to assist them in setting up and actually being in contact with people from outside care homes, and schedules were made in advance. This articulation work may involve choices to be made for residents to promote their autonomy, for examples, in when, how and with whom to communicate.

Autonomy is also tied up with mobility and the regulation of the environment with regards to mobility, where restrictions forced people to have fewer social contacts and to move around less freely. Our data was collected in settings and with residents with little mobility (i.e., compared to the rest of the population), as they either could not move on their own or/and they were not allowed to due to the restrictions. Residents also expressed that they were not happy with these sorts of restrictions in mobility when they felt they had little time left. Therefore, the restrictions in autonomy (i.e., not being able to move freely) may be perceived in a particular way at older age, especially as people living at care homes may not have the same choice of following or breaking such rules autonomously.

5.5.2 Readiness to engage with CT

The pandemic stimulated residents and care workers to deal with the impact of the pandemic by trying out new forms of social interaction and communication, especially with the use of tablets. Care workers also experimented with video conference tools to conduct physical activities and support people. At some point, residents were also open to try out the use of tablets for information retrieval and to communicate with relatives.

However, digital communication practices have varied among older adults even long before the pandemic [Karimi and Neustaedter, 2012], which is also reflected in our data indicating only a small group of residents have actually used these devices. Here, it would be possible to make these residents internal facilitators for other residents to help them with the use of tablets, as has been the case in other research (albeit with active older adults living in private homes) [Schwaninger et al., 2020]. Here, regular meet-ups also provided a space for older adults helping each other (see Chapter 4), also providing them the opportunity to help and share. In return, this would potentially decrease the articulation work of carers. In a care context with robots, then, there are further opportunities for training "power users", either among residents or even among care workers and to provide internal support for them to become experts, as we also discussed elsewhere [Carros et al., 2022]: In the respective study, certain care workers were the providers of helps to other less knowledgeable care workers, which is a phenomenon that is also known from other domains [Yuan and Yarosh, 2019, Palen, 1997, You et al., 2015]. This is also in accordance with the 'social distribution of expertise' [Randall et al., 2007], describing that certain people are more motivated or better at certain skills.

However, readiness to engage with technology depended on various factors: Obviously, one crucial factor was the availability of tools. Further, the willingness of care workers to support residents in digital communication was also crucial and required them to actively engage with technology. A lack of digital competence was also mentioned in one care home, tied to a lack of support by the government, social security and in care workers' (ongoing) education. Care workers needed to adapt their work practice to the new forms of support they were giving to the residents and by doing so changed their work habits from helping family members to meet the residents within the care home to helping the residents and the families to use this CT. Readiness to engage with new technology could be promoted through the availability of devices, training and other support structures, institutional (work) culture, working conditions and the roles of workers. This has implications on relationships and the coordination of care networks, which connects to previous research in the care and healthcare context [Vassilev et al., 2015, Milligan et al., 2011, Groth and Scholl, 2013].

5.5.3 Perceptions towards Robots

We were also interested in attitudes towards future technology as a response to COVID experiences, where residents were open to engaging with the idea of social robots in a playful manner (i.e., writing postcards to a Pepper robot or playing games). Older adults' were open for these playful interactions, where relationship-building with robots has been also explored in previous research on the use of robots at home [de Graaf et al., 2015, Schwaninger et al., 2021]. From these findings and from the experiences with CT, see opportunities for social relationship-building through robots in care homes. Robots can act as mediators, where they could be used in group settings [Wada and Shibata, 2007, **?**], for inter-generational interactions [Joshi and Šabanović, 2019] or for communication with relatives (similar to current CT use in this context).

Another aspect discussed is tied to implications for the quality of care, where attitudes towards robots can be contextualized through looking at people's actual experiences. Residents perceived the risk of care becoming less personal if parts of it became automated.

In parallel, there were residents who perceived care workers having little time. Also, with COVID, there were accessibility issues with face masks for residents who were dependent on reading facial expressions during face-to-face communication. Some older adults depended on facial expressions being a key part of communication. The expectation towards increasing automation reinforced this perceived risk of care becoming less personal, where mixed attitudes of older adults towards automation have also been found in previous HRI work [Frennert et al., 2013a, Frennert and Östlund, 2015]. It is therefore important to design hygiene rules in a way to enable communication and connectedness where possible, especially given the impact these rules had on social interaction and communication.

5.5.4 Lessons learned for next Generations of AAL

Crisis situations can change imaginaries of what is possible to respond to old and new problems.

Digital transformation has been accelerated in various sectors during the pandemic [Marston et al., 2020, Cmentowski and Krüger, 2020, Feldmann et al., 2020, Lutu et al., 2020], and we see changes also in the care context to some extent. Most notable however, the pandemic experience has changed some imaginations of what is possible or what is valued, where solutions for old problems were found. Many relatives were already living far away from residents, resulting in very few visits from them and very little contact. The problem persisted. While technology had been there and relatives had been sometimes far away, the pandemic experience has triggered the usage of CT.

When it comes to future generations of CT and AAL in general, these are often grounded in imaginaries and pre-conceptions [Schwaninger et al., 2021]; we also found mixed attitudes towards robots such as a fear of automation in care, supporting previous HRI work [Frennert et al., 2013a, Frennert and Östlund, 2015]. Furthermore, where the use of robots may not have been an idea "lying around", such devices were also not physically available at the time of the study, in contrast to tablets. However, as technology may be there to stay, as expressed by care workers, the use of tablets may also be an idea at an entry point of openness towards engaging more likely with robots in the future.

Care practices that involve CT require an ecosystem perspective with interdependencies at least between politics, organizations, workers and residents.

Care workers mentioned political agenda requirements to support the use of technology during work and to include aspects of digital competence into education and ongoing education of care workers. Institutions across care and politics can offer these opportunities and by doing so enhance digital competence and access to state-of-the art technology. On an organizational level, the willingness of care workers and residents is needed to engage with technology in day-to-day work and life. The care institutions are also the ones who engage in institutional collaborations, for example, with research institutions and private corporations. Such corporations can provide access to participation in development, where previous research stresses the importance to include care workers' knowledge and everyday work also with older adults [Frennert and Östlund, 2018]. The care workers also need a certain level of readiness to engage with new tasks and use technology to fulfill their goals in day-to-day work, provided that they are offered opportunities by care institutions to do so, and that the technology is developed for them to actually support their daily work. In the work presented, they were also the ones who initiated the usage of CT. Last but not least, residents need a certain level of openness to engage with new forms of interactions, along with digital competence. This connects to previous COVID research which suggests a perspective to understand digital tools as they are being used by residents, not merely as an instrument but also as a learning process that needs professional support, infrastructure, and training [Gallistl et al., 2021, Pipek and Wulf, 2009, Johansson-Pajala and Gustafsson, 2022].

For the potential use of robots then, political and institutional requirements are important as well as the role of workers and residents that are not necessarily a matter of technology only but a matter of the context as well. Besides that, robots were however not available at the time of this study and the idea of automation in care contexts also had negative connotations. Robots also require a different set-up, which can come with additional challenges for daily work, such as in moving a (heavy) robot (which is also known from hospital settings [Tang and Carpendale, 2008]), and mental stress regarding possible technical breakdowns [Carros et al., 2022]. When robots become more complex, they also require more resources such as battery life; which is also a known issue from when a mobile device has been deployed in a hospital [Tang and Carpendale, 2008]. The challenges then also require a different type of training and support than already discussed for these current off-the-shelf devices, i.e., tablets.

The use of new CT requires a collaborative perspective as they involved a triune of residents, care workers and family members.

For the most part, digital devices were not used in a dyadic human-human interaction between a resident and a family member, nor has there been an omniscient and omnipotent agent [Schmidt, 2008] or user, but they have been used in a triple of residents, care workers and family members. The three parties are needed to establish a connection between each other. The family calls the care worker to make an appointment, the care worker then makes an appointment between the resident and the family. Once this is established, the communication still needs additional support. The care worker sets up the video call and quite often stays in the room with the residents to help out and to give an update to the family. This triune also means that all three parties have to appropriate a new technology and learn about the changing dynamics that come with it, where they need to articulate the distributed (work) activities [Schmidt, 2008] to interact and communicate in spite of distance. For the resident, it adds a layer of transparency, since in this situation they are present and talks between the family and the care worker about the resident and their general well-being are done with them instead of outside of their room. As shown by Lahtiranta et al. [Lahtiranta, 2017], care workers are building a bridge between the people who are not used to the technology and the technology itself. Furthermore, they are mediating the bridge to the family.

The moderator role of care workers as part of a triune that we identified in the use of tablets may be even more important to consider for the use of robots, which also connects to previous work stating that the actions of care workers are crucial for facilitating human-robot interaction in certain care processes [Hornecker et al., 2020]. While robots are often envisioned in a dyadic human-robot constellation [Hornecker et al., 2020, Schwaninger et al., 2019], it is important to acknowledge the dependency of residents on care workers, and their moderator role that has been also identified in previous work with robots in institutional care contexts [Sabelli et al., 2011, Carros et al., 2020].

The use of CT adds to the workload which requires recognition, support structures and new work roles.

The workload of care workers was increased during the pandemic also because of the three party arrangement. While one could argue that fewer visits may have freed up some time for the workers, health and care sectors also rely on adult family members' support [Marston et al., 2020]. Also, care workers have mediated technology use on top of extra pandemic-related workload (e.g., due to changing hygiene concepts and evolving rules that came with the pandemic), which is related to the (mostly hidden) configuration work [Balka and Wagner, 2006], and the fact that introducing technologies into care work always comes with additional tasks, required competence [Frennert and Östlund, 2018]. Care workers however saw a value in supporting residents to virtually communicate with family members and to use technology for sports and entertainment (even though one could argue that they were running the risk of extra workload in the future). This may have an impact on the organization of work and we see a potential for new work roles, as it is not clear yet who is going to formally take the work that technology brings in. Therefore, roles of care workers need to be re-defined, which may also involve changing job descriptions and specific time allocated. There is also a need for increasing staff and support structures to change work processes (which may also involve union involvement). In order to be sustainable, the work that technology brings in needs recognition and support. Furthermore, even if some older adults may be able to use technology independently after a while (as shown in previous case studies [Springett et al., 2021]), this may not be always the case given various barriers [Fischer et al., 2014].

For the use of robots and HRI, the care workers' key role in configuration work needs to be considered. This study has shown that CT usage can lead to new dependencies which requires future work to explore opportunities for new work roles or additional staff. While it is often discussed that robots offer more *intuitive* ways of interaction [Andreasson et al., 2018, Nieuwenhuisen et al., 2010, Zafari et al., 2019], the reasons for this additional workload is also grounded in the task itself, rather than only interaction modalities of a robot. The work practices and day-to-day care along with the crucial role of care workers for putting the communication with relatives to work must be certainly acknowledged also when designing robots to be used in this context, which also needs further exploration in future work.

5.6 Summary

I presented a longitudinal study on experiences with technology for communication (CT) as an instance of current off-the-shelf AAL (to answer RQ1), and the uptake and integration in care homes as triggered by the COVID-19 pandemic. The restrictions in care homes during the pandemic have caused old problems to become more pressing, such as low digital competence and distance of residents' family members. In addition, new problems like experienced isolation, fewer visits and changing interaction and communication practices have been associated directly with the pandemic. Here, it was CT that has been available and partly used as a response to old and new problems. The usage of CT has also entailed changing work practices of care workers and increasing workload.

Shedding light on these long-term experiences with technology in institutional care homes during a pandemic is relevant for the design of robots and HRI. Several lessons learned were discussed that will be a basis to identify main factors for understanding and designing robots to support older adults (RQ). The study has shown how the integration of CT is not merely a matter of technology as such, but also a matter of context including work practices, habits, digital competence, and what constitutes social interaction and coordination between humans (and how it has been mediated by technology). As it is likely that technology is there to stay (which has also been anticipated by care workers), the workload and habits have an effect on everyday life and work. The implications that I discussed are all relevant to consider supporting older adults with robots, such as the recognition of moderator roles, the need to re-consider work roles and increased staff, the need for support structures to tackle issues of digital competence and support for ongoing education and support for teaching skills for care workers to support residents' autonomy in social interaction. For a more equal access to technology, it is important to provide multi-level support on taking into account different levels of digital competence among care workers and residents also when designing robots and HRI.

CHAPTER 6

Exploring PD Challenges for Assistive Robots

6.1 Chapter Overview

Where the previous chapters (4 and 5) provided insights about older adults' and care workers' longitudinal experiences with off-the-shelf systems and about their mixed attitudes towards robots (not actually having seen any robots), a key aim of this chapter is to engage older adults in the design of robots to understand methodological challenges (RQ2). Hence the chapter contributes to deriving main factors for understanding and designing robots to support older adults (RQ) with a design approach and engaging older adults with actual robot prototypes.

A way of designing robots bottom-up that has been increasingly proposed in HRI is through participatory design (PD) [Lee et al., 2017a, Frennert et al., 2013b, Lan Hing Ting et al., 2018]. This chapter aims to introduce and explore participatory methods for robots and with older adults and other stakeholders. To this end, three participatory design workshops and subsequent group discussions are presented with older adults and three different robot platforms. The workshops were conducted in an exploratory way, with a focus on discovering initial challenges that could arise when older adults encounter robots and when conducting such workshops from a methodological point of view. The insights mean to serve as initial reflections for the subsequent Chapter 7 on method development for the co-design of robots.

The overview of this chapter is as follows. After an introductory section which will also elaborate on grounding related work on participatory design, I will describe the workshops including their three planned phases, which also includes a description of data collection. I follow with results and a discussion on challenges for participatory design and how these are potentially relevant for method development. The chapter concludes with a summary.

6.2 Chapter Introduction

Given assistive technology needs to fit into complex realities of older adults, participatory design has been increasingly promoted and recognized as an "important route to context-sensitive, person-centred and sustainable health innovation" [Langley et al., 2019, p. 3] for older adults. Recent HRI research has also explored participatory methods for designing robots for older people and care contexts [Frennert et al., 2013b, Lee et al., 2017a, Lan Hing Ting et al., 2018, Georgiou et al., 2020, Rogers et al., 2021]. Participatory design can support designers in developing robots that meet older adults' needs, capabilities and preferences on the one hand [Rogers et al., 2021], and promote mutual learning between researchers and participants [Lee et al., 2017a] on the other.

While participatory design has been conducted in HCI for some time [Bratteteig and Wagner, 2014, Bratteteig and Eide, 2017], in HRI, it is still relatively new and comes with specific challenges [Weiss and Spiel, 2021]. As robots are technically complex, the involvement of older adults, for example, in building prototypes is not straight-forward. While co-designing screens, for example, could be done with pen and paper, building a robot prototype requires technical skills. Therefore, the co-design process itself also involves multiple people and, consequently, their perspectives [Rogers et al., 2021]. In recent participatory design studies, Lan Hing Ting et al. [Lan Hing Ting et al., 2018] use ethnographic methods to explore the co-design and evaluation process of a mobile social robotic solution for older adults following a living lab approach, involving the people who are considered primary users, sociologists, designers, and engineers. Furthermore, the use of robot prototypes can be beneficial for co-design to involve older adults with actual systems that they can discover [Lee et al., 2017a] and potentially extend.

To reflect on some of the challenges on participatory design for robots with older adults, I propose to conduct co-design workshops and engage with robot prototypes in the first instance (as proposed by others [Lee et al., 2017a]), taking an exploratory approach. Hence the aim of this chapter is to present participatory design workshops for robots with older adults and critically reflect on the experiences of running these workshops from a methodological point of view. I make suggestions for conducting such workshops with older adults, where some of these suggestions will be picked up in Chapter 7 for developing a PD-inspired tool to engage older adults in the design of robots.

6.3 The Workshops

As a multidisciplinary team, we[1] carried out three half-day participatory workshops, as also proposed in previous research [Lee et al., 2017a]. The study was conducted with 18

[1] Note, in this chapter, I refer to *we/us* in plural as the team (cf. Table 6.1), if not stated otherwise.

older adults, i.e., six people per workshop, in a living lab simulating a private flat at a care facility offering assisted living for older adults. We organized in-situ sessions with voice assistant prototypes ready for people to explore. Our intention of the workshop itself was to help older adults gain some familiarity with voice assistants, and subsequently assess their expectations of these systems and their potential use and role in their everyday lives. An important aim was to explore together with the workshop participants how the implementation should continue design wise. The idea of this was to find a common ground among the participants, where the platforms were intended as a starting point to discuss how they could be improved in a next step. A prior engagement with the robot platforms should empower participants to engage in discussing design ideas. A goal for these workshops was therefore to give the participants an idea of what the systems are capable of and to identify how to expand the functionalities as a next step. We planned a workshop agenda of three phases with a detailed time schedule in advance.

6.3.1 Pre-Workshop Phase

A care facilitator recruited workshop participants of age 65+ from within a network of participants of previous studies related to technology and tele-care. The participation at the workshop has been framed as an opportunity to participate in a study with robots.

A principal researcher, social science researcher trained in qualitative data collection and an HRI researcher planned a workshop agenda. They also prepared group interview guidelines, pre-questionnaires, and consent forms. Further, two computer science researchers designed and implemented functionalities for participant interactions with the prototypes.

6.3.2 Team Members at the Workshops

Six researchers were involved in carrying out the workshops (see also Table 6.1). A principle researcher attended to observe and take notes. A care facilitator took notes on a flipchart. Two computer science researchers were responsible for the technical setup on the day, for introducing the systems to the participants before letting them explore the robots individually and for assisting in cases where the participants needed help. A social science researcher and an HRI researcher conducted the group interviews.

6.3.3 Workshop three-Phase Agenda

Phase 1: Introductions

The participants were welcomed and this was followed by an introduction round, where the participants could also state their expectations. We also gave out pre-questionnaires covering demographic questions and consent forms.

Person	**Responsibilities**
1 principal researcher	general observation
1 care staff	recruit participants, host workshops, assist during group discussions
2 software engineers	demonstrate the systems, solve technical problems
1 social science researcher	conduct group discussions, focus on topic of interest, write report
1 HRI researcher	conduct group discussions, observe workshop, participatory observation
3x6 older adults	interact with robots, engage in group discussions

Table 6.1: Participants and their Responsibilities

Phase 2: Interactions

We created three stations with different embodiments of voice assistants for people to interact with for 90 minutes, i.e. one Echo Show, one Q.bo One, and one Anki Vector (see figure 6.1).

Figure 6.1: Anki Vector (l), Echo Show (m), Q.bo One (r).

At each station, we provided explanatory cards with a set of interactions, framed as tasks, for the participants to follow for engaging with each system. A major intention of this was that the participants get a first feeling of interacting with the systems and of opportunity spaces of the devices. The voice assistants were prototypes to be further developed upon the participants' feedback upon their desires and suggestions, not intended to be used as they were off-the-shelf at home.

With Echo Show, the participants could obtain information about diabetes and physical exercises. The interaction was designed as a decision tree, where the participants could respond with pre-defined answers to Echo's questions (i.e., yes/no; "answer 1", "answer 2", etc.). With Q.bo One, the participants were asked to read out phrases with specific keywords and Q.bo One responded with mood detection. With Anki Vector, the interaction was related to information retrieval or entertainment, i.e., to ask it to tell the weather or a joke.

According to the workshop agenda, the participants would be asked to explore the stations individually after a brief introduction by the computer science researchers. As there were six participants invited, we expected the participants to explore the robots and the interactions in groups of two at each station. The computer science researchers would help in case of technical breakdowns, or if the participants had any questions. The HRI researcher observed how people would solve the tasks on their own and potentially fail, to also explore strategies of reacting to or even overcoming situations of breakdowns and of needing help.

Phase 3: Interviews

Following these interactions, we used group interviews [Frey and Fontana, 1991] to stimulate discussions, planned to last 50 minutes each. These were meant to focus on the participants' experiences and their expectations for future robots, to provide insights for future voice-assistant implementations. We were also interested in the participants' expectations for interacting with these devices in their homes. In our interviews, we asked, e.g., about what tasks they felt more or less confident with, and what they had learned. To move the discussions towards people's everyday lives, we also asked e.g,. how people imagined engaging with a voice assistant at specific places in their homes. We also collected video recordings and notes during the workshops. The research team also held debrief sessions after each workshop day. We draw across all the data to reflect on the interplay between our participant findings and how the team conducted the workshops.

6.4 Results and Discussion: Challenges for co-designing Robots

A common response from the older adults who came to participate in the workshops was that they were disappointed by the robots, because they had fewer capabilities than they had expected. E.g., "these robots have the status of a toy". Further, they found the systems not useful in the first instance, e.g., saying there was "no additional value" (e.g., "I know my mood"), or that the devices would take away tasks people would rather do themselves or using another device (e.g. "I can [read the news] on my computer"). Accessibility issues were discussed, e.g. the maximum speech volume and the font size on the screen, along with privacy concerns. Participants further stated they did not feel confident in using the systems in their homes as they found them at the workshops, as they didn't know how to turn the systems on or off. In cases where people did feel able to use them, there was the issue of the lack of usefulness ("the added value is missing"). Moreover, the participants kept suggesting us to involve sick people or people with restrictions in mobility ("I think we are not the target group").

In the debrief sessions, the researchers also expressed disappointment at the participants' feedback and their difficulties imagining how the systems could be useful. Some of the researchers also argued that the introductions of the systems to the participants had taken too much time, and that they did not have enough of a chance to explore the systems on their own.

In sum, despite running a workshop that we considered to be well-planned, in-situ, and involving older people and robot prototypes with functionalities that were prepared to be further developed as a next step, we found disappointment of both the participants and the researchers as a shared experience, albeit for different reasons. On the one hand, our results are in support of previous research on the non-use of robots [de Graaf et al., 2017], which highlights the importance of acknowledging different groups of non-users who were facing obstacles for acceptance tied to their own unique motivations and reasons for rejecting robots. While the the feedback of the participating older adults did not really help us in further developing the voice assistants (even if this was a major intention of the workshops), they helped us fixing specific aspects of usability and accessibility (such as font size, speech volume, etc.). As also shown by Frennert et al. [Frennert et al., 2013b], our participants doubted they were the target group of our robots. On the other hand, it makes sense to also reflect on the results to propose further explanations for what happened at the workshops. Thus three factors can be identified - roles, recruitment and interactions - that may give insights for challenges to take into account for participatory design for robots. In the following, I reflect on these factors and make suggestions for future participatory research with robots, to also build on in Chapter 7.

6.4.1 Researchers' Roles

As a multidisciplinary team is needed to build robots [Lan Hing Ting et al., 2018], our team included people trained in various disciplines and with multiple skills. While the responsibilities seemed clearly assigned to the team members in advance, a couple of issues were not anticipated.

One was that the introduction into the systems would take more time than expected by other team members. The result of this was that (from the perspective of other researchers) the participants did not have enough time to explore the devices by themselves. Further, in hindsight some researchers were too quick to jump in and help the participants when they appeared to have problems and did not give them enough space to learn by trial and error. This created tensions, as others in the team were very keen on seeing the participants interacting with the systems on their own. This being guided through the interactions may explain why participants further said they wouldn't be able to use the robots independently in their homes as this was the inadvertent subconscious message by well-intentioned help.

For future workshops, a suggestion is to negotiate more explicitly in advance each of the team members' roles, their individual goals and shared goals, providing a shared understanding. The necessity of clear team goals, issues of sharing information and understandings also due to different terminologies have been highlighted also in recent HRI research by Axelsson et al. [Axelsson et al., 2021]. Further, responsibilities regarding who introduces the robots and what introducing means in this specific case may be worth negotiating beforehand. To make the distribution of responsibilities easier and to avoid tensions that could negatively affect workshops, a person with no other role than guarding the division of tasks during the workshops may be worth considering, e.g., the principal researcher in our case. However, too many researchers observing at the same time could also be worth avoiding.

6.4.2 Participant Recruitment

While the care facilitator was successful in recruiting participants, the use of the term 'robots' in advertising set up unrealistic expectations when it came to voice assistants. This may have added to participants' disappointment with the voice assistants' capabilities. Following their high expectations of interacting with robots for care, there was a clear mismatch with what these robots could actually do.

Some researchers in the team had been aware that avoiding the term robot may be useful, as previous research suggests that people's perceptions of *robots* can draw on what is perpetuated by the media and entertainment industry [Bartneck, 2004, Samani et al., 2013, Weiss and Spiel, 2021]. However, different interests (successful recruitment vs. avoiding over-expectations) and weight of awareness may have affected the way the participants were recruited after all. Further, some participants had to be asked several times before confirming their participation in the study (which they were to do without financial reimbursement), and this may also have contributed to more enticing terms like robot being used to entice participation.

We conclude that language matters as it affects people's expectations. For future participatory design for robots, I suggest to carefully use terms that convey expectations, and especially consider avoiding the term *robot* at all (cf. Chapter 7).

6.4.3 Interaction Design

The interactions we confronted the participants with represented first ideas to be further developed in the future, aiming to explore the robots in a de-contextualized manner not yet representing any tasks to be used at people's homes. The researchers kept telling the participants in the workshops that the voice assistants were not ready to use off-the-shelf, and that they had to be set up to do what the participant wanted. However, this seemed hard for participants to grasp in that they still questioned the usefulness of the systems. The interactions were also framed as 'tasks' during the workshops, which may have been confusing. While it can make sense to showcase prototypes in co-design workshops as suggested by others [Lee et al., 2017a], in hindsight our interactions were very static, e.g., interacting verbally with Echo Show with predefined answers. The static interaction may also have contributed to the feeling that the participants were not the target group, as the interaction did not require any mobility nor did it relate to their everyday life context.

When using prototype functionalities in the future in such workshops, a suggestion is to avoid interactions that are too static. A key aspect is also to develop appropriate methods to reflect explicitly on how to embed these functionalities in meaningful tasks, and to explicitly engage with the everyday life of people when co-imagining the usage of robots in living spaces, also providing a shared understanding of the context. Given robots are not as common in our society, non-expert users such as older adults can find it hard to imagine actual robots and interacting with them in their everyday life. This is in support of the literature, where participants' lack of familiarity can make it hard to imagine social connections with a social robot [Georgiou et al., 2020]. Therefore, when imagining a robot in one's homes, Bråthen et al. [Bråthen et al., 2019] point out that developing a story about a robot in the context of older people's homes and in the daily life of older adults is essential for successful design and prototyping.

6.5 Summary

While there has been increasing interest in participatory methods to design and develop robots to support older adults, these approaches also come with several methodological challenges. As a multidisciplinary research team, we conducted three participatory design workshops with older adults and using prototypes of voice assistants. The results are presented in this chapter, showing how our systems were not perceived useful by the participants right away. But where do these results come from? I unpack factors around participant recruitment, researchers' roles and interaction design in the workshops. I critically reflect on the challenges that need to be taken into account when running such workshops with robots in the future. Among these challenges, it is essential to negotiate researchers' roles and create a shared understanding, to avoid robot prototypes that are too static and de-contextualized of people's everyday life, and to handle terminology such as "robots" with caution. These results provide a first building block to answering RQ2 on identifying methodological challenges for engaging older adults in the design of robots. In the light of this, the results are a first step to explore method development for co-designing robots with older adults, which is continued in the work described in the next chapter.

CHAPTER 7

Addressing PD Challenges with a Methodological Tool

7.1 Chapter Overview

The work presented in this chapter is based on and extended from the previously published journal article “What do you mean by ‘Trust’? Establishing Shared Meaning in Interdisciplinary Design for Assistive Technology” [Schwaninger et al., 2021]. The aim of this chapter is to design and use a tool for co-imagination inspired by participatory design for robots, further exploring and addressing some of the challenges presented in Chapter 6 to answer RQ2. The chapter further contributes to deriving main factors for understanding and designing robots to support adults (RQ) based on a design approach and engaging older adults with the notion of robots in their everyday living spaces, also addressing the limitations of conducting PD workshops.

While participatory design is a way of engaging bottom-up with the design of robots for older adults, this approach comes with challenges. As shown in Chapter 6, current challenges include terminology (specifically, expectations that can arise when using the term “robot”), researchers’ roles (including a lack of shared understanding of older adults’ everyday life), robot prototypes being perceived as de-contextualized in co-design workshops, and a rejection of robots in such workshops. Furthermore, Chapter 4 points to a lack of trust of older adults in robots. There is clearly a lack of methods to address these challenges, which I aim to tackle with the work presented in this chapter.

Hence the overview of this chapter is as follows. In the introductory part, I motivate this work by elaborating on how I aim to address the challenges discussed in the previous chapter, combining participatory design, engagement with different stakeholders, elicitation tools, trust, and social practices. Subsequently, I present the conceptualization of the proposed approach and in the following, the creation of a deck of cards in several iterations. This is followed by the findings on the cards as tool, as well as on the topics and notions on the relations of places, people, technology, and trust derived through using the cards. After that, I move on to a discussion, in which I reflect on the usage of the cards, the trust concept, as well as potential implications for supporting older adults with robots. I close the chapter with a summary.

7.2 Chapter Introduction

The previous chapter yielded several challenges around participatory design for older adults.

First of all, HRI researchers in multidisciplinary teams can have different expertises and this comes with different (and sometimes conflicting) expectations. Building prototypes requires a lot of technical expertise and decisions about which lay people have no familiarity, also, as for robots, it is not as easy to build paper prototypes. It is also known from the literature that designers and engineers of robots who do make design decisions most likely experience life from a different perspective than their target group of older people [Güldenpfennig et al., 2016]. Therefore, it is promising to address this challenge by finding a common ground on people's everyday life, and developing a tool to do so.

Second, it was rather easy to say what people would *not* want instead of what they would want. As shown in Chapters 4, 5, and 6, older adults tend to discuss privacy issues, and with few exceptions, they tended to reject the idea of robots in their homes. The clear lack of older adults' trust in assistive technology [Pirzada et al., 2022] or digitalization [Knowles and Hanson, 2018] been also found in other research, where trust is overall a key concept in HRI [Hoff and Bashir, 2015, Billings et al., 2012, Wagner et al., 2018, Schwaninger et al., 2019]. This comes with the opportunity to engage in conversations around trust, using provoking scenarios as ice-breakers for conversations about robots in people's living spaces. Concerning the topic of trust, it has been also mainly studied in controlled settings in HRI [Zafari et al., 2019, Martelaro et al., 2016], which can be fruitful for studying an interaction itself. However as I stated in other work [Schwaninger et al., 2019], there is also a need for for studies in the everyday life of people that investigate the topic of trust, also taking into account people's social practices as opposed to conducting studies isolated from the context, in laboratory settings.

Third, imagining robots in private spaces that are encountered in a de-contextualized manner and with static interactions is hard in general. From the literature, we also know that envisioning abstract concepts (e.g., trust) or new technologies is also a challenge especially when engaging with older adults [Alexandrakis et al., 2019, Lindsay et al., 2012]. Here, visualization techniques may be able to support elicitation of related difficult topics [Silva and Daniel, 2019], such as the notion of robots in living spaces. They can "become bridges between strangers [...] [and] function as starting and reference points for discussions of the familiar or the unknown" [Collier, 1986, p. 99]. Elicitation techniques can also reduce power imbalances between researchers and interview partners, and they can enhance participants' ability to elaborate on their own conceptions of the world [Barton, 2015]. Playful methods can further support participants' engagement and active participation in studies [Bernhaupt et al., 2007], which is also beneficial for interviewers or designers with little training [Silva and Daniel, 2019], such as engineers working in HRI teams. Examples of tools for elicitation include collaborative card-based techniques, which can increase user involvement and investigate different aspects of design, e.g. by guiding through usage scenarios [Beck et al., 2008]. Cards can be used both to evaluate existing technology and to inform design of new platforms [Fedosov et al., 2019], as well as for understanding current concerns from the perspective of diverse actors [Lee et al., 2017b]. In the form of card decks and card games, they dominate the currently available design tools (i.e. tools for designing technologies or digital artifacts or services) [Peters et al., 2020, IDEO, 2003]. Another useful way of engaging with the everyday life of people is by using floor plans, which can support a conversation about daily practices. It does not only show spaces in a house, but also their sizes, relationships to each other, and perhaps things in each respective places to support specific kinds of living / actions there (e.g., stoves or beds), and the access between spaces [Holtzblatt and Beyer, 2016].

Last but not least, the terminology around "robots" can skew older adults' expectations and trigger potential rejections in the first place. Previous research also suggests that people's perceptions of *robots* can draw on what is perpetuated by the media and entertainment industry [Bartneck, 2004, Samani et al., 2013, Weiss and Spiel, 2021]. Therefore, a tool to co-imagine robots in everyday life should address this issue by exploring alternative ways of discussing innovation. I therefore propose to explore less robot-centered concepts like "latest invention" that allow people to focus more on their needs rather than on a specific technology in the first place.

7.3 Research Approach and Methods

I developed an tool featuring elicitation cards that has been created for the co-imagination of robots in older adults' living spaces, inspired by lessons learned from participatory design in Chapter 6. To tackle the challenge of creating a shared understanding in multidisciplinary HRI teams, I asked 10 Informatics students from a course (HCI in Healthcare)[1] 8.5. to engage in the first steps of designing a tool to do so. The iterations of this process are described in the following.

7.3.1 Designing the Cards

Drawing on the literature and on previous experiences[2] [Schwaninger et al., 2021]. This phase also included exploratory interviews to develop a sense of the challenges to talk about trust and robots, also using the term *latest invention* to discuss novel technologies.,

[1]Note, there are certainly limitations in involving Informatics students to act as proxies for roboticists/engineers working in multidisciplinary teams. I further discuss these limitations in section

[2]Note, the students were also asked to engage in an exploration phase, as also described in

we (the lecturers[3]) created a deck of elicitation cards in several iterations. The students were involved in designing an initial version of the cards, which we then further developed and which were used by the students later with older adults.

In the initial round, the 10 students designed 42 cards. In detail, they based their ideas on lecture discussions and literature on trust, robots, robots in homes, robots and Active and Assisted Living (AAL), and robots and older adults, along with first exploratory interviews they conducted. I asked them to each design at least 3 and up to 5 cards. At this point, the instructions for the students left enough room for their own ideas. Based on discussions in class, we agreed that the cards could refer to the topic of trust in multiple ways (i.e. a robot's trustworthiness as reliability [Billings et al., 2012], its competence, integrity and benevolence [Mayer et al., 1995], and in relation to people and context). The initial cards would refer to one of the following topics: people's roles (to reflect on people's associated practices in their home), motivation and skills (i.e., critical for older adults interacting with technology [Atkinson et al., 2016, Fischer et al., 2014], and to discuss daily routines, as assistive technologies should support/fit with these routines), context (with *home* being the focus of the study), interaction and communication, and robot's appearance and behavior (all to affect perceived trustworthiness [Strohkorb Sebo et al., 2018], also conveying a robot's competence, integrity or benevolence), and robot's roles (critical for domestic robots [Pantofaru et al., 2012, Dautenhahn et al., 2005]). The cards would contain provoking questions related to a latest invention in their homes. As described earlier, I used this concept to avoid skewing people's pre-conceptions around robots, which is a lesson learned from Chapter 6. Example questions would be, for example: "What if the *latest invention* knew to stay away when other people are around?", or "What if the *latest invention* speaks your native language?".

I carefully reviewed and discussed the cards submitted by the students and grouped them to develop a next version of the deck of elicitation cards. In this second round, I opted for creating 5 categories of cards (to be described further below). At this point of time, it also became evident that the students, and the lecturers too, wanted the cards to be used in a more playful manner in the qualitative interviews. We also designed simple game mechanics (see later section about playing with the cards). The 5 categories included the Golden Card, the People Card (as social environment appeared important), the Motives Card (to focus on daily routines), the Places Cards, and the Provocation Cards (see Table 7.1). The the People Card has been designed to explore the social life of the interview partners, and the Motives Card aimed at talking through a typical day and routines. The Golden Card was designed to ask for general ideas about how people imagine to be supported or disturbed by a robot. We also designed a tangible coin-shaped token to help imagining a robot at different places in people's homes during the conversation, with the words *latest invention* engraved.

The Provocation Cards contain questions regarding a *latest invention's* design cues and the interaction with a robot. The Provocation Cards are based on the initial questions

[3]Note, in this chapter, when I use the term "we", I refer to myself and the other lecturer, Florian Güldenpfennig.

2 Golden Cards	questions about support / distraction
1 People Card	questions about social life
1 Motives Card	questions about motives and plans
8 Places Cards	5 figures of rooms; 3 empty cards
24 Provoc. Cards	questions about robot design

Table 7.1: Card categories and the content of the cards.

submitted by our students, asking provoking questions to stimulate discussions. The provoking questions are also inspired by the literature on trust (see Table 1). , namely interpersonal trust from organizational theory [Mayer et al., 1995], and reliance [Billings et al., 2012]. I apply the concept of interpersonal trust to how people would trust a robot (as it has been done in previous research [Martelaro et al., 2016]), as well as how people would trust the people behind a robot, such as programmers (as found e.g. by Salem et al. [Salem et al., 2015]), or healthcare professionals when the robot collects data about a person's medical status. The reliance concept is then related to tasks that require a certain degree of reliability (e.g., emergencies or banking), or breakdowns.

7.3.2 Playing with the Cards

The cards were designed to be played within a person's home. We designed a card game, and the use of the cards is also illustrated in Figure 7.1. As an initial activity, the interviewer and the older person together lay the Places Cards out on a surface so that they visually represent the layout of the home of the interview partner. The Places Cards include a living room, a kitchen, a bedroom, a toilet and a bathroom. Additionally, empty cards can be used to draw up additional places that are not covered by the deck of cards.

To then gain more contextual information, two additional cards are introduced: the People Card and the Motives Card. The People Card contains questions to explore the social life of the interview partner, asking who they live with, whether they have any children, partners, pets, or friends, and whether there is anyone coming to their home to take care of them or the home on a regular basis. The Motives Card is then drawn and this prompts them to talk through a typical day, about plans for such a day and future life.

After this floor plan preparation and these initial questions have been asked, the next phase can start. The golden token, the Golden Card and Provocation Cards are used in a playful manner. The golden token is used to represent a *latest invention*, and it is moved from place to place on the floor plan, 'walking' from Place Card to Place Card, as a person would go from place to place on a typical day.

At each place, the Golden Card is used, asking generally how a *latest invention* could support the older adult at this place, and how it would disturb them. Subsequently, the older adult randomly pulls 1-3 Provocation Cards. For each Provocation Card, the

Provoking Questions	**Trust**
What if the *latest invention (LI)* has microphones?	I, R
What if the *LI* is connected to your bank account?	I, R
What if the *LI* knows about your medical status?	I, R
What if the *LI* can detect when an emergency happens?	I, R
What if the *LI* has a personality similar to your own?	I
What if the *LI* makes mistakes sometimes?	R
What if the *LI* watches you do things?	I
What if the *LI* can detect when you are very happy?	I
What if the *LI* is capable of expressing emotions?	I
What if the *LI* can detect when you are not feeling well?	I
What if the *LI* has cameras, and other people can see what the *LI* sees?	I
What if the *LI* has very cute eyes that are cameras?	I
What if the *LI* is very strong, so that it can lift things?	R
What if the *LI* can understand you speaking, and what if it records everything?	I, R
What if the *LI* breaks something you like?	R
What if the *LI* can make phone calls to other people?	I, R
What if you cannot turn off the *LI*?	R
What if the *LI* is very talkative to everybody around and cannot keep a secret?	I
What if the *LI* doesn‘t speak your native language, or has a strange accent?	I
What if an emergency happens, and the *LI* does NOT detect it or cannot help?	R
What if the *LI* is made of a very comfortable material, e.g. fur?	I
What if the *LI* becomes a companion?	I

Table 7.2: Provocation card questions also inspired by the trust literature including interpersonal trust (I) [Mayer et al., 1995] including benevolence, competence and integrity; and reliance (R) [Billings et al., 2012] with human characteristics, robot characteristics and environmental characteristics.

question written on the card is asked, and the idea of a *latest invention* (with specific trust-related behaviours as facilitated by the Provocation Cards) at the specific place is discussed. The questions on the Provocation Cards are answered specifically referring to the places the *latest invention* is at in the current state of the conversation. Our aim is for the cards and the token to elicit trust-related aspects that specifically situated in places and people's everyday practices.

7.3.3 Collecting Empirical Data on Using the Cards

The students were asked to form pairs and conduct two qualitative interviews with older adults of age 65+ per pair. This resulted in 10 interviews, which lasted 30-45 minutes each. The interviews were conducted mostly with older relatives or neighbors of the interviewers, while two students also approached people on the street to participate in a study.

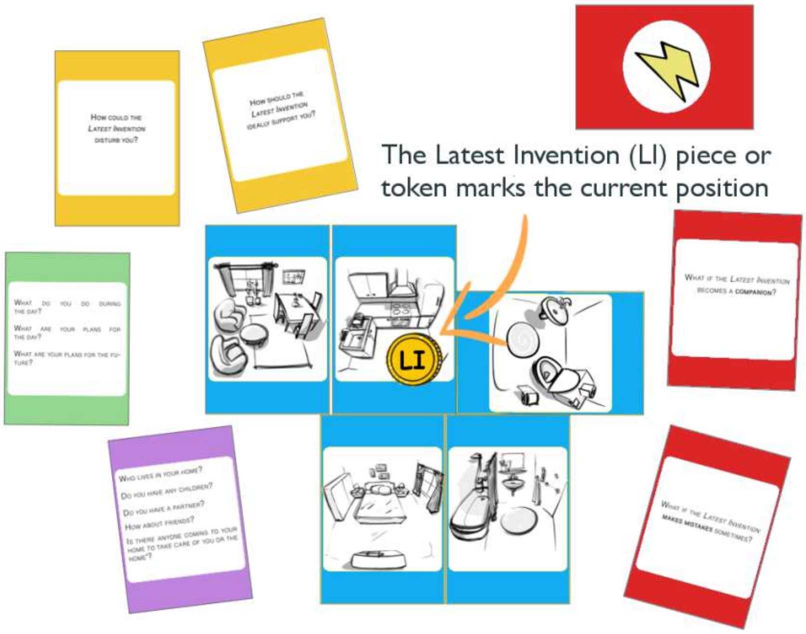

Figure 7.1: A laid floor plan (blue) with a golden coin-shaped token, two Golden Cards (gold / yellow), a Motives Card (green), a People's Card (purple), two Provocation Cards (red) and a staple of Provocation Cards (red with a flash).

No.	Age	Gender	Place	Techn. Affinity
1	65	F	Upper AT, AT	low
2	72	F	Vienna, AT	low
3	71	F	Pchelarovo, BG	low
4	66	F	Pchelarovo, BG	low
5	65-69	n.a.	South-West DE	high
6	77	n.a.	Vienna, AT	low
7	81	F	Vienna, AT	uses smartphone
8	77	F	Salzburg, AT	uses smartphone
9	72	n.a.	Deutschlandsberg, AT	high
10	63	F	Vienna, AT	high

Table 7.3: Older adults whom with the cards were used.

Among the 10 older adults (see Table 5.3.2), 75% were women, and all were above 63, with a mean age of 71.1, and a standard deviation of 5.6. They lived in cities (5) or villages (5) in Austria (7), Germany (1) or Bulgaria (2)m and their self-reported technical affinity tended to be either low (5), high (3), or they indicated using a smartphone (2). The interviews were conducted in three different languages, depending on the interview partners' mother tongues. The students took notes on how people interacted with the cards and the content of the conversations. If the participants gave permission, the students audio-recorded and transcribed the interviews, also translating them into English. As the cards were all labelled in English, they were translated by the students in the course of the conversations if they were carried out in a language other than English.

To report on the use of the cards, the students were then asked to give 30-45 minute presentations on their data, followed by class discussions. The presentations and discussions were audio-recorded, and I took notes during the class. The presented data included demographic details of their interview partners, and empirical observations of the cards being used and the findings from the interviews. They were also asked to report on meta-reflections, including their overall experience as novice researchers/engineers, challenges and suggestions for changing the cards, and reflections on the differences when using the cards vs. not using them in the previously conducted semi-structured interviews (which they had conducted in the exploratory phase).

We also interviewed the students after their presentations (both the presentations and the interviews happened in pairs). The questions we asked touched on educational, methodological and content-related reflections, focusing on the students' experiences (see Appendix 9). The questions aimed to tackle their experiences in doing the interviews, the trust topic, the terminology around robots, what they had learned about older adults' context, and implications for design.

7.3.4 Analyzing the Data

I incorporated diverse data to analyze the usage of the cards as such: the presentation slides submitted by the students; and the notes and recordings of the oral presentations and discussion in the course. Both the slides and the discussions included a meta-reflection on the card-based tool. For additional insights on the usage of the elicitation cards, I also referred to the analysis of the content of the discussions with students rather than only the meta-level reflections. To gather insights on robots from the perspective of older adults as facilitated by the usage of the cards, I drew on the submitted transcripts and notes of the interviews with and without cards. I also analyzed the presentation slides and the class discussions.

I analyzed the data using Thematic Analysis [Braun and Clarke, 2019]. I first familiarized myself with the data, which also involved an informal discussion with the other lecturer over lunch [Braun and Clarke, 2019]. In a next step, I placed all text passages from the transcripts and the notes taken at the final presentations of the projects into a spreadsheet, one paragraph per cell. Most of the notes were already paraphrased sentences of the conversations. I printed them out, cut them into pieces of text passages and added codes to each text passage. As I was also interested in analyzing the use of the components of the deck of cards (cf. section 7.4.2), I also looked for groups of topics and central elements of these according to cards, inspired by [Froschauer and Lueger, 2003]. As part of the overall data analysis, I also took into account whether a certain topic that I came across the dataset was introduced by the interviewer or by the interview partners, as this can give insights into the meaning of a topic for the interview partners [Froschauer and Lueger, 2003]. I identified commonalities and differences of codes across the data [Braun and Clarke, 2019, Froschauer and Lueger, 2003]. In the following, I constructed themes, which I then revisited and (re-)defined in repeated rounds [Braun and Clarke, 2019]. I present these in the findings and the subsequent discussion below.

7.4 Findings

In the following, I present findings from across the data. I first report on the students' experiences of using the cards, which is followed by findings on the components of the cards. In a subsequent step, I report on findings related to topics of trust and robots that came out of using the cards.

7.4.1 Playing with the Cards: The Cards as a Tool

The first part of the findings conveys insights about our deck of cards as tool for co-imagining robots. I found that the cards helped to create a fluent conversation and to establish a feeling of trust between interviewers[4] and older people[5]. Furthermore, using the cards may have facilitated active participation, a deeper reflection and learning effects for the older interviewees, while also promoting detailed discussions about topics around the home, trust, and social robots.

Creating a fluent Conversation and Trust

The interviewers, (in the following referred to as P#), who had no or very little experience with conducting qualitative interviews, reported a positive impact of the cards on the conversation flow ("there was a red thread throughout the conversation and a structure" (P2), "otherwise, how do you keep a red thread?" (P5)). They found the cards "easy to understand, and it was easy to explain to others [i.e. interview partners] what the cards were about" (P1). The students reported that the cards made the conversation appear more relaxed and like a game, even entertaining, and helped in "keep[ing] the conversation rolling" (P5). The interviewers discussed this in contrast to their experience of having such conversations without cards, where they found a tendency that the "conversation

[4] Note, in this section, I use the notions of *interviewers* and *students* synonymously, since the students conducted the interviews.

[5] The older participants who described their homes and attitude towards robots are denoted as *older adults*, *older people*, *interviewees* or the like.

Figure 7.2: A printout of the elicitation cards in use (version 1).

died out" (P6) when not using the cards. Figure 7.2 shows a conversation based on card use.

The findings also point to ways in which the cards helped to establish trust between interviewer and older interviewee, and using the cards made the conversation personal (e.g., "in the beginning I thought she [the older interviewee] had a good life [...] but later I realized [...] she was really alone" (P5)). The cards gave access to imagined actions in intimate spaces, practices and emotional dimensions in stories around older people's everyday lives ("when we talked about the bedroom, she really talked about it [...] [how] she combed her hair [...] maybe if we didn't specifically refer to the bedroom, I couldn't talk about this aspect" (P6)). To illustrate the emotions conveyed, an interviewee said, "I always need someone to care about me [...] and it's the greatest fear of my life" (P3), and another older person stated, "the floor is also wet and I'm afraid to fall" (P4) in the bathroom.

Active Participation and Mutual Learning

The Provocation Cards and the Places Cards appeared to be the most fruitful for promoting active participation of the older adults. Laying out the floor plan served as a shared task for the interview partners and established a common play ground ("they [the elicitation cards] helped us and the participants to imagine the house and not skip or miss some rooms" (P2)).

The older interviewees frequently followed the invitation to pick up Provocation Cards (up to three cards per place), indicating their active participation in the conversation.

The cards also facilitated additional points of reflection, so older adults were able to develop and revise their ideas. People happened to change their minds in the course of the conversation when talking about concrete scenes with a robot at specific places. The cards thus had an educational effect, where older people were able to reflect more on what they wanted to have in their private space.

Furthermore, the interviewers (and researchers) learned about the challenges of talking about trust, as well as about the domestic environments of older adults. They learned about the home and the social context in older people's lives, and engaged in an active dialogue with older adults about older people's concerns.

Facilitating detailed Insights

Overall, the interviewers reported that the cards added focus to the stories told by participants and thus helped to reveal details (in particular compared to conducting interviews without cards). For example, some older interviewees initially said they had few or no reservations regarding privacy. However, by means of the cards, older people later detailed in which places video recordings were acceptable and where not: "[It is] no problem if the *latest invention* has cameras and other people can see what the *latest invention* sees, except for the bathroom and the toilet, she [older interviewee] does not want to be recorded there" (P8).

It was sometimes surprising how much detail was included in the concrete scenarios with robots that interviewees talked through, e.g. an interviewee saying the robot "must not spill the bucket" (P4) when cleaning the rooms, or another older person stating that, they "could as well play a card game on a robot [but] would not want to reach out too far" (P9), and it "should be comfortably reachable" (P9), or the *latest invention* must have "a certain size to be able to reach things" (P6) in the kitchen. As the interviewers also had the experience of talking about a typical day and people's homes *without* using the cards, they found that the conversations without the cards, in comparison, tended to be less easy and lacked detail ("I think they could not have imagined it [without cards] as they did with cards" (P1)).

7.4.2 Components of the Cards

Since the cards had a positive effect on the conversations, it might be useful to unpack the components of the cards and analyse them each in more detail. These details highlight findings on the use of the token as well as particularities of each card category.

Challenges regarding the Terminology

Talking about robots per se tended to be difficult in the beginning, even when using the term *latest invention*. I gave the students the opportunity of avoiding the word *robot* by instead introducing the notion of a *latest invention* (LI). The main motivation was not to create stereotypical robot images in the mind of the older participants (e.g., *R2D2* from *Starwars*). While this term was used throughout the interviews in some cases, other interviewers found LI even more abstract, and instead introduced the term *robot* in the course of the conversations ("the *latest invention* was somehow confusing and they didn't understand it, and we should explain it" (P6)). On the other hand, some interviewers reported how it was hard to avoid the term *robot* at all ("they automatically thought about robots" (P2)). In the rest of the chapter, I will thus use both terms, indicating different strategies for handling the conversations.

Some interviewers drew on public media or movie characters to make assistive technologies tangible at first. Also, there were associations with known TV shows like *Tom Turbo*, an anthropomorphic bicycle ("[it could] make coffee like *Tom Turbo*" (P8)). One interviewer played a commercial voice assistant in different accents to demonstrate an agent's potential voice (e.g., saying, "Hey Siri, make some coffee for me" (P7)). In addition, the interviewers reported that it was useful to refer to utilities in the household and connect them to the floor plan in order to help imagining what the *latest invention* could be like.

Despite the interviewers finding initial difficulties when speaking about robots as unfamiliar artifacts, they also concluded that walking through the floor plans and thinking out loud through daily routines became easier throughout the conversations. Further, using the token (together with the Places Cards) acted as a common ground to get back on track ("otherwise, we would have forgotten plenty of things" (P5)). On the other hand, two interviewers reported how using the token was especially helpful in the beginning of the interview, i.e. "as an entry point [...] then, as the conversation was rolling, we did not need it any longer" (P1).

Students were surprised about the interviewees being so skeptical about robots. The interviewers encouraged older people to talk about specific scenarios in relation to the places. To overcome the difficulties with the terminology, there were also suggestions for future work. Two interviewers suggested that it would be useful to provide older interviewees with information about technology like assistive robots beforehand, i.e. "it would be useful to have an additional set of cards, where these things are explained" (P5). As the interviewers also struggled with not knowing about their interviewees' background, another two students proposed providing cards around technical affinity to "ask them in more detail to know exactly what is their information about [...] robots" (P6).

Introducing other People with the People Card

The People Card was intended to introduce other (significant) people of the older adults' daily lives to the conversations. Older adults talked about family members later in the conversations, as these family members had been brought into the discussion using the People Card. For example, an interviewee spoke about their grandson in the beginning when using the card. Later in the conversation, when the ability of the robot being able to make phone calls was discussed, the grandson was brought up again ("It would be nice if I say *call my dear grandson* and it does" (P9)).

Talking about a typical Day with the Motives Card

The interview partners were discussing plans for a typical day and the lives of the older adults when using the Motives Card, and more in detail when walking through the floor plan. Talking through a typical day was thus facilitated by using the Places Cards in combination with the Motives Card. Upfront, older people described their daily routines (e.g., "wake up early, go in the bathroom. She [the older interviewee] drinks coffee and feeds the animals. [...]" (P8)). However, two older adults were surprised by the question about their plans for their life given they felt old for this question. The interviewers also found the Motives Card repetitive when walking through the floor plan later in the conversation ("the repetitive explanation about the daily life, [...] both interview partners said, I explained it already" (P5)).

Discussing detailed Place-based Insights with the Places Cards

Use of the Places Cards enabled the older people to imagine being in the corresponding rooms and discuss the activities that would happen there. Privacy aspects were introduced by the cards, and older people would differentiate between the rooms and associated preferences, e.g., by saying they would have "no problem for recording in the kitchen and if it [the *latest invention*] understands what you say [...] except for the bathroom and toilet, she [i.e., the older person] does not want to be recorded there" (P7).

By using the floor plan, older adults were also able to talk about recent events at specific places. For example, one older person told the story about a "past burglary" (P3) that had once happened in their home, a theme that was taken up several times again later in the conversation when reflecting on how the robot could enhance safety (e.g., the option of a "secure and intelligent entrance door" (P3), and a *latest invention* that "consists of cameras in [the] whole house to observe and report an emergency would be again a good idea" (P4)).

The Places Cards were also tied to an older person's specific current life and how they imagined the future. For example, while mapping out the home, an interviewer said the "bedroom on the first floor will be a problem in later life" (P5). Consequently, the interviewee "liked [the] idea of using voice to trigger commands" (P5) to a *latest invention* that would serve as a hospital-bed.

The Golden Card: On Support in Housework and Personal Assistance

The general question of how the *latest invention* could support an older person triggered the interviewees to refer to the home, often to housework (e.g., "no particular support [in the living room], besides assisting with] small interior changes or help cleaning" (P10)). The Golden Card was used for such general questions, i.e., how older people could be supported and distracted by a *latest invention*. Interviewees referred to very specific activities like help with cooking ("It would also be helpful if the *latest invention* can cook" (P4)), "carrying the garbage downstairs" (P1), vacuum cleaning, work in the garden, "help with picking up things from the ground to avoid bending down" (P10), or help with cleaning in the bathroom or toilet ("it can [...] dry the bathroom after the shower" (P9)). These answers indicated a general openness for support in housework. Despite the self-reported lack of technical affinity of most older people in our study, some of them were able to imagine a *latest invention* in their homes in quite some detail. For example, when bringing down the garbage, “several steps need to be overcome” (P1), so the *latest invention* would need to be able to climb stairs.

Interviewers also reported on specific ideas for personal assistance from their interviewees. For example, an interviewee who was sitting in a wheelchair elaborated how “getting out of my wheelchair to sit on the toilet is one of the most difficult things for me. It could help me to do it and especially help me to dress up” (P4). The Golden Card was thus sometimes useful to talk about personalized support and assistance.

Strategies using the Provocation Cards

While the Provocation Cards did not suggest a strict order of questions, these cards had the most positive effect on the conversation flow according to reports of some interviewers (“It was way easier to ask provoking questions when using the Provocation Cards” (P1)). Interviewers reported that the Provocation Cards were “really good because we could use them and they were good for guiding the interview” (P2). However, other interviewers remarked how “it is difficult to keep a conversation fluent with such cards” (P3), and that “it was sometimes difficult to find the right question” (P6).

To be more responsive to the conversations flow, the interviewers created several piles of Provocation Cards with similar topics to choose from, such as voice or privacy. Other interviewers created “one [pile], where it was all about the robot, and the other one for more general questions” (P5). This way, it was possible to “get back to a pile, when the situation escalated” (P6).

While most Provocation Cards stimulated the conversation, some interviewers found using two particular cards rather difficult and named them “conversation killers” (P3). The card asking, “What if the *latest invention* can detect when you are very happy?” was sometimes not understood properly. In such a case the participants responded: “and then what?” (P3). Students reported that the participants “came to a halt, and they did not know what to do with this question, and we did not know either” (P4). Further, some interviewers found the card asking, “What if the *latest invention* is furry?”, difficult, as their interview partners could not imagine such a robot. Only one older person said they “would rather have something *real* to cuddle” (P4) (instead of cuddling with a furry robot).

7.4.3 Topics related to Trust and Robots as facilitated by the Cards

Besides findings about the *use* of the cards per se, I also have specific findings on the topic of *trust and robots* as facilitated by the elicitation cards. I provide the most significant insights that emerged from the topic analysis to further illustrate that the deck of cards was actually appropriate for revealing relevant, trust-related findings. These include (design) insights on trust that refer to privacy, control and companionship, as well as thoughts on limitations of what technology can provide for people’s lives and the future.

Privacy throughout the Home

An important dimension of trust centered around privacy. Privacy aspects were provoked by the cards, e.g., when asking older adults to imagine the robot having cameras or recording audio. Older people stated they did not want to be watched.

Often, privacy aspects were in reference to anthropomorphic robot design, e.g. "If it looks like a human, I don't have a comfortable feeling to be in the toilet and bathroom with him. I think someone is really watching me and I don't like this feeling" (P9). In this sense, the cards facilitated the interviewee imagining a robot in a very intimate place where they would undress or perform intimate activities, and hence raised concerns about *any* stranger, be it the robot or a person watching them mediated by the robot, being able to watch them in a potentially vulnerable state.

Moving through the rooms sometimes changed older people's acceptance of what the robot should be able to do. An older person stated they had nothing to hide, but as soon as they entered the toilet and the bathroom, they did not want cameras at all anymore ("No problem if the *latest invention* has cameras and other people can see what the *latest invention* sees, except for the bathroom and toilet, she does not want to be recorded there" (P7)). The Places Cards apparently inspired the interviewee's imagination of the robot actually being there when performing actions like taking a shower. Another example is provided by a case where an interviewee was also saying she had no problems with the robot having cute eyes to make video recordings, which "would be okay" (P8). However, when asked, what if the robot accompanied them everywhere in their home, the older adult objected to the robot coming to the bathroom with them ("I want to go to the bathroom on my own" (P8)), adding "and also when putting on my clothes I don't need a robot[,...] at intimate activities the robot shouldn't be there [...] it should stand in the corner and wait" (P8).

Having ultimate Authority over the Robot

A repeating theme regarding trust was control. The fear of a robot making autonomous decisions in one's home was met with the desire to have the ultimate authority over the robot. For example, an older person said, "one may be afraid that it will become autonomous and then do things that one actually does not want" (P7).

Older adults expressed skepticism regarding the robot's autonomy by indicating it needed a turn-off button ("if I cannot turn off the *latest invention* [... I] will throw it away" (P5)), a reset-button (in case of any erroneous behaviour) or the option to unplug it. Being able to turn off the robot was often a precondition for accepting a robot at all. One person said they would "place the robot in front of the door and lock it out" (P8) if the turn-off button did not work. Very often, the desire of ultimately being in control occurred in relation to privacy or spending money (e.g. "I rather do this myself" (P7)).

For trusting the robot, older people wanted the robot to explain its actions in a transparent way and to be able to communicate clearly ("I don't care about the voice, but it should be understandable" (P9)), because they wanted to be in control of the robot's performances. Control was especially important when it came to the robot spending money ("No, no, I don't want it at all" (P6), when being asked if the robot may be connected to a person's bank account), otherwise they were afraid of being robbed.

Mixed Acceptance of Companionship

While we designed the cards and the procedure of using them with an aspiration to give the *latest invention* a certain degree of agency, the idea of having a quasi-social relationship with a robot was only partly picked up or accepted. While some older adults spoke about companionship with a robot in a quite wishful manner, other interviewees refused this very idea.

The *latest invention* was mostly imagined as being quite social in the course of the conversations. An interviewee said there were moments when technology was not needed such as when somebody was visiting ("when someone is visiting, I don't need this invention anymore anyway, then I am so happy and want to be left alone with my friends and family" (P4)), or when you want to be *alone* ("[there are] moments where you want to be alone" (P3)). Not being alone when the robot is present indicates the robot being perceived social to some extent.

Human-robot companionship was brought up as an alternative to being with other humans, as loneliness turned out to be an issue for some older people (e.g., having "problems with meeting friends because of [my] high age, most friends unfortunately died" (P9)). One interviewer also reported that the People Card "made the interviewee depressed for a moment" (P6). Some older adults discussed how they imagined the robot to be involved in intimate relationships with them, as they wanted a companion to play or talk with ("I would be very pleased to have a playmate to cheer me up" (P7)), or a *latest invention* to discuss with what would be discussed with a partner, or even to "make a massage at the end of the day" (P8) when talking about support in the bedroom.

Scepticism and Limitations of Technology

Scepticism of future technologies and a notion of carefulness was also part of the conversations. On the one hand, older people said they would "not only rely on the robot" (P10) in cases of emergency if the robot was not trustworthy. Further, older adults said they would "first do a trial run for a couple of months" (P4) before actually relying on a *latest invention*. On the other hand, the interviewees anticipated limitations of technology for the future. Besides optimism in certain capacities, e.g. being able to interact via voice commands with technology in the future ("I think technology will then be advanced so it is able to understand me" (P8)), interviewees seemed quite aware of its limitations. This holds for socioeconomic issues like the digital divide ("People who need care nowadays did not grow up with technology" (P10)), and medical issues ("When a person has dementia, the robot will not be able to fix it either" (P7)).

7.5 Discussion

The aim of the work presented in this chapter is to derive aspects that need to be considered to support older adults from a bottom-up approach of designing robots. Doing so, I also addressed some of the challenges presented in Chapter 6. These included the expertise needed to build prototypes which comes with a potential lack of familiarity of older adults' everyday lives, terminology around robots, the need to embed imaginations of robots in people's everyday lives, and older adults' lack of trust. Towards this and, I presented first steps of designing a card-based tool to explore the notion of robots in private homes of older adults, also tackling the terminology around "robots" vs *latest invention*, and using provoking questions to facilitate a shared understanding of older adults' everyday life.

In this section, I discuss the findings for the cards as a tool[6], and subsequently, the implications for supporting older adults with robots, based on the findings of what came out of using the cards in terms of older adults' notions of robots in their private homes.

7.5.1 The Cards as a Tool

The findings show that by laying out the floor plan of the older person's living space, moving the token and drawing the cards, both the interviewers and older people were able to establish a common ground for the discussions, and actively participate in the conversations. Older adults were thus able to express their desires and concerns around having robots in their homes and develop their own responses further as they moved around the home with specific provocations.

The positive effect of the cards is in support of previous research, indicating that such elicitation techniques can facilitate conversations on abstract topics [Barton, 2015] like trust. Furthermore, the findings are in line with previous work showing that visual representations of the homes can facilitate discussions on social dynamics and potential automated technologies in these contexts [Lee and Šabanović, 2013].

The cards as a tool facilitated a detailed and nuanced engagement with the topic of robots and trust on several layers. Older adults were able to realize their own concerns and express them in the conversations, sometimes changing their minds throughout the conversations and exploring the topic from different angles. Interviewees changing their minds is an indicator for deeper reflections and explorations of a topic in diverse ways to uncover nuances. Being able to unpack these nuances is also depending on the skills of an interviewer, indicating this is a powerful tool to conduct interviews. The interviewers further creatively tailored the flow of the conversations, as they reported different strategies of using the cards, such as creating piles of different topics of cards to be more responsive to the conversation flow and to be able to guide these better.

[6]Note, in my published article, I also make suggestions on re-designing the cards, which includes suggestions to add, change or remove single cards, or to use piles during the conversations. I consider this discussion to be out of the scope for this chapter and rather focus on the research questions of this thesis.

Throughout the project, the interviewers learned about the challenges of addressing sensitive topics (such as the ones related to trust) in general and specifically with older adults. As also shown in other work on participatory design of robots with adults by Lee et al. [Lee et al., 2017a] who conducted workshops with robot prototypes, the interviewers were able to learn about domestic environments of older adults' and their experiences, ethical concerns and how they could imagine to use robots. While the cards did not make use of any actual robot prototypes (compared to participatory research by Lee et al. [Lee et al., 2017a] and the work presented in Chapter 6), it is especially light-weight, without substantial efforts and costs, and guiding inexperienced interviewers to learn about older adults' concerns, making this a tool to get to a shared understanding between researchers in multidisciplinary design teams.

Despite the fact that the older adults did not interact with an actual robot in the course of the interviews, they were able to imagine scenarios at specific places in a very detailed manner. This holds for describing the robot as a helper in the household, as well as for issues around privacy, control, understandability, and companionship. Hence the cards may help to develop a story about the robot in domestic environments and in particular day-to-day-lives of older adults, which is an essential part of successful participatory design of unfamiliar artefacts like robots for older people's and for daily lives [Bråthen et al., 2019], and which has been also a challenge identified in Chapter 6. In contrast to the design workshops presented in the previous chapter, older adults were not focused on specific functionalities of a robot and questioning their usefulness, rather being able to express their needs, also towards robots in their homes. Therefore, using provoking questions to tackle the topic of trust showed beneficial when addressing older adults' concerns, even resulting in positive conceptualizations (i.e., what older adults "could" need instead of what they would "not" need).

The challenges regarding the terminology as indicated by previous research [Bartneck, 2004, Sundar et al., 2016] and in Chapter 6 however could not be fully resolved. While some interviewers and older adults found it easier to use the term *robot* in conversations, others were more comfortable using the term *latest invention*. This illustrates the flexibility that is required to actually identify older adults needs in a co-design process. When using such cards in the future, I therefore suggest keeping the term *latest invention* on the token and on the cards as it allows space for both interviewers and the older person to interpret it as make sense within the specific conversational context.

7.5.2 Implications for supporting older Adults with robots

Through the data captured from use of the cards, I also identified detailed and context-specific insights around trust as well as around people's concerns in general as facilitated by having conversations about trust and robots in living spaces, which I will discuss in this subsection.

Unpacking multiple Dimensions of Trust

The analysis points to multiple dimensions of trust that are relevant in the context of the home. Trust played out by using emotional language, referring to sensitive spaces and to privacy, the latter also being discussed in chapters 4, 5, and 6. As described in the findings, communication with the robot, companionship and being in control also turned out to be relevant for trust. Furthermore, trust is connected directly to how older adults relate to places in their living spaces.

Having a robot entering one's personal and intimate space involves exposure of a variety of one's personal activities. When using the cards and co-imagining a robot in personal spaces, the control-aspect raised a lot of concerns in the course of the discussions. According to the model of integrative trust by Mayer et al. [Mayer et al., 1995], trust is defined as a party's willingness to be vulnerable *irrespective of the ability to monitor or control* the other party. With robots however, the desire for control was one of the central themes, which may be the case due to little trust. Udupa et al. [Udupa et al., 2021] also argue that people's immediate desires also need to be taken into account when interacting with a robot in order for people to be in control of it; as user control is also one of the key design criteria found in recent research for AAL systems [Pirzada et al., 2022].

The robot's capabilities (e.g. in housework) and its reliability were also important aspects of trust. This connects to previous literature on trust as reliance [Billings et al., 2012, Hancock et al., 2011], also referring to robot-related cues as one of the three aspects relevant for trust. Furthermore, a definition of interpersonal trust by Mayer et al. [Mayer et al., 1995] defines a trustee's competence as one key element of trust.

However, framing trust as reliance also states that person-related and environment-related cues have an impact on trust (reliance) in robots [Billings et al., 2012, Hancock et al., 2011]. I found that the places in a home can make a difference in how a robot may be perceived, and what design cues people are willing to accept in the course of the conversations. The findings suggest to consider the requirements of different places in a home also when building robots to support older adults in living spaces.

From a sociological point of view [Lewis and Weigert, 1985], the findings further point to notions of trust based on both cognition and affect. The use of emotional language and imaginations of companionship with a robot connects to trust based on affect rather than mere cognition (e.g., knowing about an other party's competence), which may point to potential relationship-building with a robot beyond it being a mere functional tool (e.g. for use in household). Affect-based trust is an emotional dimension of trust next to a cognitive dimension [Lewis and Weigert, 1985]. Previous research investigated traits of a social robot to be aligned with cognitive and affective trust [Gompei and Umemuro, 2018], and this research indicates that these different notions of trust can be revealed also by earlier engagement of inexperienced interviewers with older people's social practices and a light-weight tool like cards. Engaging with people's needs in relation to social robots points to both emotional and cognition-based aspects and hence trust to take into account in the process of participatory design.

Engaging in conversations about trust may be also insightful for the interviewer to learn about older people's social context and how they relate to this context in general. For example, in discussing different levels of acceptance of robots at different places, the interviewers learned about how people may relate differently to places. This also depended on the people being around (e.g., visiting friends or family members), also tackled by the use of a specific card.

Design Considerations for Robots

For many of the findings, I identified mixed and even contradictory results that depended much on the current stage of people's lives (e.g., when imagining the future), whether they were in the company of others and what place in the home they imagined a *latest invention* to be in. Regarding privacy, older adults had different concerns depending on the place in their homes. Different preferences regarding a robot were also discussed depending on whether other people were visiting or whether the older person was alone. These mixed results suggest that there is no *one-size-fits-all solution* possible. I.e., there may be better or worse solutions according to specific people's circumstances and context. In support of the literature, the findings are a call for systems that can be adapted and re-purposed over time [Fitzpatrick et al., 2015], given changing needs and different users being involved in AAL and telecare scenarios in which robots in the home may have a role to play.

I found that older adults are open for practical support by technology in housework. Participants also said they wanted a robot to be able to lift heavy things. Previous research also indicates that trusting robots would be connected to them having practical capabilities like heavy lifting [Stuck and Rogers, 2018]. In contrast to the studies presented in the previous chapters of this thesis, this is a relatively new finding within this thesis. While involving actual robots in Chapter 6 did not yield these insights, a focus on places, daily routines and the everyday life context of older adults showed beneficial in revealing this aspect.

As social contact was a repeating theme that tended to be very important to older adults (which is also in support of chapters 4 and 5), this also needs to be taken into account when designing robots to support older adults. Being able to talk to family members and connect with them for example or making contact with other people when living at home may be crucial features especially when designing for older adults [Ostrowski et al., 2021a]. Therefore, in addition to a robot being companionable (as already suggested by the literature [Stuck and Rogers, 2018]), using robots to connect easily to other people should be a design feature of high priority, along with privacy. While expert users have proposed using robots as social proxies in previous research [Dereshev et al., 2019], the data from older people in our study also support this suggestion based on findings from using the deck of cards. The role of privacy was further discussed in previous research in relation to trust. Where privacy is complex and addressing it may require individual solutions (instead of one-size-fits-all), robots need to be designed to protect the privacy of older adults [Schulz et al., 2018]. Older people need to have an opportunity to negotiate their privacy [Schulz et al., 2018] and further to adapt it [Fitzpatrick et al., 2015].

The desire for companionship and privacy however causes tensions. Designing robots to be companionable in a way that older people are likely to attach to them (e.g., using anthropomorphic design cues) may help them to trust the robot (e.g., when they find a robot particularly cute). For example, people could perceive a robot as needy, and be willing to help it (as we argued elsewhere) [Dobrosovestnova et al., 2022], which can also involve a certain level of exposure. People trusting a robot then can also involve ethical risks [Huber et al., 2016]. Older people explicitly stated that they did not want to be watched at certain places. I therefore argue that it is important to make design decisions in a way that the notion of *being watched* is not obfuscated, e.g. by designing cute eyes, but rather made transparent to older adults. While robots who have the capabilities to process data may be designed as companionable, people's desire for privacy needs to be given a high priority as well when designing for trust.

Control was a repeating theme, and it also represents a call for designing for better communication and the option to turn off technology easily without negative consequences. Certainly, the desire for control may be also tied to a lack of trust. Previous research on HRI in domestic environments however suggests that the higher people's desire was to control a robot, the more autonomously they wanted it to act when performing a cleaning task [Chanseau et al., 2016]. Control is also related to people's technical affinity and aspects like self-efficacy in HRI [Pütten and Bock, 2018, Zafari et al., 2019], as it also requires the knowledge and appropriate expectations to be able to interact with robots. To complement previous work on trust (e.g. [Zafari et al., 2019]), more research needs to be done also with older people and robots around self-efficacy in HRI and control aspects.

7.6 Summary

In this chapter, I explored the design of a deck of elicitation cards as a methodological contribution to address some of the challenges that occur in participatory design for robots in living spaces as identified in Chapter 6. The aim of this card-based tool is a to provide a shared understanding between stakeholders in multidisciplinary design teams, to engage with the topic of trust and with the everyday life context of older adults, and to tackle expectations that are linked to the terminology of robots. The findings then provide a deeper understanding of methodological challenges when designing robots by engaging older adults (RQ2) and how to potentially address these. Specifically, the cards as a methodological tool facilitate conversations about the notion of robots between older adults and researchers, providing a shared understanding and facilitating a basis to express needs towards robots that are directly related to the the everyday life context of older adults. The use of the cards also suggests a high level of flexibility that is needed regarding the terminology (i.e., whether to use a more abstract concept like "*latest invention*" or robot), and that there is no one-size-fits-all for robots in living spaces.

Moreover, the use of the cards as a methodological tool provides trust-related findings that are relevant for understanding how to support older adults. Salient trust-related findings include the participants' desire for control, companionship, privacy, understandability, and location-specific requirements with regards to trust that need to be taken into account when designing to support older adults with robots. The variety of trust-related themes also contributes to deriving main factors for understanding and designing robots to support older adults (RQ), to be discussed in more detail in Chapter 8. Moreover, the extent to which the potential of robots to support older adults is realised is not just a function of technology-specific features, but also how the complex issue of trust is negotiated in the very personal and individual space of the home.

CHAPTER 8

Discussion

8.1 Chapter Overview

The aim of this chapter is to approach the entire work presented on supporting older adults with robots in a critical discussion. To this end, I reflect on the exploratory bottom-up approach of this thesis and the findings of the four case studies, aiming to provide an understanding of long-term experiences with AAL in the field (RQ1) and of methodological challenges when engaging older adults in the design of robots (RQ2). To answer the overarching research question (RQ), I also present main factors for understanding and designing robots to support older adults. These are presented as design considerations, and they include the need to design robots for relatedness in communities, personalization, learning, people's values, and specific places and work.

The overview of this chapter is as follows. I first revisit the entire research idea and approach on aspects to consider for supporting older adults with robots, which is followed by a section on the three contributions: understanding longitudinal experiences of older adults with AAL, methodological challenges when engaging older adults in the design of robots, and design considerations for supporting older adults with robots. I then present a section that is designated to the design considerations, which I also critically reflect on and discuss against the literature. I conclude with a summary of this chapter.

8.2 Revisiting the Research

While robots are often seen promising to respond to some of the problems associated with the ageing population, the actual support of older adults with robots is still undergoing various challenges. The lack of uptake/low adoption rate in current AAL [Pirzada et al., 2022, Haslwanter and Fitzpatrick, 2017] (aiming to support people, but apparently failing to do so if not adopted) can be also anticipated for robots [Dereshev et al., 2019]. The lack of understanding and involvement of complex stakeholders and their needs [Werner et al., 2015, Boyne and Vrijhoef, 2013, Fiorini et al., 2021] (especially beyond primary users [Weiss and Spiel, 2021]) into research and design is one issue here that needs to be further tackled. Older adults use a language of distrust to refer to digitalization [Knowles and Hanson, 2018], which can be interpreted as not being able to relate to the process of digital transformation (including the development of robots), e.g., by contributing to it. Where stakeholders have been involved [Boyne and Vrijhoef, 2013, Fiorini et al., 2021], there is still a lack of understanding of relational qualities between them (i.e., going beyond the understanding of individual needs of multiple stakeholders in a socio-technical context), their values, and in everyday (work) practices [Carros et al., 2022] that facilitate these values and relational qualities. Clearly, the relevant stakeholders also include researchers who eventually conduct (participatory) design research with older adults and their care networks (working in multidisciplinary teams [Šabanović et al., 2007]), where they step into a relationship with older adults, e.g., aiming to learn from their contextual knowledge [Lee et al., 2017a, Šabanović et al., 2015]. Given there is a great body of HRI research that has focused on designing solutions in a top-down manner, I am interested in the in-situ experiences of older adults in various types of living spaces (including care workers' perspectives) to draw out relational qualities, values and work practices, learning from the longitudinal usage of off-the-shelf assistive technologies; and in engaging with participatory design, learning from current challenges addressing these, also providing a contextual understanding of older adults' perspectives. Hence the main research question of this thesis is:

What are the main factors for understanding and designing robots to support older adults?

An answer to this question is developed through two sub-questions. The first question aimed at investigating longitudinal experiences with off-the-shelf technologies, answering the question: *RQ1: How do older adults and their care networks experience the use of AAL systems in private homes and in institutional care homes?* The second question aimed at exploring the design of robots, answering: *RQ2: What are current methodological challenges for engaging older adults in the design of robots?*

In order to answer the research questions, I presented four case studies in the previous chapters. Mainly, RQ1 is answered by conducting two case studies that involve longitudinal experiences of older adults (CS1 and 2) and care workers (CS2) of their use of current AAL technologies in private homes and in care homes, providing insights around the context of assistive technology in living spaces. Here, various stakeholders have been interviewed, including predominantly older adults and care workers. They provide insights on longitudinal experiences with AAL systems that are already on the market; however, not yet engaging with actual robots[1]. RQ2, then, is answered by conducting two further case studies that tackle the topic of participatory design for robots in living spaces.

[1]Note, what constitutes a robot is not clear cut; robots are often characterized as embodied agents [Feil-Seifer and Matarić, 2009]; and they are also treated as separate entity in academic disciplines, see e.g. `https://humanrobotinteraction.org`.

After an investigation of methodological challenges that can arise when co-designing robots in CS3, I presented a tool to co-imagine robots in qualitative interviews (CS4) to further explore and address some of the challenges identified.

In the following, I present the main contributions of this thesis, also starting to discuss the findings against each other and the literature.

8.3 Contributions of this Thesis

I present the three main contributions of this thesis from across the four research studies. The contributions include (1) understanding longitudinal experiences with current AAL, (2) understanding and addressing methodological challenges when engaging older adults in the design of robots, and, as a subsequent step, (3) design considerations for supporting older adults with robots. The first two contributions are discussed mainly in reference to the respective case study chapters and the literature, also being a foundation for a more in-depth discussion in the subsequent section on the design considerations.

8.3.1 Understanding longitudinal Experiences with AAL in the Field

So far, robots have been treated as a separate entity compared to other technology in research[2], where this thesis demonstrates opportunities for lessons learned from investigating the use of off-the-shelf AAL systems for robots in the field, taking an exploratory bottom-up approach. The aim of this approach is also to avoid challenges in the uptake of current AAL systems (e.g., a low adoption rate [Haslwanter and Fitzpatrick, 2017, Pirzada et al., 2022]), which can be also anticipated for robots (cf. [Dereshev et al., 2019]) when taking traditional top-down approaches.

As older adults are a complex group of people [Fiorini et al., 2021] with different needs that are also represented in diverse and even changing living spaces, long-term studies in private homes (with older adults living more independently) and in care homes (also involving care workers) were presented. While previous long-term studies with robots in living spaces have however focused on attitudes and relationship-building typically between one person and one robot [Bajones et al., 2018, de Graaf et al., 2015, de Graaf et al., 2017], this work extends the unit of analysis to other actors in a socio-technical network (where relevant actors were identified through an exploratory bottom-up approach). These observations with AAL in the field provide an important lesson learned for HRI, as they allow a framing of HRI beyond the mere dyadic, as increasingly proposed in recent HRI research [Schneiders, 2022, Schneiders et al., 2022, Hornecker et al., 2020, Schwaninger et al., 2019, Sebo et al., 2020]. The work also adds to the discussion of extending the unit of analysis in HCI (from the individual e.g. to shared everyday practices [Entwistle et al., 2015]), moving from interactional research to practice research [Kuutti and Bannon, 2014]. The work also extends research that has focused on mere stakeholders' perspectives or attitudes towards robots, e.g., [Pan and Pan, 2020, Zhong et al., 2022], as it provides a

[2] cf. `https://humanrobotinteraction.org`

perspective on relationships between older adults and other actors, also foregrounding relationships which robots could be part of if adopted.

To shed light on relationships in care networks, in Chapter 4, a socio-technical understanding of relatedness needs (a key concept of Self-Determination Theory (SDT) [Ryan and Deci, 2000]) was developed from a bottom-up approach. Here, I unpacked multiple forms of relatedness in a care network [Schwaninger et al., 2020]. The need for relatedness also showed relevant at the time of the pandemic, where care workers initiated the use of CT to facilitate connectedness (a key aspect of relatedness [Ryan and Deci, 2000]) of older adults [Schwaninger et al., 2022]. This specific focus on relatedness needs in a network is new in HRI, especially when linking these observations with HRI research. Connectedness has been studied between people and social robots [Dereshev et al., 2019, Koyama et al., 2017], or as interpersonal, however, not taking a holistic perspective focusing on entire care networks [Schwaninger et al., 2020], and the work that is actually taken to promote connectedness by older adults or care workers [Schwaninger et al., 2022]. While previous research has emphasized the dynamic coordination of affect in order to achieve a shared understanding of emotions as part of an interactive process between actors [Jung et al., 2017], this work is in support in the way that it emphasizes how value promotion (e.g., connectedness or autonomy) is actively and dynamically achieved via work practices rather than a reflection of individual states.

A relatedness lens (as well as a socio-technical lens more generally) can be a starting point to identify relevant actors in a care network in HRI, their relationships with each other, and how these actors and relationships can provide resources within a community [Joshi, 2019] to support older adults. In support of community-centered approaches to HRI, it is critical to recognize the potential role of robots to promote intergenerational interactions between people [Joshi and Šabanović, 2019, Schwaninger et al., 2020, Schwaninger et al., 2022], and communities as a social unit for interacting with robots [Joshi, 2019]. In the studies presented, members of the community were involved to promote connectedness, including people and resources from the project, researchers, peers, or friends (Chapter 4); institutions, care workers, family members, and residents, and an interplay of these actors (Chapter 5). Taking into account living spaces and resources in social configurations there (e.g., project resources such as meet-ups and available skills, care workers, technology, political agenda requirements etc.), socio-technical infrastructures also need to be designed for (and with) communities (e.g. [Dillahunt et al., 2022, Greig et al., 2019, Lee et al., 2012]).

In contrast to dyadic HRI research, understanding experiences with AAL in the field also shows how the usage of commercially available devices is also a collaborative process, where various people have an impact on the usage (e.g., when, what and how systems are used, c.f. Chapter 4 and 5). Previous HRI research has already emphasized the need to study robots in groups and teams [Sebo et al., 2020, Jung et al., 2017], also demonstrating that robots can change group dynamics [Sebo et al., 2020] and moderate team conflicts [Jung et al., 2015]. This work has identified relevant members of groups and (care) communities bottom-up (i.e., not formed by researchers), and subsequently, their collaborative practices of using technology in diverse living spaces. In institutional settings, care workers were the ones who initiated the usage of CT, where video conferencing tools were used in a triune [Schwaninger et al., 2022]. Here, openness to engage with new systems depended on institutional, worker, and residents' requirements and on the actual availability of the devices (cf. Chapter 5), where all parties need to work together in order for devices to be adopted. CT usage also had a significant impact on work practices [Schwaninger et al., 2022], which is essential to take into account also for the adoption process of robots, as already demonstrated in institutional care settings [Carros et al., 2022].

Exploring experiences with off-the-shelf AAL also provided contextual knowledge [Lee et al., 2022] (independent of the kind of technology), which provides lessons learned for understanding and designing robots. Relevant contextual knowledge includes values of older people (e.g., self-determination needs, or learning [Schwaninger et al., 2020, Schwaninger et al., 2022]); experiences of the pandemic triggering technology usage, which may be a potential entry point for robots[3]; the role of communities and resources within communities [Joshi and Šabanović, 2019, Joshi, 2019]; and the impact of technology usage on communities that is also associated with changing work practices [Schwaninger et al., 2022, Carros et al., 2022]. However, older adults in particular also expressed skepticism towards the idea of robots in private homes, where anxiety of robots is also known from the literature [de Graaf and Allouch, 2013]. Hence there is a need to conduct studies with actual robots and their design, which leads me to the second set of contributions in the following.

8.3.2 Understanding & addressing Challenges when co-designing Robots

It is often argued that robots offer specific functionalities also due to their embodiment[4], and potentially their autonomy[5]. Because experiences with robots can also change people's attitudes and anxieties towards them [de Graaf and Allouch, 2013], it is also important to conduct studies with older adults and actual robots. A user-driven way of doing this that has been increasingly proposed in HRI recently is through participatory design (PD) [Lee et al., 2017a, Bråthen et al., 2019, Weiss et al., 2015]. However, HRI per se comes with challenges that are also linked to disciplinary boundaries [Šabanović et al., 2007, Weiss, 2012], which is also the case for collaboration in PD processes [Fitzpatrick and Malmborg, 2018], and in HRI teams conducting participatory research.

[3] As discussed in Chapter 5, experiences of the pandemic and factors like the impetus of digital literacy could provide an entry point of robots, once these are either technically ready, or people see them as tools to use and make meaning of (which may be even a key part of this readiness aspect).

[4] Embodiment can be referred to the notion of having a physical body [Fischer et al., 2012, Toscano et al., 2022], often also leveraging social cues [Ostrowski et al., 2021b]

[5] An agent, like the robot, can be defined as "an object or technology that people interact with as if it is able to act with its own purposes, motivations, and intentions" (`http://hai-conference.net/what-is-hai/`, online, last accessed: 1 March 2022).

This thesis contributes to the literature with unpacking some of the current methodological challenges with PD for robots (cf. Chapter 6), and by subsequently addressing them with a tool to co-imagine robots in living spaces using elicitation cards [Schwaninger et al., 2021]. Critical reflections on design practices are understudied in HRI [Lupetti et al., 2021], despite being a term used for several years[6]. Furthermore, while there was a wide range of conceptualizations of "humans" identified that are involved in HRI research (e.g., humans as generalizable nature, as users, or as social actors [Lee et al., 2022]), there is also work needed taking into account researchers' roles in projects more specifically, especially as researchers could be seen as extended care networks of older adults in long-term studies/projects (cf. Chapter 4).

PD challenges that were identified include expectation management and terminology around robots from the perspective of older adults and of stakeholders working in multidisciplinary HRI teams (cf. [Šabanović et al., 2007, Huber et al., 2014, Weiss and Spiel, 2021]). As the term "robot" can skew older adults' expectations, it needs to be used with caution at ideation stages [Schwaninger et al., 2021]. Pre-conceptions towards robots (including the terminology) make these technologies harder to integrate in care services than other assistive technology [Johansson-Pajala and Gustafsson, 2022]. Among stakeholders in HRI teams, a key challenge is also the need for grounding, and knowledge transfer (c.f. [Vincze et al., 2014]). A specific challenge here is also that researchers (e.g. engineers) need an understanding older adults' everyday life on one hand, where building prototypes in the co-design process requires solid technical skills on the other hand (cf. Chapter 6). In the process of people working together from across disciplines, it is also necessary to negotiate individual and shared goals, where a moderator could be useful (cf. Chapter 6).

To address the challenges of robot terminology and knowledge transfer in HRI teams, a methodological tool was presented for engineers to engage in playful conversations with older adults and to get a feeling of their everyday life at ideation stages [Schwaninger et al., 2021]. This also contributes to the methodological repertoire in HRI to engage older adults in the PD process for assistive robots [Šabanović et al., 2015]. The tool has been designed iteratively, aiming to provide contextual knowledge [Lee et al., 2022] to engineers, such as a context of space, people at home, everyday routines, and provoking questions to reflect on (tackling the topic of trust) [Schwaninger et al., 2019]; where provocations in HRI can be used to promote critical thinking [Lupetti and Van Mechelen, 2022]; and subsequently, to co-imagine (robot) support in living spaces [Schwaninger et al., 2021]. The usage of the cards fostered mutual learning between researchers/engineers and older adults [Lee et al., 2017a, Šabanović et al., 2015, Paluch and Müller, 2022]. As humans (such as older adults) mostly have a passive role in HRI research, the elicitation tool contributes to conceptualizing older adults as more active agents, as potential collaborators of researchers, contributing with their specific knowledge of their everyday life [Lee et al.,

[6] Previously, design approaches in HRI have focused on robot design (e.g., morphology, behavioral cues or paradigms, or robot appearances), interaction design (e.g., including a focus on enhancing interaction experiences through the design robots), and design outcomes for robots of studies involving design approaches [Lupetti et al., 2021].

2022] (also responding to one of the motivations of older adults participating in the study in Chapter 4, namely to contribute to research and development). Throughout the conversations stimulated by provoking scenarios, people also created stories around opportunities for robots, which is an essential element in PD for robots [Bråthen et al., 2019, Ostrowski et al., 2021a, Šabanović et al., 2015].

Engaging older adults in the design of robots also provided a contribution to trust research in HRI. Older adults' privacy concerns throughout the studies and the fact that many people rejected the very idea of a robot in their private homes [Schwaninger et al., 2020] also provided an opportunity to use *inverted* trust as a door-opener to engage in conversations with older adults [Schwaninger et al., 2021]. Previously, there have been few studies taking into account what constitutes trust in everyday life and in relation to robots there [Schwaninger et al., 2019], mainly studying trust through a dyadic lens, and/or in controlled environments [Martelaro et al., 2016, Law, 2020, Correia et al., 2021]. Situated trust aspects that were discussed using the elicitation cards included understandability (cf. [Stange and Kopp, 2020]), companionship, control, and privacy. In the co-imagination process, older adults considered robots to be beneficial when providing support in housework, like cleaning assistants (cf. [Beer et al., 2012, Kraus et al., 2022]), as potential companions or friends (cf. [Šabanović et al., 2015, Breazeal, 2011, Dautenhahn et al., 2005]), as helpers (cf. [Dautenhahn et al., 2005]), or for monitoring [Schwaninger et al., 2021]. The robot conceptualizations and trust topics are all of current relevance in HRI (e.g., [Stange and Kopp, 2020, Šabanović et al., 2015, Udupa et al., 2021, Bhattacharjee et al., 2020, Schadenberg et al., 2021, De Graaf et al., 2021], making this a light-weight tool compared to involving actual robots, and the costs that come with it. Privacy has been also strongly bound to specific places of the home [Schwaninger et al., 2021], which is a new perspective to trust research in HRI. When co-designing robots, space-related requirements need to be specified in order to build trustworthy robots.

8.3.3 Design Considerations for supporting older Adults with Robots

Main factors to consider for understanding and designing robots to support older adults with robots are also a key part of this chapter. They are presented as design considerations and they are one of the three main contributions of this thesis. Given the key role of these design considerations in the thesis, they will be presented in an own section below.

8.4 Design Considerations

The design considerations aim to tackle several of the challenges that were identified in this thesis, being actionable points to take into account for supporting older adults with robots and HRI. They include the need to design robots for relatedness in communities, personalization, learning, values, and specific places and work. I elaborate on these in more detail in the following.

8.4.1 Design Robots for Relatedness in Communities

A socio-technical lens can help to identify actors and relationships that are crucial for how technology is integrated into a socio-cultural context, i.e., as part of these relationships. While it is important to design for the needs of older adults and their social (support) network [Wherton et al., 2015], and consequently, for communities [Joshi, 2019, Joshi and Šabanović, 2019] (instead of individuals), it is also crucial to design robots as interwoven in (e.g., intergenerational [Joshi and Šabanović, 2019]) relationships. Trust relationships could be designed for this way, as trust in technology has been also influenced by people *behind* the technology [Schwaninger et al., 2020, Vaziri, 2018]. Given that CT has been also used to promote relatedness needs between people, I see a potential for robots to even enhance experiences of (remote) human-human interaction, e.g., inspired by Empathic Computing [Billinghurst, 2021]; or, if very carefully (and holistically) designed (e.g., ensuring actual connectedness with communities, not reinforcing isolation of older adults), via telepresence robots [Fitter et al., 2020]. Other specific use cases are that robots that could mediate groups of people to promote wellbeing, such as when conducting physical exercises [Baldursson et al., 2021]; or that social robots are used for playful activities in families [Kim et al., 2022].

Reciprocity (a key part of relatedness [Schwaninger et al., 2020]) between various stakeholders should be designed for on several levels. In human-robot relationships, this could be designed for e.g., through an approach that was a key part of the robot Hobbit [Lammer et al., 2014, Bajones et al., 2018], where older adults were intentionally thought of as helping the robot whenever it was not able to achieve a goal on its own; also aiming to promote older adults' activity [Lammer et al., 2014]. A robot's embodiment (i.e., designed through socially contingent movements, and social cues that can be verbal or non-verbal [Ostrowski et al., 2021b]) has been also found a crucial factor for people to engage reciprocally with voice user interfaces, both individually and in groups [Ostrowski et al., 2021b]. Robots could be also used for people to engage in reciprocal relationships with other people, e.g., for help or care [Schwaninger et al., 2020]. Last but not least, while older adults also talked about support from institutions and society in Chapter 4, they also wanted to contribute to society, making the reciprocal aspect important also on a broader societal level, which should be designed for e.g., as part of research projects or elder care in general.

As part of the community aspect, the usage of a robot can be further collaborative, with various people (such as care workers, residents, and family members [Schwaninger et al., 2022]) working together in putting a robot to work. The motivation of peers or family can also affect the adoption by older adults [Pirzada et al., 2022]. An implication is that one robot can have multiple users [Schneiders et al., 2022] (e.g., one or more older people, and a care worker [Carros et al., 2020]; or families [Kim et al., 2022]). Therefore, it is very crucial that various stakeholders also engage in the design process of robots and the surrounding scenarios. While studies with robots in groups often focus on group settings with multiple participants [Claure and Jung, 2021, Jung et al., 2017], a future direction is to engage several user groups into the design process, such as people who represent older adults, workers in care domains and organizations that have a say in care processes, such as health insurance companies. The design process then needs to focus on collaborative aspects of the usage, also designing working relationships between the stakeholders.

8.4.2 Design for Personalization and Adaptation

While users in general are associated with different roles and relationships in an (organizational) setting [Crabtree, 2003], older adults, often seen as primary (target) users (and who are often in the focus of engaging users in HRI research (cf. [Weiss and Spiel, 2021])), are also a heterogeneous group of people. This would be hard to tackle with a single or one-size-fits-all solution, or even extending a singe device with capabilities. Hence there is an opportunity for personalization [Pirzada et al., 2022] and adaptation [Del Duchetto et al., 2020, De Carolis et al., 2020, Rossi et al., 2017] for AI algorithms and robots. On a functional level, there are opportunities for personalization in the degree of complexity of navigating with systems (cf. Chapter 4 and [Wang et al., 2019]), logging in (cf. Chapter 4), font size (cf. 6), content (cf. [Schwaninger et al., 2020]), and physical challenges (cf. Chapter 7 and [Wang et al., 2019]). Personalized applications of robots to be used in institutional settings should be also offered, depending on external conditions (e.g., hygiene rules) and specific target needs (e.g, entertainment features) (cf. [Carros et al., 2022]).

Personalization is especially relevant for long-term interaction and relationship building of people with robots [Irfan et al., 2019, Irfan et al., 2020], potentially enhancing motivation of engaging in repetitive tasks (e.g., in the context of neuro-rehabilitation [Irfan et al., 2021]). On this relational level, personalization is argued to be important when robots provide communication or even companionship [Breazeal, 2011] (e.g., via a robot's embodiment [Ostrowski et al., 2021b]), or when providing emotional or sexual assistance, seeing relatedness, community, and intimacy have shown important [Schwaninger et al., 2020, Schwaninger et al., 2021]. For a robot to be perceived as sociable, a combination of a robot's embodiment (i.e., the notion of having a physical body [Fischer et al., 2012, Toscano et al., 2022]) and movement are however important in domestic environments [Toscano et al., 2022], which could be also personalized.

There are also opportunities for personalization and adaptation regarding social environments. This includes adaptive behavior of a robot depending on social scenarios, e.g., the degree to which a robot is or acts companionable might differ depending on whether and how many people are in a room [Schwaninger et al., 2021, Rosenthal-von der Pütten et al., 2020]. Here, previous work has proposed a model to learn appropriate robot approaches taking into account social scenarios, and depending on a group score [Gao et al., 2019]; where it is also important to investigate requirements in case *no* people are around. In the case of family-robot interaction scenarios, a robot may need to recognize voices of family members involved, and respond to them in an appropriate way [Kim et al., 2022]. As people may have different input preferences of a robot (e.g., regarding voice control or web control), depending on whether a task is performed individually or socially [Bhattacharjee et al., 2020], such input modalities could be also adaptable for assistive robots at home, providing less interference [Rossi et al., 2018] of interpersonal/social interactions or activities. A challenge is also that the social formations in domestic environments can change. Here, previous work has suggested to identify, enroll, and adapt to new people/unknown users (e.g., using multi-modal incremental user recognition approaches [Irfan et al., 2021]), especially when designing for longer-term interactions with robots.

Personalization and adaptation requires data collection, as a robot could be expected to have some degree of memory [De Carolis et al., 2020], or to detect people [Rossi et al., 2017]. Given privacy has been a key topic throughout the studies, there is then also a potential for privacy adaptations (cf. Chapter 7 and [Fitzpatrick et al., 2015]), especially given that people may have changing needs over time [Kubota et al., 2020], and there could be several users for a system (i.e., simultaneous usage, e.g., in groups [Ostrowski et al., 2021b], changing users at different points of time, or, as shown in the case of end-user programming (EUP), in the configuration process [Kubota et al., 2020]). The data collected needs to be stored safely, as little as necessary, and deletable, which needs to be easy to achieve and by default (e.g., no opt-out). Further, to ensure privacy and safety of people [Udupa et al., 2021], robots need to be adapted within space [Rossi et al., 2017], and specifically, they need to adapt to different levels of intimacy at places in a home [Schwaninger et al., 2021]. This could be also done e.g. via re-embodiment of agents [Luria et al., 2019, Reig et al., 2020]; where these spacial adaptations can come with challenges regarding privacy and perceived privacy, too, as in the case of re-embodiment, data needs to be transferred from one embodiment to the other [Reig et al., 2020].

Personalization of a robot can be either acquired autonomously by a robot, or through user input [Schadenberg et al., 2021, van Waveren et al., 2022]. The more autonomous a robot, the less people are in control of it [Bhattacharjee et al., 2020]; and the more input people give, the more they can be in control [Schadenberg et al., 2021]. User control is also one of the key design criteria found in recent research for AAL systems [Pirzada et al., 2022], where people's immediate desires also need to be accounted for in order for people to be in control of it [Udupa et al., 2021]. By acquiring user input (e.g., [Bobu et al., 2021]), older adults could have more choice on the content, features, physical aspects, or privacy. To ensure that people are actually able to be in control, EUP could be promising if carefully designed, e.g., using higher-level specifications, and being correct-by-default (also to avoid bugs) [Kubota et al., 2020].

8.4.3 Design for Learning

Learning and improving digital skills showed important on an individual level, concerning both adults and care workers [Johansson-Pajala and Gustafsson, 2022]; and on a social level, where learning was also a key part of the social meet-ups of projects [Schwaninger et al., 2021]. An option might be to promote learning as an activity for older people once they are retired. Here, a robot could be use to enhance people's self-efficacy [Rodrigues et al., 2021a, Pütten and Bock, 2018]), focusing on growth and communion (instead of mere goal-oriented approaches) [Zafari et al., 2019]. Robots could be also used and actively configured by older adults, as in the case of carrier robots, promoting people's agency on one hand, and connectedness to other people on the other [Simão et al., 2020]. Here, it is also promising to design for learning environments [Edmondson, 1999] that are safe [Schadenberg et al., 2021], i.e., a space where failing becomes a learning experience [Norman, 2013] and/or where team learning is improved by sharing information, talking about failures or asking for help [Edmondson, 1999].

Mutual learning between older adults and researchers [Lee et al., 2017a, Šabanović et al., 2015] (including trust relationships [Björling and Rose, 2019]) should be designed for in the process of field research, also as such collaborative approaches to HRI research practices can help to envision new potentials for interventions and/or novel types of robots [Lee et al., 2022]. In long-term projects, researchers could also be regarded as part of the extended socio-technical network or the extended care network of older adults. (cf. Chapter 4). On a project level, it is then important to build structures of trust/support that also sustain after projects end. Regular meet-ups can be also taken as a consideration for projects with robots, as activities around participating in research projects can also promote self-determination needs [Safari et al., 2022], including autonomy, competence, relatedness [Ryan and Deci, 2012], which nevertheless need to be sustained after projects end.

The different basic understandings of research (cf. Chapter 3) in multidisciplinary HRI teams [Weiss, 2012] can come with opportunities for learning. Sabanovic et.al. (2007) also argue that social robotics is a "hybrid knowledge space" [Šabanović et al., 2007], where interaction and collaboration among a large number of different disciplines is necessary. The differences in conceptual frameworks, methodological approaches, and daily work practices [Šabanović et al., 2007] may require tools to facilitate a shared understanding, such as around terminology, collaborative work practices [Axelsson et al., 2021], needs of end users [Holtzblatt and Beyer, 2016, Schwaninger et al., 2021], and for knowledge transfer [Vincze et al., 2014].

Learning is open-ended, where the outcome cannot be always anticipated. One way of remaining open about what a solution (which may or may not include a robot) can actually become (cf. also [Rittel and Webber, 1973]) is to avoid terminology (e.g., "robot" [Schwaninger et al., 2021, Johansson-Pajala and Gustafsson, 2022]) that carries specific narratives [Weiss and Spiel, 2021] . In contrast to this openness/flexibility, research projects often require very early decisions on what is being designed or developed (e.g., a zoomorphic robot of a certain size that comes with a set of pre-defined behavioral cues). Further, given that the design of an artefact is only *fully* accomplished (if ever) through the adoption and usage [Stolterman, 2021], and over time, robots can change people's needs, their desires and practices [Stolterman, 2021, Botero and Hyysalo, 2013, Williams, 2021]. E.g., owners of robots expressed fewer privacy concerns than non-owners in recent research [Reinhardt et al., 2021]. This evolutionary process also requires co-design approaches for robot-supported interventions that could extend after a robot is on the market [Botero and Hyysalo, 2013], making them more sustainable.

8.4.4 Consider People's Values for the Design of Robots

Across the studies, I identified values of stakeholders, including older adults and people working in multidisciplinary HRI teams. In the studies in private homes and care homes, the importance of autonomy (a multi-faceted concept [Calvo and Peters, 2014]) for older adults became apparent (cf. [Güldenpfennig et al., 2019, Hornung et al., 2016]). In the study in private households, people were eager to live independently in the present or future [Schwaninger et al., 2020], which may however require engagement with very situated needs and solutions that support on smaller levels [Hornung et al., 2016]. In Chapter 5, I discussed new dependencies via technology usage, also due to the circumstances of changing interaction and communication during the pandemic. Here, it is important to design robots not to undermine older adults' autonomy but to promote it [Bratteteig et al., 2020], as even the use of tablets entailed dependencies, potentially challenging older adults' autonomy. When envisioning robots in people's living spaces, control also appeared important [Schwaninger et al., 2020, Schwaninger et al., 2021], and it has been negotiated in relation to loss of control through robots [Schwaninger et al., 2021, Frennert, 2016].

As discussed especially in Chapter 4, 5, and to some extent in Chapter 7, social connectedness (a key part of relatedness [Ryan and Deci, 2000]) has been an important value. I identified social connectedness as crucial throughout participating in research projects for participants, i.e., when engaging with other participants, researchers, and to use technology in order to connect [Schwaninger et al., 2020]. In Chapter 5, it became clear that social connectedness is a need of older people (as of other people too), however, when social contact has been restricted, the care workers took over to promote this need. In the literature, there has been also an ongoing discussion how technology could mediate a sense of interpersonal connectedness [Culén et al., 2019, Calvo and Peters, 2017].

Most notably, older adults raised privacy concerns across the studies (cf. [Reinhardt et al., 2021, Ostrowski et al., 2019]). A possible candidate approach of addressing this issue is *Privacy by Design*, which involves important principles for information privacy, including, e.g., privacy as the default setting [Cavoukian, 2012], which should be implemented for various functionalities, e.g. [Rodrigues et al., 2021b]. In addition to privacy-sensitive robotics [Rueben et al., 2017] and policies required about data ownership [Pirzada et al., 2022], however, one also needs to consider what people *perceive* as privacy enhancing/preserving. In Chapter 4, older adults raised concerns about privacy violations without actually experiencing these with the systems. In addition to privacy enhancing technologies (e.g., a voice assistant that runs offline [Bermuth et al., 2022]), therefore, technology literacy is also of key relevance (the latter also discussed by Wang et al. [Wang et al., 2019]). There is a need to build awareness about privacy measures to increase trust, such as by being proactively transparent in how data is collected and stored, providing specific reports on data collected [Rodrigues et al., 2022]. Even if systems provided an explanation to people stating that systems are not actually intrusive, for example, people need to be able to understand them.

Value tensions are important to consider, as people may need to negotiate contradictions, and as they can come with design trade-offs. Regarding the potential tension between a robot being companionable and in promoting privacy (cf. Chapter 7), a cute (companionable) robot can lead to emotional attachment of people [Lacey and Caudwell, 2019], and/or deceptions [Winkle et al., 2021]. Therefore, regulations about information disclosure are required, especially as people may disclose information to a cute robot which may go against their long-term goals (e.g., privacy) [Lacey and Caudwell, 2019]. There was also negotiation between privacy and safety, with associations of AAL as of surveillance vs. potentially enhancing physical safety. Further, promoting social connectedness via CT in care contexts required assistance, which entailed dependency relations between care workers and residents, and potentially, information disclosure (cf. Chapter 5). Autonomy and connectedness need to be carefully balanced, as promoting one need could diminish the promotion of the other one.

While certain values are likely to persist, other needs could change over time. While both older adults' and the HRI context are very dynamic (e.g., with regards to technical readiness or digital competence), a focus on values and psychological needs is more sustainable, such as the need for autonomy or social connectedness [Ryan and Deci, 2017]. Also, while older adults' need for competence (cf. Chapter 4) as such may not change (cf. [Ryan and Deci, 2017]), their digital competence is likely to change in future generations of older adults. Opportunities to address such (sustainable) needs also need to be re-evaluated as technical readiness changes.

Given the crucial role of researchers [Randall et al., 2007], it is certainly important to also consider the values of research teams [Weiss and Spiel, 2021] and/or designers [Calvo and Peters, 2014] and roboticists [Cheon and Su, 2016, Šabanović, 2014, Weiss and Spiel, 2021]. Especially with dominant views of ageism, there is a risk of carrying a stigmatizing view of older adults as being lonely or in need of care [Neven, 2010]. While key applications of AAL are the promotion of health [Blackman et al., 2016], what appeared in Chapter 4 is that participants did not want to be stigmatized as "older" or in need of care (cf. [Neven, 2010]). People also participated to remain active and independent in the first place, to learn, contribute, and to help other people [Schwaninger et al., 2020]. A promising way to tackle this challenge (and to promote aging literacy among researchers [Ostrowski et al., 2021a]) is the use of methods that entail mutual learning. By conducting interviews, researchers can learn from older adults' contextual knowledge, where older adults can reflect and learn in this process [Schwaninger et al., 2021]. Further, participatory design research for robots has also focused on mutual learning [Lee et al., 2017a, Šabanović et al., 2015], such as via elicitation tools [Schwaninger et al., 2021], or in combination with storytelling [Ostrowski et al., 2021a].

8.4.5 Design for specific Places and Work Practices

Technology in private spaces can be perceived as intrusive [Blackman et al., 2016], and if people adopt assistive technology, they are also likely to change their habits, beliefs [Williams, 2021], and relationships. On a practical level, automation in domestic environments may require technical or spacial configurations, and additional tasks to be completed [Verne, 2020]. A companionable robot can change (social) habits; and so do social meet-ups associated with activities to support the uptake [Schwaninger et al., 2020], which may lead to new routines, and potential demands to enhance digital competence [Verne, 2020].

A substantial impact of robots in everyday life is also the one on everyday work of (care) workers (cf. also [Bratteteig and Eide, 2017, Ljungblad et al., 2021]), where the impact on work practices needs to be designed for. While HRI research has studied interactions between people and robots, a focus on work practices (also surrounding robots) can shed light on the work that concerns e.g. configuration work, safety measures, or regulatory aspects (cf. [Ljungblad et al., 2021]). New work tasks can lead to unanticipated work or cognitive demands, and therefore, a rejection of robots [Verne, 2020]. To not interfere with care work, robots should not distract people, even while performing non-interactive tasks [Rossi et al., 2018] (such as approaching a care worker); nor should they distract older adults at home and provide discomfort [Raggioli and Rossi, 2020]. Also, while care workers were acting as moderators for CT in Chapter 5 which involved hidden work (cf. [Procter et al., 2018]), workers are unlikely to be prepared to support a higher number of residents using CT, as the workload had already increased. Despite perceived benefits of social robots in care work, the usage can involve mental stress and unexpected physical demands of workers [Carros et al., 2022]. Spatial configurations need to be also designed for at the work place (e.g., including lifts and/or accessible floors).

Work roles also need to be designed, as new roles can emerge throughout the adoption process. While HRI research has considered potential roles of robots in society [Luria et al., 2020, Dautenhahn, 2003] or in groups [Sebo et al., 2020], also foregrounding the need for *care robots* [Stuck and Rogers, 2018] (i.e., based on human care workers), human roles that come with the adoption are to my knowledge not explicitly considered in HRI research. In Chapter 5, care workers acted as moderators [Lahtiranta, 2017], a known scenario of deploying robots in institutional care settings [Carros et al., 2022, Carros et al., 2020]; and the task of humans helping robots [Lammer et al., 2014] may eventually lead to new roles. It is important to design for *desired* (work) roles, foregrounding a need for worker-centered design. This could include debates about working conditions, “good jobs”, and regulatory structures [Fox et al., 2020], also accounting for the wellbeing of workers.

8.5 Limitations

As in every research, there are limitations that need to be discussed and critically reflected on.

First of all, while this thesis demonstrates experiences and lessons learned from the usage of current AAL systems, the systems that were actually part of the studies are rather simple, and with limited assistive functionalities. However, the fact that the technologies (or very similar ones) were also commercially available provided an opportunity to engage with aspects other than only the systems per se, such as values or psychological needs. As people's attitudes, anxieties, and mental models towards robots can change after people actually interacted with a robot [de Graaf and Allouch, 2013, Paetzel et al., 2020], there is certainly a need to conduct longitudinal studies with actual robots, which could result in other/additional factors for understanding and designing robots to support older adults. As stated in Chapter 1, I had a collaboration planned to conduct a longitudinal study with a robot at a care home as a final study of this thesis. Due to the pandemic and restrictions however, this was possible only to a limited extent, with delays, and without me as a PhD researcher being able to travel to conduct the study on-site. This required substantial re-structuring of the thesis and research approach and questions, and it resulted in the study on how the pandemic itself has triggered technology usage in care contexts (Chapter 5).

There are certainly limitations to reflect on regarding the older adults and care workers as participants. Given that participating in a study is voluntary, it is likely to work with people who do at least have some connection or positive attitude towards technology, and likely, a certain socio-economic status. Older adults who tend to participate in research projects are among the most motivated and "healthy" ones, which provides a limited overview of the actual group [Tournier, 2020]. This limitation has been also expressed by participants of the study presented in Chapter 4, sometimes not even considering themselves as the "target group" of such devices (also found in previous HRI studies [Frennert et al., 2013b]). Older adults with various health conditions, including dementia, for example, certainly require other methods for engagement, and perhaps personalized solutions [Alves et al., 2019]. Working with other (sub-)groups of older adults is also likely to provide a different understanding of their experiences, and subsequently, this provides an opportunity for extending the main factors to consider for understanding and designing robots as presented here.

The residents in care homes who participated further required the help of care workers, who then influenced the decision on who had been invited, which also depended on people's ability to write (as keeping a diary was part of the study design). Therefore, the findings are applicable to older adults as a group only to a limited extent. Otherwise, the fact that older adults were rather active also provided an opportunity for people to engage more independently, which may be also an opportunity to learn about possible entry points of technology that are more likely to be accepted later when more assistance could be needed. Further, while we considered residents' family members to some extent, we did not take into account people who have been closer associated with caregivers or managers. Social circumstances around caregivers might also have an effect on their life and work and to the integration of technology in these contexts. Regarding the elicitation tool presented in Chapter 7, the extent to which Informatics students are actually good proxies for designing a co-imagination tool for engineers could be questioned. Certainly, this limitation provides an opportunity to include actual roboticists to further explore and address methodological challenges in future research.

8.6 Outlook: Future Work

Assistive technology can support older adults and care workers also with more complex health conditions, such as dementia [de Jong et al., 2019,Stara et al., 2019], disabilities [van Delden et al., 2020], or even multiple chronic conditions [Berry et al., 2019]. Therefore, there are certainly opportunities for future research in developing or co-creating technology, potentially robots, for these needs, that go beyond mere communication or information retrieval. This would also extend the understanding of older adults' experiences in diverse living spaces to an understanding of people's experiences with specific or more complex health conditions, and subsequently, of the design considerations for supporting older adults with robots. In order to enhance quality of life of people with various health conditions, it is also important to promote values such as autonomy or social connectedness. Further, the people and their context as well as their conditions need to be taken as a starting point to iteratively make decisions about holistic interventions to design, which can, but do not need to end up involving a robot.

While I argued for a need of more bottom-up research in HRI and to engage with more off-the-shelf systems and robots in the design process, also highlighting relational qualities in care networks, there are certainly opportunities for taking this exploratory approach also into other in-the-wild contexts. A candidate here is to conduct HRI research in public spaces, especially given there are commercially available systems deployed to date [Dobrosovestnova et al., 2022]. An opportunity for future research is here that given there are space-related requirements for trust in private spaces [Schwaninger et al., 2021], requirements for privacy could be defined in a more systematic manner. These could be then also investigated and further specified with regards to privacy requirements in public spaces.

In this exploratory work, theoretical approaches from other disciplines came in to interpret the data and to shed new light on them. Relatedness from Self-Determination Theory [Ryan and Deci, 2006] was used and even extended in a way to unpack forms of relatedness in a care network. In future HRI research, SDT can be used as a starting point to identify relevant actors and to shed light on relational qualities between older adults and other actors in a care network. This theory can also guide researchers to work towards value promotion [Calvo and Peters, 2017], extending previous approaches of designing for values in HRI.

There are certainly opportunities to work on the topic of collaboration in the co-creation process [Axelsson et al., 2021,Fitzpatrick and Malmborg, 2018], further extending the repertoire of PD methods in HRI to develop practical collaboration strategies in HRI, also addressing PD challenges. In other work, we developed a toolkit for developers to develop eHealth solutions for people with low eHealth literacy, where part of the project has also focused on including the perspective of these stakeholders [Prinzellner et al., 2022]. Such an approach could also be taken further to develop practical collaboration strategies for HRI that focus not only on ideation phases [Schwaninger et al., 2021], but also on subsequent steps.

Concerning the elicitation cards (also tackling the collaboration topic), these could be also adapted and/or extended to be used at later stages of conceptualizing, prototyping, and evaluating robotic systems. The cards or an extended version could also be used for participatory evaluation [Spiel et al., 2017]. Exploring challenges in the process of participatory evaluation in HRI could also usefully extend the contribution on PD challenges here. Furthermore, systematic comparative studies in using the cards may be useful: e.g., a comparison between an open-ended and a structured procedure of using the cards is an option, as well as between experienced and inexperienced interviewers to draw more generalised conclusions across participants and interviewers. Another option is to explore the use of the cards with different team members such as engineers, developers, social scientists and people who are more or less familiar with issues around robots and AAL.

The validation of both the elicitation cards and design considerations holds potential for future research. In order to address PD challenges around multidisciplinary collaboration and grounding in HRI teams, the cards could be further developed and potentially validated with people working in multidisciplinary teams, such as roboticists/engineers. Here, the terminology around "robots" vs. *latest invention* could be further explored, and in a next step, possibly showing videos of robots [Alves-Oliveira et al., 2015]. Further, both the considerations that came out of using the cards and of this thesis as a whole could be validated and translated into more recommendations and/or opportunities for practitioners. In a subsequent step, some of the aspects that I developed and discussed could be developed towards design patterns for robots and HRI [Kahn et al., 2008, Ligthart et al., 2020], or as more actionable guidelines specifically for various types of engineers or policy makers.

Given that ageing is a global trend and that digital transformation also has a global impact (e.g., as products could enter a global market), future research needs to take into account these challenges not only focusing on local needs and development, but also global interdependencies. In 2050, 80% of older adults are expected to be living in low- and middle income countries [World Health Organization, 2021]; and Japan is already a super-aged society [D'Ambrogio, 2020]. Welfare systems and especially care systems that target the ageing population in other countries are younger [Wang and Tsay, 2012] and therefore expectations may be different towards institutional care (as compared to family support, for example). Previous HRI research has already proposed and taken important steps in cultural robotics [Šabanović, 2014, Wang et al., 2010, Korn et al., 2021, Langer and Levy-Tzedek, 2021], conducting comparative studies with robots between China and the US [Wang et al., 2010, Joosse et al., 2014], and providing insights about preferences with regards to attitudes towards robots and implicit vs. explicit communication of a robot [Wang et al., 2010], and proxemics in HRI [Joosse et al., 2014]. Taking into account local settings can be also useful for understanding social dynamics in the home [Lee et al., 2017b, Lee and Šabanović, 2013]; and learning from the use of current assistive technologies could be then conducted in various cultural environments, both comparatively, and complementary. This could facilitate cross-cultural collaboration, the design of culturally adaptive systems [Evers et al., 2010], and/or provide mutual learning across cultures.

Given this thesis has demonstrated a situated understanding of trust and even the need to specify space-related requirements to build trustworthy robots, there are certainly opportunities to study this concept with a cultural lens too. Because this thesis illustrates the diverse needs of people and a highly situated notion of trust [Schwaninger et al., 2021], the concept would be also valuable to discuss in other contexts. In authoritarian countries, for example, privacy perceptions may be very different compared to Europe, providing opportunities to start with the trust concept to understand local needs, and to discuss cultural particularities and future paths for design.

8.7 Summary

In this chapter, I revisited and discussed the entire research on supporting older adults with robots against each other and the literature. After revisiting the basic ideas and the research questions, I presented the main contributions that also aim to answer the research questions: understanding longitudinal experiences of older adults and care workers with AAL (RQ1), understanding and addressing methodological challenges when engaging older adults in the design of robots (RQ2), and design considerations for supporting older adults with robots (RQ). The design considerations can be summarized as follows. There is a need to design for relatedness in communities, including the need for a socio-technical perspective to extend individual-focused and dyadic HRI research, reciprocity, and collaboration. It is also important to design for personalization and adaptation also with regards to robot functionalities, space, and privacy; as well as for learning, such as for older adults and in terms of mutual learning in participatory research. There is also a need to design for older adults' and researchers values; and for specific places and work practices, also taking into account the impact of robots on everyday life and work, and potentially evolving work roles.

CHAPTER 9

Conclusion

The ageing population is a global development, also stated as one of the most pressing challenges of the 21st century (together with climate change, for example). The extent to which robots can actually provide a (partial) solution to some of the associated problems, such as by supporting older adults and their (care) networks in everyday life, also relates to how the problem space is overall approached. One aspect is how we understand the role of people in the conceptualization, design, and development of infrastructures.

In contrast to technology-driven top-down approaches, which are nevertheless important to explore e.g. the feasibility of technical systems, I aimed to provide a people-driven perspective. Here, the aim was to focus on the context in which robots are intended to be used to support older adults, and on the design of these by engaging with older adults and their care networks, also taking into account HRI teams who design and develop robots. I chose qualitative methods to engage in this bottom-up (i.e., people-driven) research in an open-ended way, allowing me to take an explorative approach.

In this thesis, I provided three main contributions to research:

- An understanding of longitudinal experiences of older adults with current off-the-shelf assistive technology in diverse living spaces, i.e., private homes and care homes (Chapter 4 and 5), was developed. Through an exploratory bottom-up approach, relational qualities in care networks were identified, including forms of relatedness between different actors in a care network, and values that were promoted or undermined when using communication technology in a care context. Technical interventions need to promote values including autonomy or relatedness. Furthermore, work configurations also need to be taken into account and designed for when designing such interventions.
- An understanding of methodological challenges of PD for assistive robots with older adults (Chapter 6) was developed. This includes the need for grounding in

HRI teams, knowledge transfer in these multidisciplinary teams, and expectation management when using the term “robot”. The challenges were further explored and addressed through the iterative design of a methodological tool specifically designed for engineers to get a feeling of the everyday life of older adults. Here, “inverted” trust was used as an ice-breaker for conversations (Chapter 7). Using the tool in interviews with older adults then also revealed that the extent to which robots are likely to be perceived trustworthy depends very much on whether they meet space-related requirements.

- Design considerations for supporting older adults with robots, based on the four case studies presented. The design considerations include the need to design for relatedness in communities (e.g., in families, for collaborative use, and for reciprocal relationships), for personalization (e.g., with regards to accessibility issues, social environments, privacy, or companionship), learning (e.g., concerning learning environments in project meet-ups, or mutual learning in PD), values (e.g., autonomy, connectedness, and privacy; where possible value tensions also need to be considered, as well as researchers' values), and the need to design for specific places and work practices (e.g., changing spatial configurations, and desired work roles of people making use of robots).

When aiming to support people of a certain group (i.e., limited to a condition that is tied to a specific age, other health conditions, for entertainment, social stimulation, etc.), it is important to design holistic interventions, which a robot may or may not be part of. Nevertheless, it is also important to engage with dynamically changing opportunities (e.g., from a technical point of view). I hope to have shown in this research that there are multiple aspects to consider when aiming to support older adults, such as work-related aspects, relationships which could be designed for and which robots could be part of, layers of privacy, and space-related requirements that are important to facilitate trust.

I was motivated to do this work by adding a people-driven perspective to emerging technologies, using methods that allow to take an exploratory approach and provide an in-situ understanding, and at the intersection of technology and people. I hope to have added to the discussion on emerging technologies, and that fellow researchers can make use of the work presented in the future.

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Appendix

Consent Forms used in Case Study 2

Forschungsprojekt

Einverständniserklärung

Liebe Teilnehmerin, lieber Teilnehmer,

vielen Dank für Ihre Bereitschaft als Proband an dem Forschungsprojekt der Universität Siegen in Kooperation mit der TU Wien teilzunehmen.

Im Rahmen der Studie werden verschiedene Erhebungen durchgeführt, um in erster Linie die Benutzerfreundlichkeit und Nutzbarkeit der roboter-basierten Intervention im Alltag zu analysieren. Nähere Details zu den Methoden entnehmen Sie bitte den **Probandeninformationen**.

Mit Ihrer Unterschrift bestätigen Sie, dass Sie die Probandeninformationen, die über Zweck und Inhalte der Studie informieren, gelesen und den Ablauf der Studie verstanden haben. Des Weiteren bestätigen Sie, dass keine medizinischen Bedenken gegen physische und kognitiv stimulierende Aktivitäten bestehen und dass Sie eigenverantwortlich und freiwillig an der Studie teilnehmen.

Die Teilnahme an dieser Studie ist freiwillig. Sie können jederzeit ohne Angaben von Gründen die Teilnahme beenden und ohne dass Ihnen dadurch ein Nachteil entsteht.

Sollten Sie weitere Fragen bezüglich der Studie haben, können Sie sich gerne an die entsprechenden Projekt-Mitarbeiter der Universität Siegen wenden, die Ihr Anliegen gerne auch telefonisch entgegennehmen.

Teilnahme an der Studie? **O Ja** **O Nein**

Vorname, Nachname ....

Siegen, den ....

....

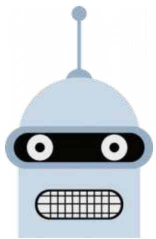
Unterschrift Proband Unterschrift Testleiter/in

Teilnahme an bestimmten Forschungsmethoden

Im Folgenden können Sie nun freiwillig und unverbindlich angeben, an welcher der in den Probandeninformationen beschriebenen Forschungsmethoden Sie im Rahmen der Studie teilnehmen würden. Die Mitarbeiter der Universität Siegen und deren Kooperationspartner der TU Wien treten dann im Laufe der Studie gegebenenfalls individuell mit Ihnen in Kontakt, um das genaue Vorgehen bei diesen Forschungsmethoden mit Ihnen zu besprechen.

Teilnahme an der Vorstudie?	**O Ja**	**O Nein**
Teilnahme an den Workshops?	**O Ja**	**O Nein**
Teilnahme an der Erprobung?	**O Ja**	**O Nein**

Consent Form used in Case Study 4



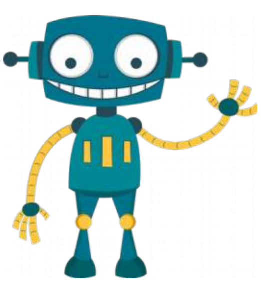
✓ **I** agree that the data that I submitted as part of the AAL block (i.e., **interview transcripts** and the **lecturers‘ notes from my presentations**) of the course HCI in Healthcare in the summer semester of 2019 which will be **fully anonymized** will be **used** as part of future courses (such as HCI in Healthcare in the summer semester of 2020) and for publications.

✓ I have spoken to **my interview partners** and they agree too.

Name: Kristina Schiechl (00726448)

Date and Signature: 25.03.2020

Thank you!



Interview Guideline for the Study on AAL Systems in private Households

26. März 2019

Leitfaden qualitativer Interviews für WAALTeR

(auf Empfehlung von Gabriele zur Einleitung:) Bitte scheuen Sie sich nicht davor, ehrlich zu sein. Die Fragen im Fragebogen waren vermutlich etwas enger gestellt, jetzt haben Sie die Chance, alles zu erzählen, was Sie sich im letzten Jahr gedacht haben. Wir sind auch speziell dankbar für negatives Feedback. Es ist Ihnen niemand böse über das, was Sie sagen – Sie haben jetzt die Chance, alles loszuwerden, was Sie sich denken!

Einstieg

Was hat Sie motiviert, bei WAALTeR mitzumachen?

Was haben Sie sich vom Projekt und von WAALTeR speziell erhofft?

Erzählen Sie mir kurz über Ihr letztes Erlebnis mit WAALTeR! *(kann sich sowohl auf die Technologien, als auch auf das Projekt beziehen)*

Selbstbestimmtheit, Autonomie

Welche Funktionen von WAALTeR verwenden Sie?
Wofür verwenden Sie WAALTeR?
Was Anwendungen (Funktionen) haben Ihnen am besten gefallen?

Welche Bedenken sind Ihnen bei der Verwendung mancher Funktionen (Anwendungen) gekommen?

Gibt es Anwendungen, die Sie nicht verwenden?
Welche Anwendungen wollen Sie nicht verwenden?
Welche Vorbehalte haben Sie gegenüber Anwendungen, die Sie nicht verwenden?
(Warum haben Sie manche Funktionen nicht verwendet?)

Können Sie 1-2 speziell positive Erlebnisse, auch Erfolgserlebnisse, beschreiben, die Sie mit WAALTeR hatten?

Können Sie 1-2 Erlebnisse beschreiben, in denen Sie frustriert waren, oder sich geärgert haben?
Was haben Sie in diesem Fall / in diesen Fällen getan?
(Nachfrage: Was hat Ihnen insbesondere geholfen, oder nicht geholfen?)

Wie haben sich Ihre Erfahrungen (bzgl. Umgang mit Herausforderungen, Vorteile und Nachteile) über die Zeit verändert?

Welchen Nutzen sehen Sie durch Anwendungen oder Angebote von WAALTeR?
Hat WAALTeR immer das getan, was Sie erwartet haben?

Wie sicher fühlen Sie sich im Umgang mit WAALTeR?

Design, Nachvollziehbarkeit

Wie würden Sie einem Freund / einer Freundin erklären, was WAALTeR tut?

Wenn Sie WAALTeR perfekt auf Ihre Bedürfnisse zuschneiden könnten, was würden Sie ändern? Was würde so bleiben, wie es derzeit ist?

Können Sie eine Situation schildern, in der Sie von WAALTeR überrascht wurden?
Was hat Ihrer Meinung nach zu der Überraschung geführt?
Wie haben Sie auf die Überraschung reagiert?

Sicherheitsempfinden, Privatsphäre

Was hat sich in Ihrem Leben verändert, seit Sie bei WAALTeR mitmachen? *(- evtl. nachfragen: in Bezug auf Wohlbefinden? Mobilität? Sicherheitsempfinden?)*
Wenn Sie zurückdenken, haben Sie seit der Verwendung von WAALTeR neue Verhaltensweisen angenommen? Welche?

Welches der zusätzlichen Pakete würden Sie einem guten Freund / einer guten Freundin empfehlen (wenn überhaupt), und welchen Nutzen hätte die Person in ihrem Alltag?

Was hat zu Ihrer eigenen Entscheidung bzgl. der zusätzlichen Pakete im Wesentlichen beigetragen? Unter welchen Bedingungen würden Sie sich anders entscheiden?

(Haben Sie Sicherheitsbedenken gegenüber WAALTeR?)
Welche Sicherheitsbedenken haben Sie gegenüber WAALTeR?

Was macht WAALTeR-Technologien vertrauenswürdig?

Inwiefern sind diese Technologien nicht vertrauenswürdig?

Ausblick in die Zukunft

Ausgehend von Ihren Erfahrungen:
(In welcher Weise haben Sie das Gefühl, die Entwicklungen solcher Technologien bewegen sich in die richtige Richtung?)
Haben Sie das Gefühl, dass die Entwicklung von Technologien, die im Alltag genutzt werden können, in die richtige Richtung geht?

(Wo sehen Sie mögliche Chancen für sich / für andere / für zukünftige Generationen?)
Was würden Sie sich diesbezüglich für die Zukunft wünschen?
In welchen Bereichen können Sie sich vorstellen, dass Sie / andere / zukünftige Generationen derartige Technologien noch unterstützen könnten?
Wo sehen Sie mögliche Probleme für sich / für andere / für zukünftige Generationen?

Angenommen, die Technologien wären noch intelligenter, könnten zum Beispiel sprechen, und wären vielleicht sogar Roboter: In welchen Bereichen könnten Sie sich vorstellen, solche Technologien zu verwenden?

Welche Chancen und Probleme würden Sie darin sehen, Roboter zu verwenden?
Was würde Ihnen Skepsis oder gar Misstrauen bereiten?

Was bräuchte es, damit Sie diesen Technologien vertrauen würden?

Abschließende Reflexion

Hat WAALTeR Ihr Leben in irgendeiner Form verändert?

Haben Sie anderen von WAALTeR erzählt? (Wenn ja:) Wie haben die Personen darauf reagiert?

Was haben Sie mit der Zeit durch WAALTeR gelernt?

In welcher Art und Weise haben sich Ihre Hoffnungen in das Projekt erfüllt? *(Klammer 1. Frage)*

Fällt Ihnen noch etwas ein, das Sie gerne hinzufügen würden?

Interview Guidelines for the Study on AAL Systems in Carehomes

Interview Guideline for Residents

Leitfaden Onboarding (inkl. erster Fragen) 15 Min

Begrüßung (30sek)

Vorstellung (1min)

Wie empfinden Sie die aktuelle Situation? Gibt es etwas, das Sie derzeit besonders beschäftigt?

Was hat sich für Sie in den letzten Wochen (zum Positiven / Negativen) verändert?

Können Sie eine Situation in den letzten Tagen beschreiben, die weniger gut gelaufen ist? Was würden Sie rückblickend anders machen?

Hat sich für die Mitarbeiter in den letzten Wochen etwas verändert?

Haben Sie sich in der letzten Woche etwas gewünscht? Wenn ja, was?

Haben Sie in der letzten Woche technische Geräte verwendet?

Haben Sie in der letzten Woche telefoniert? (/ Videochat verwendet?)

Haben Sie oder Personen in Ihrem Umfeld je Erfahrungen mit einem Roboter gemacht?

Glauben Sie Roboter könnten Ihren momentanen Alltag verändern? Wenn ja, wie?

Glauben Sie ein Roboter könnte den momentanen Alltag der Mitarbeiter im Pflegeheim verändern? Wenn ja, wie?

Gibt es etwas, das Sie noch sagen möchten?

Interview Guideline for Care Workers

Leitfragebogen Pflegekräfte:

Erfahrungen in den letzten Monaten für Pflegekräfte

- Wie war Ihre Erfahrung in den letzten Monaten?
- Was hat sich in Ihrer Arbeit in den letzten Monaten verändert? Gab es einschneidendere Veränderungen in den letzten Monaten für Sie? (Gab es Einschränkungen?)

Erfahrungen der Bewohner und Angehörigen

- Wie hat sich der Tagesablauf für BewohnerInnen in der Corona-Zeit über die Zeit verändert? (Gab es z.B. Veranstaltungen, Unterhaltung, Körperpflege,…)
- Gab es einschneidende Veränderungen für die Bewohner (positive / negative)? (-> Phasen)

  Beispiele: Besuchsverbot, Veränderungen in Gruppenaktivitäten, Konzerte, Veranstaltungen,… Auswirkungen auf die Gesundheit?
- *Wenn noch nicht angesprochen:* Was hat sich für die Bewohner speziell durch die Isolation verändert? Hatte diese irgendwelche Auswirkungen, z.B. auf deren Gesundheit?
- Was hat sich für die Angehörigen verändert? Wie sind diese mit der Situation umgegangen?

Veränderte Qualitäten von sozialen Beziehungen und Örtlichkeit

- Haben die Bewohner ein Bedürfnis nach vermehrten sozialen Kontakten geäußert? (Oder haben Sie Vorteile darin gesehen, sich zu isolieren?)
- Gab es Strategien, um soziale Kontakte zwischen Bewohnern herzustellen? Gab es diesbezüglich auch Hindernisse oder Hemmungen?

  z.B. Telefonie, Videotelefonie, Besuchs-Boxen, Container, …

Technologien, Robotik

- Haben Sie Technologien in den letzten Monaten anders genutzt als vorher? (...oder die anderer Mitarbeiter?) - Wie fanden Sie das?
- Wie ist es dazu gekommen, dass (nicht) mehr Technologien genutzt wurden? Gab es Schulungen o.ä.? Sehen Sie Bedarf an begleitenden Maßnahmen (Schulungen / Weiterbildung), wenn mehr Technologien eingesetzt werden? (konkrete Situation?)
- GFO: Wie haben Sie das Videotelefonat letztens erlebt?
- Was würden Sie dem Roboter zutrauen?
- Gab es je einen Moment, in dem Sie dachten: jetzt wäre ein Roboter praktisch?
- Haben Sie etwaige Bedenken, den Roboter im Pflegeheim einzusetzen? Gibt es etwas am Roboter, das Ihnen Skepsis bereitet?
- Was wäre für Sie wichtig, damit Sie dem Roboter vertrauen können?

Nachhaltige Effekte, Auswirkungen der Arbeitsweisen / Alltag

- Wie stellen Sie sich das nächste halbe Jahr im Pflegeheim vor?
- Welche Veränderungen werden bleiben? Inwiefern?

Diary used in Care Homes

Liebe Teilnehmer,

zuerst möchten wir uns bedanken, dass sie an dieser Studie teilnehmen. Sie sind ein wertvoller Teil unserer Forschungsarbeit und ohne Sie wäre es nicht möglich Fortschritte zu machen.

Gemeinsam arbeitet die Universität Siegen mit der Technischen Universität Wien an Systemen, wie dem Roboter Pepper. Ziel dieser Studie ist es herauszufinden wie ein solches System eingesetzt werden kann. Dabei wollen wir auch davon lernen wie Sie andere technische Geräte nutzen. Insbesondere in dieser besonderen Zeit, die für uns alle das Leben tiefgreifend verändert. Hierfür haben wir uns eine Reihe von Fragen und Geschichten überlegt, von denen wir uns wünschen, dass Sie jeden Tag ein paar davon ausfüllen. Allerdings, und dies ist uns wichtig, bitte tun Sie dies nur freiwillig. Wir freuen uns, wenn Sie teilnehmen, haben aber auch Verständnis dafür, wenn Sie nicht mehr wollen oder können.

Ihre Daten sind bei uns sicher, alle Aussagen werden anonymisiert. Wir wollen Sie kennenlernen, aber dies wird keinem anderen offengelegt. Dies ist uns ein wichtiges Anliegen.

Vielen Dank, dass Sie teilnehmen!

Vielen Dank, dass Sie teilnehmen!

Im Übrigen sind wir jederzeit für Sie erreichbar. Rufen Sie uns gerne an, wenn Sie Fragen haben oder etwas nicht klar geworden ist.

Mit herzlichen Grüßen

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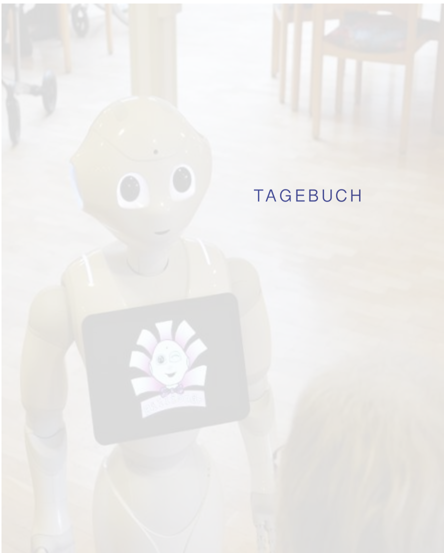
Universität Siegen

Tag 1 Datum: ____________

Wie geht es Ihnen heute?

Mit wem haben Sie derzeit Kontakt? Und wie haben Sie Kontakt?

Wie empfinden Sie die Maßnahmen im Zusammenhang mit dem Corona-Virus?



Tag 0 Datum: ____________

Bitte bantworten Sie die folgenden Fragen.

Wie alt sind Sie?

Was ist Ihr Ges-

Haben Sie Kinder?

Wie ist Ihr Familienstand?

Wie lange wohnen Sie bereits im Marienhem?

Waren Sie jemals im medizinischen Bereich oder im Pflegekontext tätig?

Haben Sie etwaige Einschränkungen (z.B. hören, sehen)? Welche?

Was sind oder waren früher Ihre Interessen?

Was fällt Ihnen zum Thema "Roboter" ein?

Haben Sie oder Personen die Sie kennen Vorerfahrungen mit einem Roboter? Wenn ja: können Sie diese kurz beschreiben?

Tag 3 Datum: ____________

Welche praktischen Herausforderungen hatten Sie in der letzten Woche? Können Sie eine Situation beschreiben, in der Sie diese Herausforderungen gut gemeistert haben? (z.B. Was ist passiert, wann war das, weshalb hat das funktioniert, wer war noch dabei, und welche Rolle hatten Sie dabei?)

Was assoziieren Sie mit "Einsamkeit"? Wie würden Sie dieses Gefühl beschreiben?

Tag 4 Datum: ____________

Welche technischen Geräte haben Sie in den letzten zwei Wochen genützt, falls Sie welche genützt haben? (z.B. Telefon, Computer, Handy, Tablet, Smartphone, Fernseher; Radio, Fitness-Uhr, Sonstiges...)

Was bereitet Ihnen Freude?

Tag 2 Datum: ____________

Beschäftigt Sie heute etwas? Wenn ja, was?

Welche Aktivitäten gab es in der letzten Woche im Heim (zum Beispiel Sport oder Spiele), falls es welche gab?

Hatten Sie in der letzten Woche Kontakt zu anderen Bewohnern im Pflegeheim? Wenn ja, wie war dieser Kontakt? Was beschäftigt diese Personen derzeit? Oder: Was denken Sie, beschäftigt diese Personen?

Tag 5 Datum: ____________

Bitte schreiben Sie eine Geschichte mit folgendem

EIN SCHÖNER TAG MIT PEP-

Tag 7 Datum: ____________

Was haben oder hatten Sie am heutigen Tag vor, falls Sie etwas vorhatten?

Was würden Sie als erstes tun, wenn die Corona- Maßnahmen aufgehoben würden?

Wann hatten Sie zuletzt Kontakt mit einer anderen Person (z.B. Zimmernachbarn oder Verwandtschaft)? Inwiefern war dieser Kontakt für Sie bedeutsam? Was hat diesen Kontakt bedeutsam gemacht?

Hatten Sie in der letzten Woche Kontakt mit Personen außerhalb des Marienheims? Wenn ja: Wer hat diesen Kontakt initiiert?

Haben Sie in letzter Zeit jemanden um Hilfe gebeten? Oder wurden Sie in letzter Zeit um Hilfe gebeten? Wenn ja: Können eine dieser Situation(en) näher beschreiben?

Tag 6 Datum: ____________

Können Sie eine Zeit in Ihrem Leben beschreiben, in der alles sehr gut war? Weshalb war diese Zeit gut? Wer war noch da? Welche Rolle hatten Sie in dieser Zeit?

Wie werden Sie derzeit von Personen im Pflegeheim oder von Personen außerhalb des Pflegeheimes unterstützt? Wodurch fühlen Sie sich besonders unterstützt? Gibt es etwas, das Sie als störend empfinden? Was könnte sich für Sie verbessern?

Gibt es Entwicklungen im Zusammenhang mit Corona, die Ihnen Angst machen?
Und gibt es Entwicklungen, die Sie positiv bewerten? Weshalb? Können Sie diese näher beschreiben?

Denken Sie, dass der Roboter Pepper in der Lage wäre, Sie gegen das Corona-Virus zu schützen? Wenn ja, wie? Und wenn nein, was würde dagegen sprechen?

Tag 8 Datum: ____________

Was hat sich in Ihrem Leben in der letzten Woche veändert (falls sich etwas verändert hat)? Wie empfinden Sie diese Veränderungen?

Bitte Schreiben Sie die folgende Geschichte zu Ende!

Heute hat mich ein Pfleger dazu eingeladen mit dem Roboter Pepper und einigen anderen Bewohnern ein paar Bewegungsübungen zu machen. Ich sitze neben den anderen in einem Aufenthaltsraum und sehe Pepper, wie er die erste Bewegung „Äpfel pflücken" vormacht und uns darum bittet, sie nachzumachen.
…

Tag 9 Datum: ____________

Wie würde ein toller Tag für Sie aussehen? Falls Ihnen nichts dazu einfällt: Wo wären Sie an einem tollen Tag? Wie würde es dort aussehen? Mit wem wären Sie zusammen, und was würden Sie tun? etc.

Tag 10 Datum: ____________

Was macht Sie fröhlich?

Bitte schreiben Sie eine Geschichte mit folgendem Titel:

EIN SCHRECKLICHER TAG MIT PEP-

Tag 11 Datum: ____________

Wie war Ihr Tagesablauf in der letzten Woche normalerweise?

Was würden Sie einer *anderen* Person empfehlen, die sich einsam fühlt?

Wie zufrieden sind Sie derzeit mit dem Kontakt zu anderen Menschen, den Sie haben? Was macht Ihre Zufriedenheit aus? Oder: Was macht Ihre Unzufriedenheit aus? Was würden Sie sich wünschen?

Gibt es etwas, das Sie uns noch mitteilen möchten?

Tag 12 Datum: ____________

Wie geht es Ihnen heute?

Weshalb könnten sich andere Personen Ihrer Meinung nach einsam fühlen? Was würden Sie diesen Personen raten?

Schreiben Sie eine Postkarte an den Roboter Pepper! (Bedenken Sie bitte, dass Pepper noch nicht schreiben kann, und Ihnen daher nicht antworten kann.)

Angenommen, der Roboter Pepper wäre derzeit im Marienheim. Denken Sie, dass die Pflegekräfte nach wie vor in der Lage wären, Sie gut zu betreuen? Was könnte sich durch Pepper verändern? Was könnte sich für Sie persönlich verbessern, was könnte sich verschlechtern?

Können Sie an eine Zeit in Ihrem Leben denken, in der alles nicht so gut war? Was war damals, weshalb war die Zeit nicht gut, wer war noch da, was war Ihre Rolle?

Können Sie an eine Zeit in Ihrem Leben denken, in der alles *gut* war, und in der Sie wenige soziale Kontakte hatten? Was war damals, weshalb war die Zeit gut für Sie? Was war Ihre Rolle?

Tag 13 Datum: ______________

Welche Medien (TV, Buch, Radio, etc.) haben Sie in der letzten Woche konsumiert, falls Sie welche konsumiert haben? Was oder welche Sendungen würden Sie gerne lesen oder hören?

Wann hatten Sie zuletzt Kontakt mit Angehörigen oder Freunden? Wie war dieser Kontakt? Was hat der Kontakt für Sie bedeutet?

Tag 14 Datum: ______________

Beschäftigt Sie heute etwas? Wenn ja, was?

Was bedeutet es für Sie, alleine zu sein?

Tag 16 Datum: ____________

Hatten Sie in der letzten Woche Aufgaben? Wenn ja: welche? Welche Aufgaben hätten Sie gerne?

Wären Sie in der Lage, den Roboter Pepper selbst zu bedienen? Wenn ja: Können Sie eine Situation beschreiben, in der Sie Pepper bedienen? Falls nein: Würden Sie Pepper gerne selbst bedienen?

Tag 17 Datum: ____________

Wie geht es Ihnen heute?

Haben Sie in der letzten Woche Technologien verwendet? Wenn ja, welche? Wenn nein, hätten Sie gerne verwendet?

Tag 15 Datum: ____________

Bitte schreiben Sie eine Geschichte mit folgendem Titel:

PEPPER UND

Gibt es Menschen, denen Sie sich derzeit zugehörig fühlen? Wenn ja: Wie würden Sie diese Zugehörigkeit beschreiben?

Tag 18 Datum: ____________

Wählen Sie eine der Fragen aus, und stellen Sie sie einer Mitarbeiterin / einem Mitarbeiter des Pflegeheims:

A. Nach ihren Erfahrungen mit dem Roboter Pepper, wie würden sie ihn einsetzen, wenn sie ihn selber steuern könnten?

B. Was wäre das Schlimmste was ihnen passieren könnte, wenn Sie den Roboter steuern?

C. Wie finden Sie sieht Pepper aus? Was würden Sie verändern?

D. Was würden Sie sich vom Roboter Pepper wünschen, damit er Sie derzeit im Arbeitsalltag unterstützt?

E. Würden Sie sich derzeit zutrauen, den Roboter Pepper zu steuern?

Gibt es technische Geräte, die andere Bewohner im Marienheim im Alltag einsetzen, Sie aber nicht?
Welche Vorteile sehen Sie dabei, solche technischen Geräte einzusetzen? Was würde Ihnen Skepsis bereiten?

Tag 20 Datum: ____________

Beschäftigt Sie in letzter Zeit etwas? Wenn ja, was?

Welchen Interessen sind Sie in der letzten Woche nachgegangen, wenn Sie solchen nachgegangen sind? Gibt es Interessen, denen Sie gerne nachgehen würden?

Welche Frage haben Sie gewählt?

Wie lautete die Antwort?

Was denken Sie über diese Antwort?

Tag 19 Datum: ____________

Hatten Sie in der letzten Woche eine Tagesstruktur?
Wenn ja: Welche?
Welcher Tagesablauf wäre nächste Woche ideal für Sie?

Wie empfinden Sie die Maßnahmen im Zusammenhang mit dem Corona-Virus?

Wenn der Roboter Pepper speziell für Sie hier wäre, und wenn er auf Sie zugeschnitten wäre: Was würden Sie den Roboter machen lassen? Was dürfte der Roboter auf gar keinen Fall tun? Was sollte er idealerweise können?

Tag 21 Datum: ____________

Wie geht es Ihnen heute?

Was bedeutet Einsamkeit für Sie?

Tag 22 Datum: ____________

Was haben oder hatten Sie heute geplant, wenn Sie etwas geplant haben?

Hat sich in Ihrem Leben oder im Leben anderer Personen in Ihrem Umfeld seit der Corona-Maßnahmen etwas geändert? Wenn ja, was?

Mit wem hatten Sie in der letzten Woche Kontakt? Und wie hatten Sie Kontakt? Was bedeutet dieser Kontakt für Sie?

Nutzen Sie Videotelefonie mit Angehörigen oder Freunden?
Wenn ja: Was bedeutet dieser Kontakt für Sie?
Wenn nein: Würden Sie sich wünschen, Videotelefonie zu verwenden? Was hindert Sie daran?

Wenn Sie sich aussuchen könnten, was Pepper heute für Sie tun könnte: Was wäre das? Wären Sie in der Lage, den Roboter dazu zu bringen das zu tun, was Sie möchten?

Haben Sie in Ihrem Leben je positive Erfahrungen damit gemacht, alleine oder einsam zu sein? Können Sie diese näher beschreiben?

Hatten Sie in der letzten Woche Kontakt zu anderen Bewohnern im Pflegeheim? Wenn ja, wie war dieser Kontakt? Was beschäftigt diese Personen derzeit? Oder: Was denken Sie, beschäftigt diese Personen?

Angenommen, der Roboter Pepper wäre in Ihrem Zimmer. Wo würden Sie den Roboter hinstellen? Fällt Ihnen eine Situation ein, in der Sie den Roboter gerne verwenden würden? Oder würden Sie dem Roboter gerne etwas erzählen? Wenn ja, was?

Haben Sie in letzter Zeit anderen Personen dabei geholfen, Kontakt mit anderen aufzunehmen? Wie haben Sie der anderen Person geholfen?
Würden Sie anderen Personen gerne helfen? Wenn ja, wobei würden Sie anderen Personen gerne helfen?

Tag 25 Datum: _____________

Weshalb denken Sie könnten Personen aufhören, sich für Technologien zu interessieren? Was würden Sie diesen Menschen empfehlen?

Gibt es Entwicklungen im Zusammenhang mit Corona, die Ihnen Angst machen? Gibe es Entwicklungen, die Sie positiv bewerten? Weshalb? Können Sie diese jeweiligen Entwicklungen näher beschreiben?

Tag 23 Datum: _____________

Was hat sich in Ihrem Leben in der letzten Woche verändert, wenn sich etwas verändert hat? Wie empfinden Sie diese Veränderungen?

Tag 24 Datum: _____________

Hat Sie in den letzten Tagen etwas beschäftigt? Wenn ja, was?

Was würden Sie als erstes tun, wenn die Corona-Maßnahmen gelockert oder aufgehoben würden? Und was würden Sie anderen empfehlen zu tun?

Tag 26 Datum: ____________

Wie geht es Ihnen heute?

Gibt es etwas, das Sie uns noch mitteilen möchten?

Tag 27 Datum: ____________

Wovon hätten Sie zur Zeit gerne mehr oder weniger?

Gib es einzelne Maßnahmen im Zusammenhang mit dem Coronavirus, die Sie aktuell lieber nicht hätten? Wenn ja, welche sind das, und wieso?

Hatten Sie in letzter Zeit Kontakt mit Angehörigen oder Freunden? Wenn ja, hat Ihnen jemand (z.B. das Pflegepersonal) bei der Kontaktaufnahme geholfen? Wer hat Ihnen geholfen, und wobei hat diese Person Ihnen geholfen?

Bitte Schreiben Sie die folgende Geschichte zu Ende!

Es gibt viel zu tun im Marienheim. Seit gestern ist Pepper wieder hier. Der Roboter hat ein neues Programm mit einer Funktion zur Unterstützung der Pflegekräfte. Er kann mich nun gezielt in meinem Zimmer unterstützen. Ich gehe auf Pepper zu, der auf der anderen Seite des Zimmers steht. …

Hatten Sie oder eine Person in Ihrem Umfeld je Erfahrung mit Einsamkeit oder Alleinsein? Können Sie eine solche Erfahrung von sich oder einer Person in Ihrem Umfeld näher beschreiben?

Wenn Ihnen Pepper helfen könnte, Kontakt mit anderen Personen aufzunehmen, würden Sie das zulassen? Wie würden Sie sich die Kontaktaufnahme vorstellen?

Tag 28 Datum: ____________

Was hat sich in Ihrem Leben in der letzten Woche verändert, wenn sich etwas verändert hat? Wie empfinden Sie diese Veränderungen?

Tag 29 Datum: ____________

Wählen Sie eine der Fragen aus, und stellen Sie sie einer Mitarbeiterin / einem Mitarbeiter des Pflegeheims.

A. Nach ihren Erfahrungen mit dem Roboter Pepper, wie würden sie ihn einsetzen, wenn sie ihn selber steuern könnten?

B. Was wäre das Schlimmste was ihnen passieren könnte, wenn Sie den Roboter steuern?

C. Wie finden Sie sieht Pepper aus? Was würden Sie verändern?

D. Was würden Sie sich vom Roboter Pepper wünschen, damit er Sie derzeit im Arbeitsalltag unterstützt?

E. Würden Sie sich derzeit zutrauen, den Roboter Pepper zu steuern?

Bitte schreiben Sie folgende Geschichte zu Ende!

Heute bringt ein Pfleger den Roboter Pepper in mein Zimmer. Der Pfleger erklärt, dass Pepper nun eine neue Funktion eingebaut hat, mit der ich andere Personen anrufen kann. Ich kann zu Pepper sagen: „Pepper, kann ich mit einer bestimmten Person sprechen?". Damit kann der Roboter eine Verbindung herstellen, sodass ich mit der Person telefonieren kann, solange ich möchte. Der Pfleger erklärt, dass es mir damit möglich ist, meine Angehörigen, Freunde, Ärzte oder auch Pflegefachkräfte selbstständig anzurufen. Außerdem haben die anderen Bewohner im Pflegeheim auch einen Roboter, mit dem sie telefonieren können. Somit kann ich beliebige Personen in meinem Umfeld anrufen, oder von diesen Personen angerufen werden.

Das sind Neuigkeiten, da ich von nun an Pepper verwenden kann, um zu telefonieren. Nachdem mir der Pfleger erklärt hat, wie ich Pepper benutzen kann, verlässt der Pfleger den Raum. Nun steht Pepper bei mir im Zimmer. …

Bitte Schreiben Sie die folgende Geschichte fertig!

Nach dem Frühstück kommt ein Pfleger in mein Zimmer und bringt Pepper herein. Der Pfleger sagt, dass Pepper heute den Tag mit mir verbringen wird und dass ich mit ihm Spiele spielen oder ihn um Hilfe bitten kann. Er erzählt, dass Pepper zum Beispiel Quizfragen stellen kann oder mir sagen kann, was es heute zum Mittagessen gibt. Danach verlässt er mein Zimmer und lässt mich mit Pepper alleine. …

Bitte schreiben Sie eine Postkarte an die Forscher Felix Carros und Isabel Schwaninger!

Tag 30 Datum: ____________

Wie geht es Ihnen heute?

Sind die Maßnahmen, die derzeit gegen das Corona-Virus unternommen wurden, in ihrem Interesse?

Bitte schreiben Sie die folgende Geschichte zu Ende!

Am Morgen wache ich auf. Pepper steht auf der anderen Seite des Raumes. Eine Pflegefachkraft kommt vorbei, um mich zu begrüßen und den Roboter einzuschalten. Danach bin ich wieder allein mit Pepper. Der Roboter hat die Augen auf mich gerichtet. Ich frage Pepper: "Wie geht es dir heute so?". Pepper sagt: "Danke, mir geht es gut. Und dir?". Ich antworte: "Ich habe gut geschlafen. Kann ich heute mit meinen Angehörigen telefonieren?" Pepper fragt: "Mit wem möchtest du telefonieren?" Ich sage Pepper, mit wem ich telefonieren möchte und bitte ihn, mir dabei zu helfen. Doch Pepper sieht mich nur an und antwortet nicht mehr. …

Welche Frage haben Sie gewählt?

Wie lautete die Antwort?

Was denken Sie über diese Antwort?

Was bedeutet Einsamkeit für Sie?

Mit wem haben Sie derzeit Kontakt? Und wie haben Sie Kontakt?

Telefonieren Sie derzeit? Wenn ja: Können Sie ein kürzlich geführtes Telefonat näher beschreiben? Wenn nein: Würden Sie gerne telefonieren? Was hindert Sie daran?

Wie empfinden Sie die Maßnahmen im Zusammenhang mit dem Corona-Virus?

Wären Sie in der Lage, Pepper selbst zu bedienen?
Wenn ja: Können Sie eine Situation beschreiben, in der Sie Pepper gerne bedienen würden?
Falls nein: Würden Sie Pepper gerne selbst bedienen?
Was würden Sie ihn machen lassen? Was sollte er auf keinen Fall machen?

Tag 31 Datum: ____________

Wie geht es Ihnen heute?

Was macht Sie froh?

Vielen Dank für Ihre Teilnahme!

Wie hat Ihnen das Tagebuch gefallen? Wollen Sie abschließend noch etwas mitteilen? Dann können Sie das auf dieser Seite tun.

Bitte geben Sie dieses Heft anschließend an den sozialen Dienst.

Provocation Cards and Trust Categories

Provoking Questions	**Trust**
What if the *latest invention (LI)* has microphones?	I, R
What if the *LI* is connected to your bank account?	I, R
What if the *LI* knows about your medical status?	I, R
What if the *LI* can detect when an emergency happens?	I, R
What if the *LI* has a personality similar to your own?	I
What if the *LI* makes mistakes sometimes?	R
What if the *LI* watches you do things?	I
What if the *LI* can detect when you are very happy?	I
What if the *LI* is capable of expressing emotions?	I
What if the *LI* can detect when you are not feeling well?	I
What if the *LI* has cameras, and other people can see what the *LI* sees?	I
What if the *LI* has very cute eyes that are cameras?	I
What if the *LI* is very strong, so that it can lift things?	R
What if the *LI* can understand you speaking, and what if it records everything?	I, R
What if the *LI* breaks something you like?	R
What if the *LI* can make phone calls to other people?	I, R
What if you cannot turn off the *LI*?	R
What if the *LI* is very talkative to everybody around and cannot keep a secret?	I
What if the *LI* doesn‘t speak your native language, or has a strange accent?	I
What if an emergency happens, and the *LI* does NOT detect it or cannot help?	R
What if the *LI* is made of a very comfortable material, e.g. fur?	I
What if the *LI* becomes a companion?	I

Table 1: Provocation card questions also inspired by the trust literature including interpersonal trust (I) [Mayer et al., 1995] including benevolence, competence and integrity; and reliance (R) [Billings et al., 2012] with human characteristics, robot characteristics and environmental characteristics.

Interview Guideline for interviewing the Students about the Usage of the Elicitation Cards

Questions for TrustCards Presentations

Experience doing Interviews (Educational Aspects)

1. What did you do to get the conversation going without cards?
2. What aspects of the “rooms” cards did you find most useful for talking about robots?

Trust Concept

3. In both interviews, how was your experience with the “trust” concept?
   - 3.1 How did you first introduce the trust concept?
   - 3.2 How did your interview partners define trust?
   - 3.3. What were the key dimensions of trust in the conversation?
4. Did any control aspects come up during the talks, e.g. on a loss of control, being able to control the device or the rooms, etc.?

Robot & “Neueste Erfindung”

5. How was your experience with the term “latest invention” / robot?
6. How was your expectation to how your IP would react to the idea of a robot in their homes? How was their reaction different?
7.1 Were you able to talk about any CONCRETE examples of the robot disturbing or supporting people? Where / how?
7.2 Did you face any contradictions in what people said, e.g. regarding privacy?

Daily Practices

8.1 Where did the Provocation cards refer to the story of a “typical day”?
8.2 Where did the Provocation cards bring in new aspects of the “typical day”?
9. Did your participants talk about other people during the interviews?

Design Ideas (& Educational Aspects)

10. What did you learn new about robots in homes from the interviews?
11. How would you define key features of a robot in homes based on your findings?
12. Is there anything you did not find out but you would need to know to define key features (or features to avoid) of a robot?
13. How would you prepare a similar study differently next time?
14. If a company was to build trustworthy robots, what were the key aspects you would recommend them to do?

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CURRICULUM VITAE

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PROFESSIONAL EXPERIENCE

2018-2022	**University Assistant & PhD Candidate** at the ***Trust Robots*** **Doctoral College** Human-Computer Interaction Group, Faculty of Informatics, TU Vienna, Austria Projects: WAALTeR (2019), CCIV Telemonitoring (2020), AAL Got-It (2021)
2022	Research Internship at **Fraunhofer Portugal AICOS** in Porto
2017-2018	**Scientific Researcher** in the project *„The Microfoundations of Authoritarian Responsiveness“*, Department of East Asian Studies, University of Vienna Data Science & Natural Language Processing on Chinese online content
2015-2017	**Chinese - German language Teacher** - „Deutschzentrum für Chinesen“ in Vienna
Apr-Jun 2015	International Affairs Internship - Austrian Embassy and Cultural Forum, Brussels
Fall 2011	PR & Journalism Internaship - Human Rights NGO in Vienna
Summer 2010	Summer Internship - Electrotechnical Company Jean Müller Gmbh, Shanghai

EDUCATION

2018-2022	Dr. techn. **Informatics,** TU Vienna
2015-2020	BSc **Software & Information Engineering**, TU Vienna Bachelor Thesis on Telemonitoring for Patients with Chronic Heart Failure
2008-2014	Mag. **International Development**, Vienna University 3-months Field Research in China, Vienna University's KWA Scholarship
2008-2012	BA **Chinese Studies** at Vienna University Chinese Language Certificate HSK (Level 5/6) 2009: Chinese Summer School at Chengchi University in Taipei, Taiwan
1999-2008	**Highschool „Musisches Gymnasium“ in Salzburg** Focus on Fine Arts; subject-specific work in German Literature Exchange Semester in Michigan, US in 2006

PUBLICATIONS

Articles

- **Isabel Schwaninger,** Felix Carros, Astrid Weiss, Volker Wulf, Geraldine Fitzpatrick: Video Connecting Families and Social Robots: From Ideas to Practices Putting Technology to Work. In: Universal Access for the Information Society, 1–13. doi: 10.1007/s10209-022-00901-y
- Till Bieg, Cornelia Gerdenitsch, **Isabel Schwaninger**, Bettina Kern, Chris Frauenberger. 2022. Evaluating Active and Assisted Living technologies: Critical methodological reflections based on a longitudinal randomized controlled trial. Computers in Human Behavior, 107249. https://doi.org/10.1016/j.chb.2022.107249
- **Isabel Schwaninger**, Florian Güldenpfennig, Astrid Weiss, Geraldine Fitzpatrick (2021): What Do You Mean by Trust? Establishing Shared Meaning in Interdisciplinary Design for Assistive Technology. International Journal of Social Robotics, 1–19. https://doi.org/10.1007/s12369-020-00742-w

Conference Proceedings

- Felix Carros, **Isabel Schwaninger**, Adrian Preussner, Dave Randall, Rainer Wieching, Geraldine Fitzpatrick, Volker Wulf. 2022. Care Workers Making Use of Robots: Results of a Three-Month Study on Human-Robot Interaction within a Care Home. CHI '22 Full Paper. https://doi.org/10.1145/3491102.3517435
- **Isabel Schwaninger**, Ch. Frauenberger, G. Fitzpatrick (2020): Unpacking Forms of Relatedness around Older People and Telecare. DIS '20 Short Paper, 10.1145/3393914.3395867
- **Isabel Schwaninger** (2020): Robots in Older People's Living Spaces: Designing for Trust in Situated Human-Robot Interaction. HRI Pioneers '20, https://doi.org/10.1145/3371382.3377449
- **Isabel Schwaninger**, Geraldine Fitzpatrick, Astrid Weiss (2019): Exploring Trust in Human-Agent Collaboration. ECSCW '19 Expl. Paper, https://doi.org/10.18420/ecscw2019_ep08
- Setareh Zafari, **Isabel Schwaninger**, Christina Schmidbauer, Astrid Weiss, and Sabine T. Koeszegi (2019): 'You Are Doing so Great!' – The Effect of a Robot's Interaction Style on Self Efficacy in HRI. Ro-Man '19 Full Paper, https://doi.org/10.1109/RO-MAN46459.2019.8956437

Position papers (juried)

- **Isabel Schwaninger** (2021): Design Considerations for Trust in situated Human-Robot Interaction. In: Proceedings of the 19th European Conference on Computer-Supported Cooperative Work: The International Venue on Practice-centred Computing on the Design of Cooperation Technologies, (ECSCW), Zürich, Switzerland; 2021-06-07 - 2021-06-11. doi: 10.18420/ecscw2021_dc003
- **Isabel Schwaninger**, Geraldine Fitzpatrick (2020): Exploring the Concept of Relatedness for Technology Ecosystems around Older People. CHI 2020 Workshop Technology Ecosystems: Rethinking Resources for Mental Health, Hawaii, US.

- **Isabel Schwaninger**, Astrid Weiss, Christopher Frauenberger (2019): Qualities of Trust: Capturing Aspects beyond System Reliability. IEEE Ro-Man 2019 SCRITA Workshop „Trust, Acceptance and Social Cues".

- **Isabel Schwaninger**, Geraldine Fitzpatrick (2019): Exploring Care Networks with Senior Citizens in Vienna. ECSCW 2019 Workshop „Who Cares? Exploring the Concept of Care Networks for Designing Healthcare Technologies".

- **Isabel Schwaninger** (2019): On the Interplay of Psychological Safety and Trust in Long-Term Human-Robot Collaboration. HAI 2019 Workshop „Designing and Measuring Trust".

Book Chapters

- **Isabel Schwaninger**, Astrid Weiss, Geraldine Fitzpatrick (forthcoming): "Exploring Bottom-Up HRI Research for Ageing in Home Environments. In: Trust Robots, TU Wien University Press.

- **Schwaninger, Isabel C.** (2016): „Begegnungen in Yunnan: Exotisierung und Kommerz". In: Profanter, Annemarie (Ed.): Dialog der Kulturen. Anthology, Bozen, Peter Lang Verlag.

Invited Talks

- **Schwaninger, Isabel** (2022): Human-Robot Interaction in Home Environments. Invited Talk: LarSys Institute, Lisbon, Portugal, 3 March 2022.

- **Schwaninger; Isabel** (2021): Home is where my Robot is? - Exploring HRI in Living Spaces. Invited Talk: Trust Robots Lecture Series, TU Wien, 01 October 2021-31 January 2022.

- **Schwaninger, Isabel** (2021): Menschen und Roboter: Die Bedeutung von Beziehung und Vertrauen in der Telemedizin und Pflege. Internationales Dialogforum Goldegg, Österreich, 20-22. September, 2021.

- **Schwaninger, Isabel** (2020): Ergebnisse zur Studie "Barrieren und Motivatoren zur Nutzung von Telemonitoring" . Online Conference: CCIV 4. Digitales Vernetzungstreffen Chronische Herzinsuffizienz (CHI), (invited); 2020-10-10.

- **Schwaninger, Isabel** (2019): Older Adults and Trust in Robots: Reflecting on Older People's Experience with Technology for Care. Medien in Kooperation 2019, Universität Siegen.

Workshop Organizations

- Jesse de Pagter, Gullieglmo Papagni, Laura Crompton, Michael Funk, **Isabel Schwaninger** (2020): Trust in Robots and AI. Workshop, Robophilosophy Conference 2020, Aarhus, Denmark

Theses

- **Schwaninger, Isabel C.** (2014): „Exotische Kulissen: Begehren und Ethnizität in Yunnan". Master thesis, University of Vienna.