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What do Older Adults Want from Social Robots? A Qualitative Research Approach to Human-Robot Interaction (HRI) Studies

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Abstract
This study investigates what older adults want from social robots. Older adults are often presented with social robots designed based on developers' assumptions that only vaguely address their actual needs. By lacking an understanding of older adults' opinions of what technology should or could do for them–and what it should not do–we risk users of robots not finding them useful. Social and humanistic research on the robotization of care argues that it is important to prioritize user needs in technology design and implementation. Following this urgent call, we investigate older adults' experiences of and approach to social robots in their everyday lives. This is done empirically through a qualitative analysis of data collected from six group interviews on care robots with health care service users, informal caregivers (relatives), and professional caregivers (healthcare workers). Through this "Need-Driven-Innovation" study we argue that, to secure a functional and valuable technology-fit for the user, it is crucial to take older adults' wishes, fears, and desires about technology into account when implementing robots. It is also crucial to consider their wider networks of care, as the people in these networks also often interact with the assistive technology service users receive. Our study shows that more qualitative knowledge on the social aspect of human-robot interaction is needed to support future robot development and use in the health and care field and advocates for the crucial importance of strengthening the position of user-centered qualitative research in the field of social robotics.

Keywords Older adults · Gerontechnology · Social robots · Norway · Participatory design · Qualitative method

1 Introduction

Human-Robot Interaction (HRI) is an interdisciplinary research field looking at the interactions between humans and robots. Its primary technological aim—implementing technology that works—is strongly connected with sociotechnical issues of making technology that is accepted by users and works for their lifestyles. This paper questions whether older adult human end-users are sufficiently included in robot development and empirically demonstrates the usefulness of a qualitative user-centered approach to this question. Within a Social Sciences and Humanities (SSH) framework, several socio-technical approaches are developed that can contribute to the understanding and design of human-robot interaction through offering analytic tools that takes the situated nature of such interaction close into account.

Social robots are increasingly seen as a possible augmentative tool to solve healthcare service delivery issues related to efficiency and quality concerns, especially in the rapidly ageing countries [1–3]. However, this turn to robotization of human-robot interaction in the healthcare sector is accompanied by major ethical and societal challenges [4–6], such as end-users being potentially treated as a quantifiable, controllable variable in the technology development process. An important tool to counteract such tendencies is to take the future use context more in-depth into account during development. This can sensitize and secure a technology development that speaks more to the unique individual end-users' different and personal wishes and fears about challenges in their own everyday life, thus making the technology able to better answer their needs. A more extensive use of qualitative research methods built for the purpose of exploring context, emotions, and social interaction will contribute to this sensitization.

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Critical arguments against qualitative studies often target their low number of informants and more limited potential for generalization compared to quantitative and experimental methods. Yet, the classic statistical generalization to the population is not an ideal within qualitative research, which instead aims to provide a rich, contextualized understanding of human experience through the intensive study of particular cases [7]. Another important measure for generalization within qualitative research is theory-development, often known as conceptual generalization [8]. The end product of qualitative analysis is a generalization on the method's own terms, in addition to the illumination of the particulars of human experience in the context of the given phenomenon [9]. This can also contribute to the growth of systematic knowledge. Taking individual dreams and preferences into close account is especially important when considering how to design "the robot" to exist in human environments rather than just robot environments [10]. This applies both to formal work environments and to the private home, which in many concerns represents a much more complex social arena to navigate within than what is often anticipated [11]. Unfamiliarity of this complexity can become a bias in robot development and implementation.

For example, qualitative research studying the ways that technology can enter and become part of social interaction shows that human actors interpret and act towards social robots as expressing and perceiving emotions during their communication or while using natural cues such as gaze or gestures [2]. Qualitative methods that are designed to be sensitive towards situational and interactional dimensions of social action are the most efficient tools to grasp such details. Some scholars suggest that there is a lack of mutual inspiration between developers of robotic systems for older adults and other individual-based technology development [12, 13]. Two related problems that better end-user engagement can contribute to solve are the "I-methodology" trap where developers create technology chiefly based on their own needs and beliefs and the "configuring the standard user" trap that can lead to technology that works only for the imagined standard (hu)man and not for specific users [14]. More knowledge about context, use and needs as experienced by the end-user of the technology can thus bridge the gap between the development of robots for older people and standard individual-based technology development.

1.1 Targeting Socially Assistive Robots in Context

Robots that portray social abilities to socially assist or support humans are, not surprisingly, called *socially assistive robots*. They have been deployed for different end-user ages, from older adult-care [15, 16] to children with autism [17]. It is often argued that robots' potential as assistive technology to supplement human contact in care can increase individual autonomy and independence [3, 18–21]. Robot technology could, for instance, be an interface that connects older adults to social networks, such as their relatives, friends, and healthcare workers [22]. In a study of social robots with video call capability, Moyle et al. [23] found that both family and professional caregivers of persons living with dementia experienced that robots reduced social isolation and increased connection by enabling residents and families to 'visit' each other. Additionally, they found that staff members thought that having a face and a voice on the robot made it more "real", thus making it seem less like a piece of machinery. These findings exemplify why it is important to be optimistic about the possibilities of socially assistive robots. Yet, they also exemplify the necessity to take the situated context of HRI into account, through addressing variables that are complex, individual and shifting over time, such as the social functioning, size, and resourcefulness of the end-users' social network.

The rapid speed of robot capabilities improvement efforts calls for a more extensive investigation of social cues that need to be included in HRI systems. As Dobrosovestnova et al. argue [10], this must be accompanied with a turn from approaching robots as artifacts alone to approaching them through an interactionist perspective. This includes taking a process approach to the robots. For instance, there have been suggestions for a Robot Facilitation Framework that divides facilitation into pre-, peri-, and post-facilitation [24]. This demands more in-depth knowledge of how users' experiences of and interactions with technology affect and change during the human-robot relationship.

This paper contributes with findings from a qualitative empirical study of end-users and their preferences and worries about interacting with robots. The paper particularly highlights the role of the chosen qualitative methods used with the hope that such methods can be used in similar studies of other robotic systems. The study was based on qualitative interviews with older adults and designed in accordance with an interdisciplinary SSH approach that combines insights from social studies of healthcare, digital Science and Technology Studies (STS) and HRI-studies. The paper investigates the requirements for real-world use of ICT and robots as seen by older adults with different needs, thus taking a user-perspective to social barriers for the accomplishment of a human-robot relational fit.

In doing this, we follow Frennert and Östlund's [13] urgent call for "participatory design that includes users at the early stages of social robot development and continues to include them iteratively throughout the design process". Similarly, and in line with e.g., Dobrosovestnova et al. [11] we urge the international robotics community to understand social robots more as a social construct that interacts in a

social and situated environment. This includes considering how people perceive themselves in relation to robots since the perception shapes how humans make sense of the robot and guides the narratives constructed about it [25]. Resourcing the robotics community with tools for taking social concerns and use contexts more into account will strengthen its ability to develop healthy and appreciated human-robot interactions. We ground our discussion in an empirical exploration of older adults' general perceptions of interactions with social robots and the societal challenges that these robots produce. Firstly though, let us consider more in-depth why societal development trends necessitate an increased focus on robotics and robots' social role, as this background information is context as well.

2 Aging Increasingly with Novel Technology

Technology designers have just recently begun to engage with contemporary social, technological and political conditions and to seek outputs that reframe the view of end-users as individuals and collectives situated in complex sociocultural and political settings [26]. Yet, current moves within design communities reflect an understanding of the relationship between the social and the technological that has developed within the STS-field, and particularly within more sociological perspectives in STS: technology and social relations operate as assemblages, that is, together they constitute "events" that are shaped by various factors, concepts, practices and relations [26], such as a physical meeting between a human and a robot that is shaped according to its social context and resources.

Approaching robots as artifacts in events that are involved in interactions within broader socio-political contexts opens up the possibility for empowering stakeholders through involving them in co-design processes [10]. This approach also requires knowledge about these contexts, and how context is defined can be seen as a political choice. For instance, deciding whether it is the older adults themselves, relatives, or public service organizations and individual service providers that are the main end-users of a robot technology has clear implications for what the context for using the robot is and, consequently, whose concerns should be considered during design of the robot.

Awareness about politics and policy development provides an in-depth understanding of the current state of robot development for the public health and care sector. This development has in general sparked due to political demands for restructuring welfare policy thinking and systems. technology development of robots for older adult care is highly politicized in industrialized countries in the Global North—perhaps especially in the Nordic countries where we situate our study. An important ingredient in the typical story of the need for robotization and digitalization in older adult care, is the mentioned aging demographics that pose challenges to the current models of care provision. Globally, the proportion of people 60 years old or older is projected to nearly double from 12% to 2015 to 22% in 2050 [27]. This is expected to lead to a dramatic shortage of healthcare workers [28–30] and an increased demand for health and social care services [31]. The increase in public healthcare expenditures on account of this demographic shift raises concerns about the long-term sustainability of the current healthcare model [32–35]. Technology represents a core strategy to reorganize the health and care services, together with a turn in policy towards values of "active living" [36] and "the home" as the place where most people want to stay while they age [37].

Robotics has increased the productivity and resource efficiency in the industrial and retail sectors, and there are expectations that a comparable transformation in healthcare can emerge [38]. Many efforts are taking place to realize this transformation, for instance through innovation and design processes to further develop care-delivery models [39, 40] and the testing of new technology in different care and treatment contexts such as therapy for non-neurotypical children [41] and municipal home care services [42]. In the Nordic countries, the technologies that emerge through this initiative are known as "welfare technology." This is a technological cluster that expresses the cultural mix of demographic development, the Nordic welfare state model and ongoing restructuring of the welfare system, and expanded ICT possibilities [43].

Some argue that the current rate of health technology innovation is becoming overwhelming for both the patients and their caregivers [44]. Other claims that welfare technologies contribute to individuals' self-reliance and knowledge of their own health [45]. They can for instance empower users to be more social, either by increased mobility outside of the home (with the use of physical assistants or robotic wheelchairs) or by bringing the world into the home of the user e.g., through telepresence or communication technology [46]. But, as Östlund et al. [43] warn, "older people will continue to participate [in welfare technology testing] in the form of constructed hopes of technical solutions and a range of products will land randomly in our everyday lives, some as innovations, others as failures." Consequently, a holistic view of how technology is integrated into their daily lives is essential so that older adults are not bombarded with seemingly random technological solutions that may not be relevant to their specific situation [47]. This highly concerns social robots, as they are even more associated with a gap in ideas and realities for what they can do for us - than more mundane technologies such as mobility aids.

Thus, as this short description of the societal context for social robots designed for older adults shows, their need for robots is first and foremost defined by other stakeholders than themselves - and these are stakeholders who have the power to shape the older adults' everyday lives at a distance from their home. This makes it even more pressing to mobilize awareness about the human component in HRI, to secure an ethical development of future human-robot interactions among older adults and their robotic tools.

In the healthcare field, HRI has long posed promises that have not been completely fulfilled—as demonstrated in Sect. 4.1 of our paper on thwarted expectations. For instance, a general challenge is how to preserve the older adults' dignity when facing a function reduction. Developers often miss a crucial opportunity to contribute to this issue when not taking end-users' wishes and fears into account [48]. Sustaining an ability to live healthy and independently at home contributes to an individual's perception of dignity without feeling like a burden to their friends or relatives [49]. Then it is crucial that specific homes and the adults residing in them are understood on their own terms. While robots have been freeing up human resources in an industrial context, this is not necessarily a desired or achievable effect of social robotic technology in care services. While it is desirable to have solutions that provide more free time to caregivers, attention must also be paid to the importance of human contact and how this added resource can be used to further benefit the recipients of care. This delegates responsibility to service management, as they must secure an approach to technology use that is not primarily grounded in a cost-benefit calculation. Such local concerns related to organization structure and performance incentives can affect the interaction pattern between end-user and robot as well and must also be taken into account by the relevant design community.

3 Methodological Considerations

Approaching social interaction as the main analysis unit to explore the social organization of people and technology is no new exercise [50, 51]. However, this has taken place mostly within micro- and meso-oriented qualitative research that technology or engineering researchers or practitioners have not widely participated in. This is in contrast with the general value of qualitative research to support technology development being more widely accepted [49], as for instance demonstrated through the increased demand and call for user-centered research or participatory design. This represents a turn to user-involvement as a core issue in inclusive design to ensure that the end-users' needs, wishes and desires become a driving force for the technology development [26].

Table 1 Empirical material

Interview approach	Sample #	Interviewees N = 22	Themes	Duration
World Café Method	A	5	Robots in everyday life	90 min
	B	4	Robots as welfare technology	90 min
	C	4	Robots and relations	90 min
Focus groups	D	4	Experiences with robots as informal caregivers	110 min
	E	3	Experiences with robots in users' homes	65 min
	F	2		40 min

Selecting the best method to empower users' participation in user-centered design and research processes is commonly seen as difficult [26]. We therefore thoroughly describe our design in this paper. To map what older adults want from social robots, we decided to go directly to the source and interview them and their networks of caregivers (formal healthcare workers and informal caregivers (relatives)). Our inquiry followed a model of participatory design called "Need-Driven-Innovation" [46]. This model emphasizes the technology user's existing and future needs, to ensure that the development of solutions adheres to these. One premise is that technology users are experts of their own life and daily practices. Thus, they hold intrinsic knowledge of what technology can (and can't) help them with. In addition to the end-users, there are multiple stakeholders involved as secondary users, and collectively they constitute a "user-segmentation" [52]. For our case study, this user-segmentation consists primarily of healthcare employees, relatives and local management at municipal healthcare centers.

Our study design integrates six qualitative focus group interviews (A–F), with strategically sampled informants representing the user segmented network around older adults' needs, wishes, and fears concerning social robots and welfare technologies. Older adults as end-users were also represented in the focus groups. The interviews were done as part of several collaborating social scientific Norwegian-based national and international research projects that all focused on the role of social robots in society. The projects studied technology development and contextualized technology in a user-centric model of participatory design. The core data material consists of two main approaches to group interviews as shown in "Table 1: Empirical material."

The first three group interviews were thematized as "coffee-talks about home robots" (A,B and C). Each group consisted of 4–5 participants, with representation from all age cohorts (from 40 to 80 s), genders, and differently abled people. They were health care service users, close relatives of service users (or both), members from

local elderly councils, and healthcare professionals. The informants were either participating in ongoing municipal projects using social robots or had prior experience with welfare technology solutions, of varying complexity. This ranged from experience with social robots such as Pepper, to simple automatic pill-dispensers. Some informants had prior knowledge of each other, but the majority were unfamiliar to each other. The informants were recruited through an open invitation to participants of the selected ongoing projects. All who accepted the invitation were invited to participate. This was supplemented by special invitations to missing stakeholders deemed relevant. such as elderly council represents. The interviews were done and facilitated by the first and third author, together with an acknowledged graduate student, in spring 2019. The "coffee-talks about home robots" framing was strategically chosen to shape the dynamic of the focus groups. The framing was inspired by World Cafe Method (WC), a participatory assessment tool that is widely used in for instance community development and organizational change processes, as complimentary to traditionally organized focus groups [50]. This group of interviewees were heterogenous in their composition and were asked both what they themselves would want from a healthcare robot as well as what they thought their relatives and loved ones would want. This puts a responsibility on the side of the interviewee to imagine technologies and solutions. One possible mitigation of this difficulty is to combine it with other methods, e.g. product demonstrations. There is a risk that the informants want to please the interviewers by being more positive towards technology than they would otherwise be, but we underlined that we were asking them objectively and that we did not have any stake in the different technological solutions.

The dynamic of focus-groups is sensitive to the number of informants, the researcher role undertaken during facilitation and the combination of formal and informal roles that the informants have in advance or take to each other during the interview. This is also a key strength of the focus-group, as it opens up the possibility to study the interaction between the different informants simultaneously as their meanings about the questioned topics emerge. One group consisted, for instance, of healthcare workers, caregivers, retirees and researchers. This group discussed different aspects and ambitions of welfare technology that concerned them all, such as security and future wishes for needs to be addressed. Combining stakeholders provides the possibility to explore how different meanings and worldviews get woven together during the group's dialogue. WC implies implementing as inclusive an approach to the group discussion as possible, to secure an open, yet intimate, dialogue that accesses the views and knowledge present within the larger group of people [53]. Thus, "coffee-talks" function as a low-threshold framing of the interviews and encourages interaction and inclusive dialogue between the informants of the focus groups. It also describes the researcher's multiple roles during the interview—shifting between a waiter who offers new topics to discuss from the menu and a doorman, with the responsibility of closing up when it is time to stop.

The other groups (D, E, and F) were interviewed in a home-robotics project, with groups of 2–4 participants consisting of end-users and secondary users (in the form of relatives who served as informal caregivers) of robotic systems in the home. Group E and F knew their respective co-interviewees, whereas group D consisted of dependents involved in the project who did not know each other. These interviews were done and facilitated by the first author, together with an acknowledged graduate student, and were conducted in autumn 2019. Here, the focus was both to evaluate and elicit experiences on how the home robot system that they had tested performed while also inquiring how such systems could be improved in the future. All informants (Groups ABC and DEF; total $n = 22$) were recruited through the projects, with all ethical and informed consent requirements fulfilled. The gender distribution was about 2/3 women, and informants ranged from 40 to 80s years of age. One empirical shortcoming was the lack of geographic diversity, as all informants were Norwegian. As this group of interviewees were actively engaged with specific robotic systems, they could explain in-depth their experience with said robots; they did not have to imagine solutions in the way the other informant group not necessarily enrolled in robotic testing would need to. They could thus describe their relationship and experience with robots based on first-hand knowledge.

Potential limitations of the study include the heterogenous data from two distinct methods and the lack of full representation, e.g. of marginalized groups who might lack access to research events. Regarding the data, we have made efforts to compare thematically in order to gain insight from different stakeholders and users—both current and potential—of robotic solutions.

The interviews focused on what opportunities and challenges are created by technology, specifically what the informants saw as the most crucial functionality that a social robot needed to have for their own and their relatives' health and wellbeing. This qualitative approach does not seek to "unveil" quantified data on the average user; it rather endeavors to first open the "black-boxes of technology" [54], as end-users—particularly older adults—are often not part of the discussion on reflecting how their (welfare) technologies should work. Thus, starting a dialogue and involving the end-users in the conversation about robots is a first step on inclusive design that can contribute to emphasizing

the importance of considering the social dimension of social robots. The questions were led by the interviewers. Examples of questions for Groups ABC were:

- *What could you need extra help with in your own home (in general, not just with robots)?*
- *What do you envisage that robots can help with in your everyday life?*
- *What should a robot be like for you to want to use it?*
- *Do you have any experience with welfare technology (technology that can help people have a better life by promoting independence, activity, and participation in society)?*
- *What do you think of robots?*
- *What do you think your own family and friends would think if you got a robot at home?*
- *Can robots be a link between grandchildren who look forward to having the robot with their grandparents?*

The interviews generated a rich and complex data material, which we analyzed through an inductive strategy and a thematic analysis (TA) framework [55], looking for trends and topics that emerged from the data material. Interviews were coded in the qualitative data analysis software NVivo through a thematic analysis. Through initial coding, search for themes, review of themes identified and mapping of relations between themes, a pattern in the informants' own stories about social robots evolved. Examples of such inductive codings are: wishes (reminders, song and dance, simple tech), communication, exercise, "being a bother," loneliness, warm hands vs. cold tech, GPS, and governing vs. autonomy. Succeeding in this necessitated a deliberate choice to not predispose categorical inquiries onto the informants to allow older adults themselves to organize their thoughts about social robots in ways that made sense to them, to define the core of their inquiries for social robots. This inductive strategy was of course also followed during the interviews. We also flipped the normal design choice on its head, not asking how an older adult should use a specific social robot, but rather, how a social robot could be designed to better help with actual people's needs and wishes. We categorized our findings in the following results, as presented in the next section.

4 Findings: Make Robots that Help with Relevant Problems

Many topics and themes emerged through the different focus-groups' discussions. In this part, we summarize key results found in the empirical data. The informants expressed that they were glad to finally be asked about their thoughts on socially assistive robots and other welfare technologies, as for many, this was the first time they were asked about their opinions and ideas about what they wanted out of the technologies being designed for them. This can be seen as related to a general technology-fatigue of "too much that doesn't work the way we want it to work" (according to one of the informants).

4.1 Thwarted Expectations

There was a major puzzlement among the informants that the social robots developed did not match people's perceptions of what they *should* be able to do. People's perceptions of robots were often quite skewed by fictional representations, and many informants expressed that they expected more. However, the general autonomy of robots like Pepper were described as "lifelike, eerie, and someone's there." For many of the informants, the robots represented something quite novel, almost like a new species one needed to interact with in new ways. There was the expectation for social robots to really deliver what they promised, which made many of the informants quite reluctant to want to engage with robots, at least "until they do something useful for my life", as one informant explained. Let us consider this first meeting with a Pepper robot at an elderly care facility, where one of the programming nurses told us how inhabitants such as "Kari" (fictional name) from the World Café group reacted:

> *It was quite fun. We had this "exercise with Pepper" event, where I could program Pepper to tell individuals that "You are doing great, 'Kari!' and then Kari would light up and say "Oh God, he recognized me! Ooooh!" And this was a resident with dementia, so there was a lot of good laughter and a happy mood with the other participants too. It became something humorous. And when they got encouraged directly, by their own name from Pepper I could see that they felt important. The downside is that I expected Pepper to be able to do more, and I was a little disappointed that the development isn't further ahead.*

The healthcare workers pinpointed that robots such as Pepper need to be able to activate themselves and be autonomous. According to the healthcare workers, a robot that can move around without having to be activated and followed by human staff all the time is needed. "He needs to be able to move freely, in the hallways, in the living-rooms, and if he gets a reaction from the elderly, he needs to be able to react and answer them, so that we can really benefit from having a robot here." It was emphasized that a robot needs to free up time instead of taking up time. Only then could it

be seen as truly social, without having to be constantly monitored. It was also mentioned that recognizing faces, names, and voices of the inhabitants would add significant value.

However, it was seen as negative when robots became too autonomous and then did things on their own that weren't socially acceptable. For example, an informant who had tested robot technology explained that when the robot started to speak at 4 am, this was quite scary for the older adult who was sleeping, who could think that someone had entered their home. One healthcare worker at an elderly care facility told us in the World Café the following experience when a Pepper robot came to their facility:

> *When Pepper came, instead of adding a hand, he required a hand. I do really like the warm hands of caring, but I see that things must change to become better. We must be open to new things; we see that times are changing. But it is a bit scary. I educated myself to work in healthcare because I like people so much, and I see how much safer our inhabitants are when they get a good conversation, through caring, if they are anxious and so. I have some difficulties seeing something else talking to them in room...*

Many are (rightfully) skeptical about what robots can actually do and are not very impressed with the robot technology currently being tested. As our informants say, as long as the robot is not autonomous and requires people to operate it, it just adds to all the work they already have to do. However, the more often users have direct contact with the technology and try it out, give their feedback, and become part of the development, the more their expectations will be rooted in reality and not e.g. by fictional beliefs of what a robot is.

Our informants' attitudes towards the robot also impacted how they anthropomorphized the robot, which can itself contribute to the robot feeling acceptable or not. Kari responded positively to Pepper by excitedly saying "He recognized me!", implying that Pepper was in some way thought of as a living entity, whereas the skeptical healthcare worker responded to the same robot—designed to look humanoid—in a more ambiguous manner. The worker said that "he" [Pepper] "required a hand" i.e., needed assistance from healthcare workers to carry out its tasks. But when the worker talked about Pepper having a social interaction with an older adult, this skepticism was expressed by saying they had "some difficulties seeing something else talking to them in the room." The robot was a "something" rather than a "someone." This points to the importance of the purpose of the robot. Is it meant to be strictly utilitarian in helping accomplish specific tasks? Or, given that loneliness and lack of emotional connection is a chief concern especially for older adults [56], should the robot seek to provide emotional connection? And while some people may be supportive of such emotional engagement, others may be especially distrustful of such engagement coming from what they perceive as an inanimate object inappropriately trying to mimic human interaction [57]. These examples of nuanced expectations as well as differing responses to the same behavior is important for developers to consider.

4.2 Heterogeneous Needs

Further, experiences with what types of welfare technologies and social robots proved useful were quite heterogeneous and multi-layered. Some of our interviews were with users of an integrated system of social robots and sensor technology. The robots had a social aspect by talking to users. They also collected information about users' actions through sensors and relayed that information to informal caregivers through a smartphone app, thus providing information in a non-social context. For example, informal caregivers often described the sensor-feedback that they received through mobile devices in connection to social robots in the home of their family members as reassuring, allowing them to gain more freedom and autonomy in their own lives [46]. Thus, the social aspects of social robots were not always seen as the most beneficial form of welfare technology, although some of the functions of these robots—e.g. sensor notifications—were seen as very useful. Although older adults did report general dissatisfaction with loneliness in their old age, they often sought solutions for practical, mundane problems that were more pressing—difficulty walking up and down staircases, fear of slipping on icy ground, insecurity about who could help if it was suddenly needed—rather than being interested in very social robots.

Fitting the technology into the homes of users is important. As an example, one informant from focus group D described how power cords could prove a hindrance in their particular home situation:

> *Sometimes the system will tell me 'all internet connections offline' and then I know my parent has pulled out all the cords, they pull them all out before going to bed out of habit. But we have hidden the contact under a table, so that it won't be noticed that easily. But sometimes the cleaners who come pull out the plug to the robot when they need it for the vacuum machine...and then we get error messages.*

When speaking about the needs of heterogeneous users, the needs of informal caregivers are also important as secondary users. One informal caregiver explained that through monitoring technology, their life became much easier. "Previous to getting the sensory technology I worried much,

much more for my old parent. Now I am much calmer on their behalf. I used to not travel away from the house much, fearing my parents might wander off or hurt themselves, but now I can check in the app that they are okay." For the older adult using the robot sensory technology, the needs were a bit different than for their child who was caring for them. The older adult saw the robot as something that talked and had some company to it, while their child saw the sensor technology connected to the robot as the key benefit for their own need to feel that their parent were doing okay.

User segmentation is important to break the assumption that there are only a few "standard users" among "the elderly." This stereotyping does not take into account the heterogeneity of older adults as people with very different life experiences that shape their own individuality, and a standard robot cannot possibly fit the diversity of personalities of older adults as a group. We need robots who can give knitting recipes, but also robots who can recommend bungee jumping sites—we need robots that stay in the background and only speak when spoken to, but also those who actively engage lonely older adults if that is indeed wanted by the end-user. And beyond functionality, there are also differing opinions of what a robot should *be* as we saw earlier; should it be an entity that can approximate human interaction, or should it be a fully inanimate object? A robot perfectly tailored for each user is not economically or technically feasible—but there is still huge potential in tailoring it beyond the "standard user."

4.3 Robots as Part of a Larger Digital Shift

Interestingly, the informants reminded us that social robots were not anything new for them in terms of technological shift—even though robots may quickly evoke associations of them being something completely different than the technologies that are already domesticated in society. As several informants underscored, they had lived through the technological transitions involving TVs, radios, the internet, social media and more. They had seen technologies come and go and thus saw robots in a longer trajectory of technologization and digitalization of society. Although social robots represented something new, they also reminded them about older types of technology. For instance, some informants in focus group D who had personal experiences with robots emphasized that the robot was only part of the user's technological home and everyday life, and they compared it to when the television was introduced to the home of their loved one—"the TV, now *that* was a major change!"

For example, one member of the focus group was a caregiver to a close family member with mild cognitive disabilities who were using a social robot for companionship. In this case, the social robot was interpreted more like a gradual implementation into everyday life, rather than a radical one with paradigmatic effects. The family member used the social robot as a social addition to her life, with the technology being integrated into what can be termed a "home-technology infrastructure" of TV, radio and other sound-making equipment that mostly provided entertainment. In contrast, for the caregiver, the robot represented a connection node to a technological network that provided reassurance that the person they cared for was doing okay, due to it connecting the user to sensors, monitoring technology and thus to the health and care services. This contrast was performative, in terms of it shaping the different actors' interaction with the robot differently.

One of our informants from focus group D whose older relative had tested out a sensor-system connected to a robot, argued that welfare technology should be implemented earlier in the process. Her relative lived alone, but had cognitive difficulties, and when the system was installed, it was two years too late in terms of learning how to use the technology, thus making it difficult to truly become part of the user's home environment. This informal caregiver argued that it should be a mandatory right to get offered such technologies, just as she perceived citizens in Norway to have the right to safety alarm technology if they have a documented assistance need that can be met with the alarm. Their dream was that a certain age threshold would trigger an invitation to get welfare technology implemented to support the safety of their aging loved ones. It is desirable that older adults be able to age in their own homes as long as possible, from an economic point of view in addition to a quality-of-life point of view, thus implementing such a system could ultimately save municipalities money in the long run.

5 Discussion: Bringing the Human Back into Human-Robot Interaction (HRI)

Turkle [58] warns against long-term consequences of care technologies which can end up making us "alone together" as we risk becoming lonelier than we were before we had the technology. Other scholars stress that robots may be the problem they try to solve, exacerbating, for instance, the feeling of loneliness that they aim to bridge [59, 60]. Thus, it is imperative that technology is designed, developed, and domesticated in a just and responsible way. This includes making the humans in the HRI more visible. As Neven [61] makes clear, it is important to make the changes that technology implies to the lives, self-understandings and everyday organizing practices of older people clearly visible. Even though technology often seems so evidently "the right thing to do" we argue that it must be the right technology for users' needs and wants—and what is right or not does not

exist in a box. When looking at our findings in comparison with Frennert and Östlund's article, "Seven matters of concern of social robots and older people", [13] there are a lot of similarities, but some divergent points:

5.1 Role of Robots in Older People's Lives

Frennert and Östlund [12] write, as we among others do, from a STS perspective, and they are in line with our understanding of social robots as situated data, described by them as "technological change intertwining with existing social and technical relations that are already in place" [13]. The social construction and interpretative flexibility of technology are important STS-pillars that guide our work, seeing technology as something constructed between societal actors with different values, backgrounds, and interpretations of how a technology is and should be used [62]. Taking robots into our lives, or domesticating them, has a social component—it is not only the single user who has to adapt to robots, but a wide network of stakeholders, such as caregivers, policy-makers, organizations, developers and more who are involved [47, 63].

Thus, they critically challenge the notion of robots "having no social baggage" [64]. One key aspect they discuss is the "helper theory" [65], where social robots could potentially be enabling the user by giving them something to help and care for rather than the robots caring for the users. Dautenhahn [66] juxtaposes these paradigms as the "robot as a caretaker for the human" vs. the "human as a caretaker for the robot". As Frennert and Östlund [13] write, "If robots are considered as caretakers or assistants to humans, they need to be able to recognize us as individuals, understand our intentions and remember our habits and preferences". This was borne out in our data, where our informants expressed a desire for technology that not only understood them and their individuality, but who could also be a companion and add something novel to their lives. This turns social robots from having mainly a servant function, to them having a potentially much larger repertoire of roles in interaction with humans, thus adding meaning to HRI.

5.2 Factors Affecting Older People's Acceptance of Robots

There are multiple socio-cultural functionality issues that need to be taken into consideration if people are to accept social robots [67]. For instance, as with most artefacts, Flandorfer [12] points out that people who have had previous experience with robots accept them much more quickly than those who meet a robot for the first time. We noted the same observation in our study. Symmetrically, we found that this also holds true for previous *negative* experience. An illustrative example is "pilot-fatigue" where users who were in multiple pilot programs and had experiences with technology that didn't work well for them (yet) wanted quicker results, which was in tension with the need of technology to be tested and changed based on its workability. Test-users reported that they often tried "potential solutions'' rather than working ones, but some of the general pitfalls could be avoided by asking end-users earlier in the process what they actually need from social robots. Such negative preconceptions are then taken into subsequent situations where the users are predisposed to have negative feelings towards new robots. Thus, our findings align with Frennert and Östlund's recommendation [13] that "identifying the purpose of the robot and its development, has to involve all stakeholders including prospective older people, healthcare professionals, relatives and family. It has to work for everyone, when one needs it, and in accordance with how one needs it." Social robots are distributed social events that connect stakeholders. Due to the different functions the robot fills for them in their everyday work or life situations, the stakeholders also ascribe the robot different meanings. It is therefore critical to avoid a dominant spokesperson-policy during technology design and testing. As we have seen in our analysis, older adults have diverging needs of what a social robot should be for them, implying that this must be taken into account through flexible design solutions that are recognized as such also by the end-users—not only the designers.

5.3 Lack of Mutual Inspiration in the Development of Robots for Older People

One of our interviewees, a community leader of an older adult council stated: "you know what, this is the first time anyone actually asked *me* what I want from these robots!" Although they had been approached many times with ideas of how social robotics could improve their life and the lives of fellow older adults, this was the first time they had been approached as an equal with unique expert knowledge. The prevalence of such interactions is not surprising given that, as Frennert and Östlund [13] note, the vast majority of previous robotic literature treat "the elderly" as a homogeneous group that is an object for research and technology rather than a partner in robotic development. Part of the problem has to do with the term "the elderly'' which, as Neven [68] notes, often carries reductionist connotations of general physical and cognitive frailty. When one thinks of older adults as always physically and cognitively frail, it is easy to assume what needs must be addressed and that the end-users aren't suited to meaningful engagement in developing solutions. In reality, older adults exist in many states of cognitive and physical fitness and, when they are properly approached, they can reveal a wide swath of issues where

robotic assistance could benefit them, as well as ideas about how those needs should or should not be met. While old age evokes few positive cultural connotations, thus reproducing a narrow understanding of old age and "the elderly", we also suspect that the reductionist connotations of physical and cognitive frailty have to do with the public older adult care institution itself and its role in society, as it upholds the associative link between old age, frailty and dependence. To overcome thwarted expectations, as we've discussed in our analysis, engaging older adults in the conversation is a first step towards inspiration between users and producers.

5.4 Robot Aesthetics

The aesthetics of robots, which is an important consideration for their design and use, is, as other aspects addressed above, situated in socio-cultural contexts. This has previously been explored, e.g., through the gendering of robots [69, 70]. What a robot should look like, and how this impacts the way people use and *want* to use it was of key importance in our study as well, but on a quite pragmatic level. Whilst researchers often get lost in cyborgian meta-ontological debates of what robot-human relations *could* be, we argue for the urgent need to critically engage with people who use robots today and could in the near future about how they experience them and what they want them to look like. For many of the informants, the technology's aesthetics were trumped by its usability—if it works, it doesn't matter so much what it looks like. On the other hand, some were also joking about how it seemed to adapt to the local culture, e.g. through knowing local music. Our analysis finds that robots are often seen as part of larger technological shifts, but that technologies that are thought of as quite mundane, like TVs, were quite the game changer when introduced. This meaning-making process is understudied from a user-perspective, and we call for further research on how technology might adapt to different cultures from the standpoint of *the end-users* themselves. This would clearly be in line with core principles of paradigmatic SSH methodologies (see e.g. [71]).

5.5 Ethical Implications of Using Robots in Caring for Older People

There are major ethical implications inherent in the use of *any* robot. Social robots for taking care of older people are perhaps one of the most ethically challenging arenas for robots to work in, see e.g. [72–74]. Within our study, the main criteria again is the lack of involvement of older adult end-users in social robot development and implementation projects. This involvement is a cornerstone of ethical technology development, and a part of robot design where many past mistakes could have been avoided—e.g. deciding on the best placement for robots, where one of our interviewees described robots having to compete with the sound levels of TVs when placed right on top of them. In such situations the robot had little chance of being heard, especially when the user experienced some level of hearing loss. Involving the end-user is crucial for avoiding the severe pitfalls of potential ethical breaches that can occur during HRI. In some cases it can be extremely challenging, e.g. when interacting with people with dementia who do not have the cognitive ability to consent. Such cases demand a lot of the HRI researcher or technology developer, as they take on a huge responsibility for the people involved in the technology interaction. Yet, the dreams, desires and longing of people with dementia must be taken into account so engaging with them is essential while simultaneously securing their dignified right to privacy and consent. It is also important to symmetrically care for the robot, to secure good work conditions for it in action, thus improving the quality of the human-robot interactions.

5.6 Robotic Research Methodology

As Frennert and Östlund [13], our discussion, and this special issue make clear, there is a need for advancing the methodology of social robot implementation and HRI research. We argue that a key concern for this further development of robotics research methodology, is to take the user into account in a meaningful and precise manner during the entire technological design process—from the initial ideas and aspirations to the stage of practical implementation and evaluation. This argument is also grounded in a contextually oriented SSH research tradition whose methodological resources can benefit the more technically oriented but interdisciplinary research field of HRI.

5.7 Technical Determinism Versus Social Construction of Social Robots

Many of the pitfalls identified in the points above can be traced to a reliance, either explicit or implicit, on "technological determinism". This is the belief that technology has an intrinsic quality bestowed upon it by its designer and that it can thus be used only in one specific way (see e.g. [10]). In this framework the creativity of the user that can adapt technology to their own particular circumstances is ignored in favor of the developer who is in control. This mindset can often lead to developing technologies that simply don't work within diverse, real-life contexts. Frennert and Östlund [13] instead describe "social constructions of robots" where the meaning of the robot and what it can do is dynamically constructed through actual interactions and

unpredictable use-scenarios. In this framework, situatedness and adaptability of the system is key. We especially encourage roboticists to think beyond the "standard user" to see the heterogeneous needs of robot users.

6 Recommendations for Involving the End-users in Social Robot Design

When putting Frennert and Östlund's [13] seven matters of concern in conversation with our findings and empirical analysis, we suggest the following five recommendations as being particularly useful for thinking about how welfare technology, such as social robots, can be designed in a more inclusive way by engaging older adults as end-users in their design:

1. **Are you creating something that the real end-user actually needs and wants, or are you designing it for your imagined end-user?** By talking to, discussing with, and inclusively engaging with the end-users, their thoughts and ideas can be taken into account during the design phase resulting in products that are more tailored for their actual needs, rather than their imagined needs. You may also ask yourself if you create this "something" for the health and care authorities primarily, or for the end-users. The imagined buyer or booker of the technology may also affect the design process. We are not advocating that all robots need to have a one-to-one design for their individual user, but rather that roboticists think beyond the standard user, and take into account different subgroups (e.g. people from rural communities, those that do not speak English, users of different body shape and size, those with cognitive challenges, to name a few).
2. **Are you creating functions of snake-oil or for health, wellbeing and increased life-quality?** Social robots are difficult to create and program, but rather than implementing the "easy solutions" (e.g. playing random music or telling the weather), for end-user engagement, what are the functions needed and most urgent?
3. **Has a diverse group of users been enrolled in the design-process?** Who will end up using this product? Is it imagined as a homogenous group, e.g. "the elderly" or have steps been taken to ensure that designers and developers know that people aged 65 + are just as diverse in their interests, needs, wishes and fears as other age segments? When designing a new gadget for people in their 20s, one would not lump them all together into one user-group; they would be segmented into diverse user profiles. The same should be done for older users of technology, especially social robots who need to know the user.
4. **Have you recognized how data is situated in a specific cultural and social context**? The social robots developed will be part of a social world where practices, relationships, connections, imaginaries and ways of life are constantly changed and negotiated. Social robots need to be adaptable to this situated and thus changing nature of the social world.
5. **Have you mapped and assessed if previous qualitative methods can be used to enhance your project?** There is a wide variety of excellent methodological frameworks that can be utilized to engage in better thinking, reflecting, engaging and including different societal and user-oriented perspectives into your project or product. Participatory design, such as user-oriented design is but of many.

7 Summary

Social robots are not designed in a vacuum. Older adults, as end-users of technology, should have a say in what they want and fear from technology. One method for facilitating this is through a context-oriented qualitative participatory design to provide guidelines of what social robots should and should not do. Older adults have valuable lived experience concerning technological innovations that should not be discounted. Our findings suggest that developers need to take technology-fatigue into account, as the user group is often overwhelmed with too much technology that is not useful or viewed as a positive addition into their daily lives. Further, technology developers should be open for heterogeneous experiences with different types of welfare technologies, e.g. studying how social robots can prove meaningful in more complex social contexts characterized by multiple layers of interaction between different stakeholders, users, and their relatives. Robots are not just entering interactions with individuals, but with social networks; geographically and socially distributed groups and larger collectives in the communities they are put into. All these relations are characterized by the potential for different interpretations of what robots are and which problems they can solve or not, something which can contribute to shaping the lived human-robot interaction practices.

Participatory and user-centered design's practice of user-segmentation [52] is in line with Flandorfer's [12] call for individual-based technology development where there is a deeper focus on the actual end-users. No shoe fits all, but through careful development, someone can perhaps get a perfect shoe—in this case a tailor-made (to some degree) social robot, or at least a social robot that the user will be

able to engage and interact with in ways that meaningfully assist them in their everyday life. Thirdly, and related, there is a need for a closer engagement with what people perceive that a robot should be able to do based on prior experience with real and fictional robots. The development and domestication of social robots should take older adults' wishes, fears and desires into account, to create better and more responsible robots for the actual end-user(s). Robots that enter end-users' lives as part of a public health and care service are technological reflections of the services' interpretations and decisions about the end-users' assistance needs and physical reductions. The importance of a responsible fit is therefore extraordinarily crucial in such a setting, to avoid the too common impression of the technology being a replacement for human-centered services.

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Declarations

Compliance with Ethical Standards All the data collected during focus group interviews was anonymised. The eWare project received ethical approval by the Norwegian Regional Committee for Medical and Health Research Ethics with reference 2018/1911/REK nord. The LIFEBOTS Exchange and My Robot Friend projects were exempt from ethical approval as no clinical studies were conducted and no private user information was collected during the projects.

Conflict of Interest The authors declare that they have no conflict of interest.

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