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A Multiperspective Evaluation of a Service Robot for Seniors: the Voice of Different Stakeholders

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Purpose: The potential of service robots for seniors is given increasing attention as the aging population in Western countries will continue to grow as well as the demand for home care. In order to capture the experience of living with a robot at home, a multi-perspective evaluation was conducted.
Methods: Older adults (n=10) were invited to execute an actual interaction scenario with the Care-O-Bot® robot in a home-like environment and were questioned about their experiences. Additionally interviews were conducted with the elderly participants, informal carers (n=7), and professional caregivers (n=11).
Results: Seniors showed to be more keen to accept the robot than their caregivers and relatives. However, the robot in its current form was found to be too limited and participants wished the robot could perform more complex tasks. In order to be acceptable a future robot should execute these complex tasks based on the personal preferences of the user which would require the robot to be flexible and extremely smart, comparable to the care that is delivered by a human carer.
Conclusions: Developing the functional features to perform activities is not the only challenge in robot development that deserves the attention of robot developers. The development of social behaviour and skills should be addressed as well. This is possible adopting a person-centred design approach, which relies on validation activities with actual users in realistic environments, similar to those described in this paper.

Keywords: aging in place; service robots; older adults; independent living

Introduction

The population of Western countries is aging and will continue to grow the upcoming years [1-3]. With this prospect more attention is given to the development of assistive technology (AT). Ongoing technological developments made it possible for the AT domain to evolve over the past decades [4] and many ATs became commercially available to support individuals in their independence, such as wheelchairs, smart home technologies, and accessibility adaptations of the home. Ongoing technological developments also resulted in a new emerging field within the AT domain: robotics. Robots have the potential to support care and independence in many ways [5]. But even though the technological developments are promising, the majority of robotic developments do not reach the market and only a limited number of robots designed for older adults become commercially available [6]. There are various reasons for not reaching the market. One may be that robot developments often seem to be guided by the technical feasibility, the type and tasks a robot can perform and often too little attention is given to the actual needs and wishes of the targeted users [6, 7].

The European Acceptable robotiCs COMPanions for AgeiNg Years (ACCOMPANY) project was a robotic project that aimed to provide services to older adults in an acceptable manner to facilitate independent living at home [8, 9]. In this project, a state of the art service robot platform, the Care-O-bot® 3 (Picture 1), was used to assess user requirements throughout the project [10]. The wishes and needs of potential users (i.e., older adults with no

cognitive decline who need some support to remain independent in their own homes, informal carers, and professional caregivers) were used as a starting point and focus group sessions with potential users were conducted during different stages of the project [11, 12]. This led to a realistic user scenario that was realised at Zuyd University of Applied Sciences in Heerlen, the Netherlands. The scenario was designed from a socio-technical viewpoint, that is focusing on robot's functionality as well as the quality of interaction with the final user. During the technical implementation of this scenario, different technological components were integrated within the action sequence described in the scenario, such as the interacting robot, the use of the robotic arm, the user localisation, the user identification, and the user interface. This scenario allowed us to test the robot in a home environment.

Picture 1. Care-O-bot® 3.

In order to capture the experience of performing the realised scenario and to reflect on the interaction with the robot a multi-perspective evaluation was conducted with older adults, informal caregivers and professional caregivers. We call this kind of evaluation "multi-perspective" since different stakeholders, with different role in the use of the robotic platform, confronted their point of views giving birth to a rich and complex set of "desiderata" and insights for the development of a next generation of social robots for domestic use. This article presents how different stakeholders evaluate the role of a robotic assistant at home, what this means for future robot developments and functions as an inspiration on how other scenarios can be designed and implemented.

The Care-O-bot® 3

The Care-O-bot® 3 (see Picture 1) is a high-tech research platform that can be used as a robust, close-to-product research and development platform [10]. It is equipped with omnidirectional drives, a seven degrees-of-freedom manipulator, a three-finger gripper and a tray that can be used to carry objects. The 'head' of the Care-O-bot® 3 contains range and image sensors enabling object learning and detection and 3-dimensional supervision of the environment in real time. The robot can move autonomously and can fetch, carry and manipulate objects.

Method

In order to evaluate the scenario individual user tests were conducted with older adults at Zuyd University of Applied Sciences in Heerlen, the Netherlands. This scenario consisted of two parts (see Figure 1) [13]. During the first part of the scenario the user needed to use the robot to get a parcel at the front door of the apartment. During the second part of the scenario the robot noticed the user has not drunk in 3 hours. The robot therefore reminded the user to have a drink, accompanied the user to the kitchen to get the drink, carried the drink back to the sofa and served it to the person by gently placing the drink on the table in front of the user. Additionally, the robot also observed if the user would drink from the cup. If not, the robot gently reminded the user to drink.

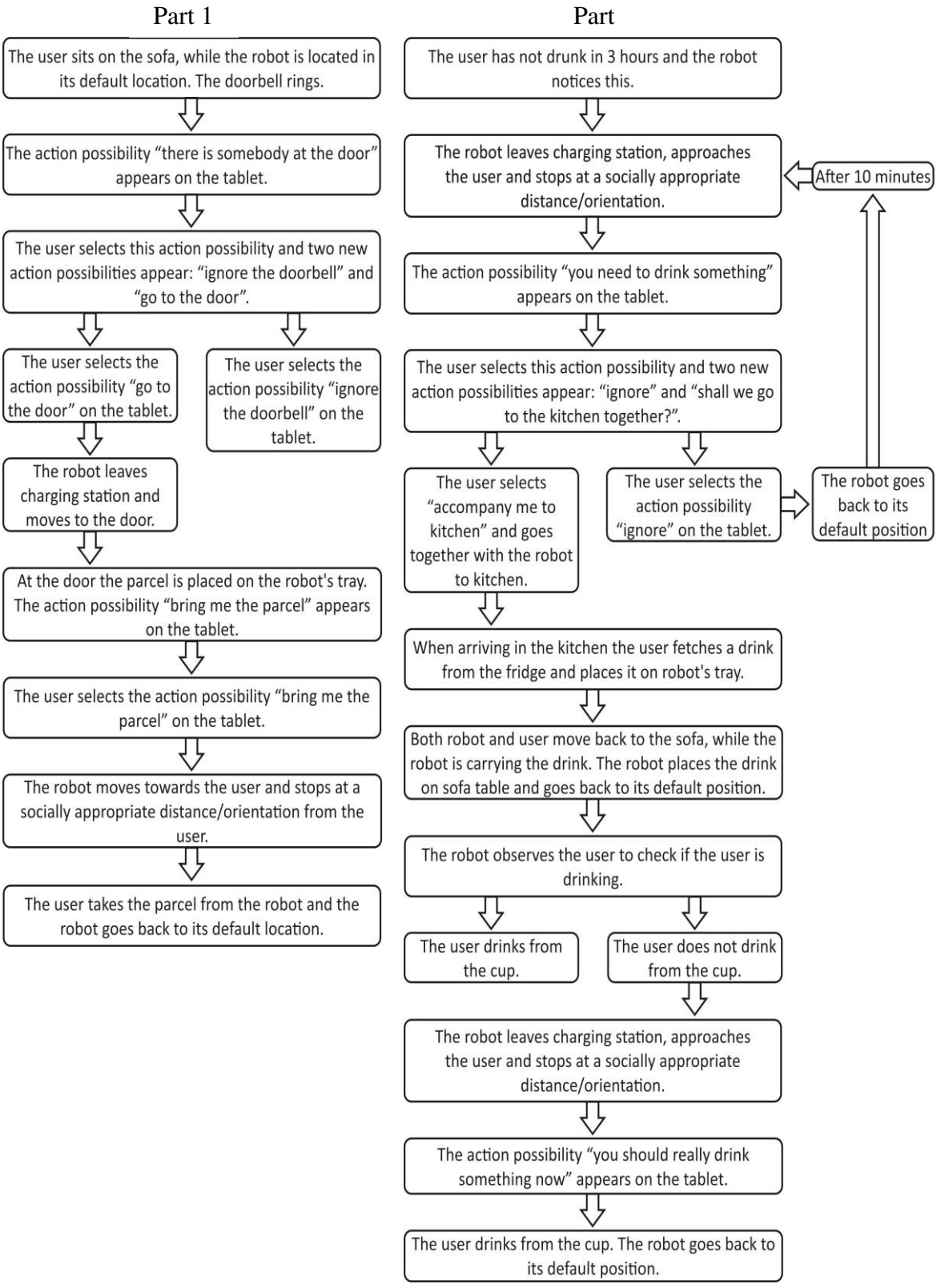

Figure 1. The realised scenario.

During the whole scenario the robot made use of two different colours lighting in its torso: blue and yellow. The standard blue lighting turned yellow when the robot started moving to a different position, for example when moving towards the front door or kitchen.

The robot could be operated with a remote control (i.e. tablet). A graphical user interface (GUI) on this remote control was used to interact with the robot (see Picture 2). This GUI was developed following a person-centred approach based on the concept of action-possibility. This means the robot has the possibility to execute tasks in a context dependent way [14]. For example: if the environment gets dark, the action-possibility "Switch the light on" appears in the form of a button on the screen. Or if the person did not drink for a long while, the action possibility button "Bring me the water" pops up. The GUI is dynamic since the action possibilities change according to the interplay between the specific configuration of the environment, the potential need/desire of the user and the likelihood for the robot to execute a task.

Picture 2. GUI on the tablet.

Participants

Older adults were contacted through two elderly care organizations in the south of the Netherlands. Their selection took place based on four criteria: aged 60+; living at home; no cognitive decline; receiving home care. Informal caregivers were contacted through the older adults and personal network. Professional caregivers were contacted through the care organizations. Informal caregivers either looked after an independently living older adult on at least a weekly basis, or had taken care of an independently living older adult on a weekly basis in the past year. The selection of professional caregivers was based on their work activities/profession. It was required that they worked closely at least weekly with older adults who live independently.

Setting

The Care-O-Bot® 3 was part of a smart environment installed in the premises of Zuyd University of Applied Sciences to carry out the evaluation (see Figure 2). The space was enhanced with a multi-angle camera fusion system and sensor network providing information

about the living patterns of the older adult and current states of objects in the environment.

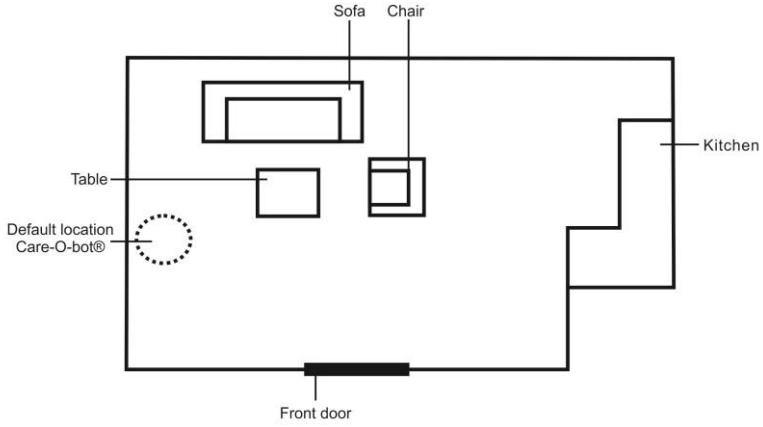

Figure 2. Lab setting.

Data collection and analysis

Individual user tests were conducted with older adults. A researcher (SB) was present during all user tests. Before executing the realised scenario, participants were given the opportunity to practise the scenario once with the robot in order to become familiar with operating and interacting with the robot. During the practise session the participant was free to ask questions concerning the execution of the scenario. After this practise session the participants had to execute the scenario by themselves. After performing the scenario, participants were asked to fill in a questionnaire assisted by the researcher to capture their experience. This questionnaire consisted of 27 Likert-scale questions covering the following 8 topics: 1) Picking up parcel from the front door, 2) Reminder to drink part 1, 3) Getting a bottle of water from the kitchen, 4) Reminder to drink part 2, 5) Operating the remote control, 6) The understanding of the changing patterns of coloured lights on the robot's torso, 7) Performance and 8) Being in charge (see Table 1). The user test sessions were video recorded. The total duration per session was 1.5 hours.

Older adults who participated in the user tests were also invited for an additional semi-structured interview to reflect on the interaction with the robot and to discuss the possible role of the robot in the daily living situation. Older adults were asked to also invite their informal caregiver(s). At the start of the interview a video of the executed scenario was shown. The interview guide included questions regarding the experience of performing the scenario together with the robot and the usage of such a robot in daily living. All interviews were audio recorded and the total duration of the interview varied between 45 and 90 minutes. These semi-structured interviews were summarized in written form. All data were analysed by two researchers (SB and LH) using directed content analysis [15].

Results

Participants

A total of 10 older adults (7 females and 3 males) with the average age of 79,3 years (62 – 93)

participated in the user tests. After performing the scenario with the robot, all participants filled in the questionnaire assisted by the researcher. All participants were also invited for the additional interview. Due to illness one female participant dropped out, which resulted in a total number of 9 older adults (6 females and 3 males) with the average age of 78,9 years (62 – 93) who participated in the interviews.

Only one informal caregiver (male) was able be present at the interview of the older adult (female) he was taking care of. For this reason an additional group session was organized with 6 informal caregivers. All were taking care of (one of) their parents. Also, two group sessions with care professionals were organized. This resulted in a total number of 7 informal caregivers (5 females and 2 males) and 11 professional caregivers (10 females and 1 male). Three out of the 7 informal caregivers and 9 out of the 11 professional caregivers also visited Zuyd University of Applied Sciences and experienced the scenario live.

Questionnaire

Overall, elderly participants were positive about performing the scenario (see Table 1). They had a positive attitude towards the two tasks and how the ACCOMPANY robot executed them. Participants also did not mind that the robot reminded them to drink, and found the way the robot did this appropriate. The speed of the robot was most often commented as most participants found the robot to be too slow, especially when placing the drink on the table. Also the place the robot stopped and the spot where the robot placed the drink evoked a mixed response as the different participants had different personal preferences about the best place for both actions. All older adults understood they had to operate the robot with the remote control. Also the use of the touch screen based interface was rated as pleasant, even though none of the participants had previous experience with touch screens. The majority stated it was clear how to select an option on the interface. Only half of the participants noticed the changing colours on the robot's torso, but it was not clear to them what these changing colours meant and some even thought it had no meaning. This suggests that colours should never be used arbitrarily in design.

Participants found it easy to perform both tasks and almost all participants had the feeling they executed these tasks together with the robot. Finally, some statements were given about being in charge. This topic evoked mixed responses and three opinions could be distinguished. One group of elderly participants argued that they operated the robot by pushing the buttons and without them the robot would not do anything. They therefore stated they were in control. The second group of elderly participants thought neither they nor the robot were the leaders. They evaluated the interaction as a cooperative effort between them and the robot. The third group had the feeling that the robot was the leader since it suggested to drink and they just executed what the robot proposed them to do. When asking if they would prefer to always be the leader the majority thought it would depend on the situation and again on the personal preferences of the user.

Table 1. Number of participant response per question after performing the scenario.

Topic		Question	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	Picking up parcel from the front door	The way the robot approached me, when bringing the parcel, was pleasant.	3	4	2	1	-
		The robot approached me, when bringing the parcel, with a pleasant speed.	2	6	1	1	-
		The robot approached me, when bringing the parcel, from a pleasant direction.	4	6	-	-	-
		The robot stopped at a pleasant distance from me, when bringing the parcel.	1	7	-	2	-
		It was clear to me when I could take the parcel of the tray.	2	4	2	2	-
		The way the robot handed me the parcel was pleasant.	5	3	2	-	-
		It was clear when the robot was finished with the first task.	2	8	-	-	-
2	Reminder to drink part 1	It was pleasant that the robot reminded me to drink.	4	5	1	-	-
		The way the robot reminded me to drink was appropriate.	2	6	-	2	-
3	Getting a bottle of water from the kitchen	It was clear that I needed to walk to the kitchen together with the robot.	-	7	1	2	-
		It was pleasant to walk to the kitchen together with the robot.	2	8	-	-	-
		Standing in the kitchen with the robot was pleasant.	2	8	-	-	-
		The way the robot unfolded the tray was pleasant.	3	5	2	-	-
		Walking back to the couch with the robot was similar as walking to the kitchen.	3	3	3	1	-
		The place where the robot stopped with the drink was pleasant.	2	5	1	2	-
		The way the robot placed the bottle on the table was pleasant.	1	3	5	1	-
		The robot placed the bottle on the best spot on the table.	1	5	1	2	1
4	Reminder to drink part 2	It was pleasant that the robot monitored if I drank.	4	5	1	-	-
		The robot used the best manner to remind me to drink	-	5	2	3	-
5	Operating the remote control	It was clear I could operate the robot with the remote control.	6	4	-	-	-
		The usage of the touch screen was pleasant.	5	4	1	-	-
		It was clear how I could select an option on the touch screen.	4	5	-	1	-
6	The understanding of coloured light	I noticed the robot used different coloured light.	2	3	-	1	4
7	Performance	I found it easy to perform the tasks.	8	2	-	-	-
		I performed the tasks together with the robot.	5	4	1	-	-
8	Being in charge	I had the feeling I was the leader.	-	4	2	2	2
		I think I should always be the leader and not the robot.	2	3	1	4	-

Interview

Although the participants were in general positive about the current scenario, older adults, informal caregivers and professional caregivers all acknowledged during the interviews that the robot in its current form was too limited. They all stated the robot should perform more complex tasks in order to support independent living at home successfully. When discussing the type of tasks the robot should support in the future, tasks such as fetching & carrying of objects, contacting others in case of a fall or other emergency, opening door and cooking were mentioned by the participants. Tasks that required the robot to be more delicate (e.g. touching a human being) such as supporting showering, toileting and getting dressed were often mentioned as not allowed and/or impossible as participants foresaw problems related to technical limitations of the future robot and/or the level of intelligence required.

Participants also stated that a future robot should execute tasks based on the personal preferences of the user. “One size does not fit all” applies here. Especially the informal caregivers agreed that the robot should be able to support the user in a personal manner comparable to the support provided by a human carer. They stated that caring for someone requires having an eye for details. For example: a human caregiver can see if someone’s skin is dry or if one has a wound that requires special care. Informal caregivers recommended that a future robot should be able to do this as well in order to be acceptable. This would require the robot to be extremely smart and its behaviour should be adapted to the specific needs of the seniors. For this reason some of the professional caregivers preferred a robot acting like an assistant of the caregiver; such a robot would never perform any tasks by itself. It would just support the caregiver in executing tasks (e.g. with the robot only one caregiver, instead of two, would be sufficient to take care of a bedridden senior).

How to introduce the robot was a topic that was intensively discussed during both sessions with the professional caregivers. This topic did not appear during the session with the informal caregivers or during the interviews with the older adults. Professional caregivers stated that introducing the robot required more than just placing it in the home of the end user. They were worried that older adults would need time to get familiar with the robot and thought it would be best if a human caregiver would introduce the robot step by step. In this case the robot could start with executing (simple) tasks together with the caregiver and after a while the robot could perform more (complex) tasks until it would execute (complex) tasks by itself without the presence of a caregiver. Professional caregivers expected that this type of introduction would help the senior to get used to receiving care from a robot and to accept the robot.

Informal caregivers were worried that older adults would not be capable to operate the robot as older adults have limited experience with ‘new’ technologies (e.g. computers). Other professional caregivers shared the same concern. Informal caregivers and professional caregivers both thought older adults would need support (e.g. from their children or a company) to interact with the robot. The elderly participants did not share these worries and indicated that they found the interaction with the robot rather pleasant and clear, especially after the practise session. When discussing the use of the remote control through the tablet based interface, older adults stated that they appreciated the synchrony between the robot approaching them and the pop-up button appearing on the screen as this triggered them to

look at the remote control. Some of the older adults also suggested that a sound could reinforce the feedback.

Informal caregivers preferred their parent(s) to have a human caregiver instead of a robot. However, the majority of the informal caregivers, as well as the professional caregivers, preferred the robot over a human caregiver since they disliked being dependent on others for support. An important note here is that they all expected to be able to maintain social relationships by themselves. Both informal caregivers and professional caregivers stated that social contact is extremely important. For some older adults the moment their caregiver visits them is the only social contact during the whole day. For them these moments are indispensable. Informal caregivers and professional caregivers therefore believed that a robot would not be suitable for such older adults. They preferred older adults to be given the choice between a human caregiver or a robot. The older participants had different opinions concerning this topic. Half of the older adults preferred to receive support from a robot, especially the ones that expected to need more intensive support in the future. Older adults, informal caregivers and professional caregivers stated that one of the biggest advantage of the robot was to be available to support during the whole day whereas a human carer is usually available only on fixed times. The main reason for the older adults to prefer the human care was related to the social interaction; they liked to have a chat with their carer and were not willing to give this up.

Discussion

This study enabled us to evaluate and discuss from a multiple perspective the performance, use and interaction of the Care-O-bot® robot in a home-like environment with older adults, informal caregivers and professional caregivers living in the Netherlands. The scenario was fully working, which made it possible to have realistic interaction with the robot, and required no need to instruct or support the elderly participants during the evaluation. The use of the questionnaire highlighted emotional aspects as well as the subtleties of the interaction (e.g. it was pleasant to walk to the kitchen together with the robot), while the interviews provided more in-depth information.

Although participants found that the robot with its current functionalities was still too limited, they were positive towards the idea of a robot that would provide sufficient support to prolong independent living of older adults. In order to do so successfully, the robot should support activities related to self-care (e.g. washing, toileting, feeding, drinking), mobility (e.g. making transfers, mobility in and around the home), and social participation (e.g. visiting others, communicating, receiving visitor) [11]. In the implemented scenario, the robot is only able to perform a very small subset of these complex activities since picking up a parcel at the front door is related to mobility and reminding the user to drink is related to self-care. It is therefore not surprising that older adults, informal caregivers and professional caregivers wished a future robot would be able to execute more complex tasks. However, when the robot would be able to perform more complex tasks, participants also wanted the robot to be able to execute these tasks according to the personal preferences of the user in order to be found acceptable. And also the role of the robot should depend on these personal preferences, for example who should take the lead in which situation. This requires the robot to have a high

level of intelligence and again highlights the importance that not only the technical development deserves the attention of robot developers, but also the development of social behaviour and skills [12].

Elderly participants had mixed responses on specific robot's behaviours. For example they did not agree on where the robot should stop when serving a drink and where it should to place the drink on the table. This debate shows that they paid attention to the subtleties of the interaction with the robot (like the expressivity of the movement), and not only to the functionality offered by the robot. When testing a robot with real people in a realistic home environment, a successful task execution from a technical point of view is just a starting point for an engaging human-robot interaction. The trial allowed the participants to focus on the experience of living with the robot, focusing on feelings of engagement rather than considering only functional aspects.

Additionally, the changing coloured lighting was not noticed/understood by the majority of the participants. Again this is an indication that abstract or arbitrary representations of the robot behaviours do not work. People need to make sense of the interaction, and they pay attention to natural cues that express the robot's behaviour (e.g. movement) rather than arbitrary feedback.

Previous experience of participants with technology also plays a role in the acceptance of robots [16]. This means that both informal caregivers and professional caregivers are more likely to have a positive and open attitude towards the robot as they most likely have more experience with using technology. Nevertheless, the informal caregivers and professional caregivers in this study expressed more concerns than the older adults about the acceptance of the robot also related to potential technical issues. The older adults were rather positive about performing the scenario with the robot and found the robot clear and pleasant to operate. This is also in line with the results of a previous study which showed that older adults were open to the idea of having a robot supporting them in their daily life [12] as well as with the results of a study by Broadbent et al. [17] in which residents of a retirement village showed a more positive attitude towards a health-care robot than both staff and relatives.

Informal caregivers and professional caregivers preferred the robot over a human caregiver for themselves, but only when being able to maintain a social life on their own. For their parents, the informal caregivers preferred a human caregiver. Their motivation for refusing a robot for their parent(s) was unclear, but mostly related to the lack of social contact since all participants agreed that the robot could not be a replacement for human contact. In line with the findings of Sparrow & Sparrow [18] and Decker [19], also the professional caregivers participating in our study preferred a robot able to assist human caregivers rather than replace them.

Limitations

The inclusion criteria for participants were rather broad. For example, no specific criteria concerned the gender balance of the sample. This resulted in an overrepresentation of females. The user tests were performed in a home-like lab setting reproducing a living room area, a kitchen area, bathroom and a front door. Even if the setting was realistic, it was not the real home environment of the older adults participating to the study. Additionally, the elderly

participants only performed the scenario twice with the robot. This limits the possibility for the participants to make sense of what living with a robot means.

Conclusion

In this paper we presented the findings of a scenario-based evaluation involving older adults interacting with a robot at home. The evaluation was multi-perspective since it involved also other stakeholders like professional and informal caregivers who evaluated the role of a robotic assistant at home. This article underlines the importance of taking different perspectives during the evaluation to improve the robot acceptance. The stakeholders involved in the study turned out to have a different attitude towards the robot. Older adults turned out to be more positive about performing the scenario, while informal caregivers and professional caregivers were more sceptical on the use of an assistive robot, especially concerning technical issues. The current version of the robot was judged too limited by all participants. They all stated that a future version of the robot should be able to support more complex tasks (related to the problematic activities of older adults) in order to actually be able to prolong independent living of older adults. Additionally, a future robot should also be able to execute tasks in an acceptable manner that matches the personal preferences of the user. It's behaviour and support should also be comparable to the care delivered by a human caregiver. Implementing the functional features to perform various activities is therefore not the only challenge in robot development. The robot's social behaviour should be carefully addressed as well.

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References

[1] Soede, A. J., J. C. Vrooman, P. M. Ferraresi and G. Segre (2004). Unequal Welfare States. Distributive consequences of population ageing in six European countries. Den Haag., SCP

[2] Verzijden, D. and J. Fransen (2004). Vergrijzing in Nederland - onderzoek uitgevoerd in opdracht van de Rijksvoorlichtingsdienst/Publiek en Communicatie ten behoeve van het ministerie van Volksgezondheid, Welzijn en Sport Veldkamp.

[3] Suzman R, Beard J (2011) Global health and aging. National Institute on Aging http://www.nia.nih.gov/research/publication/ global-health-and-aging/preface. Accessed 4 Feb 2014
[4] Vlaskamp F, Soede M, Gelderblom GJ. History of assistive technology: 5000 years of technology development for human needs. Heerlen, the Netherlands: Zuyd University of Applied Sciences; 2011.
[5] Bekey G, Ambrose R, Kumar V, et al. WTEC panel report on international assessment of research and development in robotics (Final report). World Technology Evaluation Center; 2006.
[6] Bedaf S, Gelderblom GJ, de Witte L. Overview and Categorization of Robots Supporting Independent Living of Elderly People: What Activities Do They Support and How Far Have They Developed, Assistive Technology: The Official Journal of RESNA, 2015;27:2:88-100. doi: 10.1080/10400435.2014.978916
[7] Butter M, Rensma A, van Boxsel J,et al. Robotics for healthcare TNO report. Funded by European Commission, DG Information Society, 2008.
[8] http://accompanyproject.eu/. Accessed February 22, 2016.
[9] Amirabdollahian, F., Op Den Akker, R., Bedaf, S., Bormann, R., Draper, H., Evers, V., ... & Hu, N. (2013). *Assistive technology design and development for acceptable robotics companions for ageing years.* PALADYN: Journal of Behavioural Robotics, 4(2), 94–112. doi: 10.2478/pjbr-2013-0007.
[10] Fraunhofer IPA, Stuttgart, Germany
[11] Bedaf S, Gelderblom GJ, Syrdal DS, et al. Which activities threaten independent living of elderly when becoming problematic: inspiration for meaningful service robot functionality. Disabil Rehabil Assist Technol 2013;9(6):445-52. doi: 10.3109/17483107.2013.840861.
[12] Bedaf S, Draper H, Gelderblom GJ, et al. Can a Service Robot Which Supports Independent Living of Older People Disobey a Command? The Views of Older People, Informal Carers and Professional Caregivers on the Acceptability of Robots. International Journal of Social Robotics (2016). doi: 10.1007/s12369-016-0336-0.
[13] [FraunhoferIPA]. (2013, December 5). *Robot companion for the elderly.* [Video file]. Retrieved from https://www.youtube.com/watch?v=Z1MJPdhniXc
[14] Iacono, I. Marti, P. Engaging Older People With Participatory Design. Proceedings of the 8th Nordic Conference on Human-Computer Interaction, NordiCHI2014, 26-30 October 2014, Helsinki, Finland. ISBN: 978-1-4503-2542-4.
[15] Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative health research*, *15*(9), 1277-1288.
[16] Flandorfer P. Review Article Population Ageing and Socially Assistive Robots for Elderly Persons: The Importance of Sociodemographic Factors for User Acceptance. International Journal of Population Research 2012, Article ID 829835, 13 pages. doi:10.1155/2012/829835.
[17] Broadbent E, Tamagawa R, Patience ANet al. Attitudes towards health-care robots in a retirement village. Australasian Journal on Ageing 2012;31(2):115-120. doi: 10.1111/j.1741-6612.2011.00551.x

[18] Sparrow R, Sparrow L. In the hands of machines? The future of aged care. Mind and Machine 2006;16:141-161. doi:10.1007/s11023-006-9030-6.
[19] Decker, M. Caregiving robots and ethical reflection: The perspective of interdisciplinary technology assessment. AI & Society 2008;22,315–330.