Research Through (Co)-Design: Engaging Older Adults in the Design of Social Robots

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Abstract

Robots increasingly enter our everyday environment in an effort to fulfill people's needs. Yet, users themselves are not as often included in the design of these technologies as co-designers. This paper seeks to provide an example of a long-term co-design methodology that amplifies older adults' participation in the design of social robots, a technology that will directly impact them. We present seven different stages as examples of this methodology that build on each other to engage users as co-designers and discuss the methodology through research through design (RtD) evaluation criteria: process, invention, relevance, and extensibility. We have successfully deployed these seven stages over the course of a year in a home social robot co-design project with 28 older adults. We demonstrate the value of leveraging people's lived technology experiences through co-design and research through design activities.

CCS Concepts

• **Human-centered computing → User studies**.

Keywords

older adults; experience-based co-design; qualitative research; speculative design; social robots

1 Introduction & Background

As the older adult population increases worldwide [1], we find more potential for social robot technology to innovate ways to reduce people's loneliness [21], promote social engagement [6, 18], and assist with healthcare [14] and mental wellbeing [13] with its companion-like features. With the increasing development of social robots for older adults [5], it is crucial that designers of the technology reject older adult stereotypes and understand how these technologies may impact older adults' lives, wellness, and autonomy [5]. Drawing on stereotypes, such as older adults being unable to use technology, prevents older adults from being seen as meaningful contributors to the design processes of future technologies [16]. Co-design and participatory design are valuable methodologies to incorporate users into design processes, amplify their voices that are often not heard in technology design [10], and empower users as purposeful contributors to design [8]. Participatory design and co-design have been well studied and utilized in human-computer interaction (HCI) and design research fields, and researchers have been adapting them to designing human-robot interaction (HRI) in the recent years [4, 17, 18]. As robots are becoming more commercially available in various parts of our lives, researchers must equip themselves with a mindset to study these systems in the real-world context [15] and design these systems in partnerships with end-users [19].

1.1 Co-Design of Robots

Co-design and participatory design are often used interchangeably in technology design. We refer to our work as co-design or collaborative design (i.e. "processes of creative cooperation" [22]) to emphasize the role of users as co-designers. Engaging users in co-design can empower them and provide a sense of ownership in the decision making of technology development [11]. This is accomplished through democratizing innovation by mediating the power dynamics between researchers and participants [3]. Participants can leverage their prior technology experiences and their environmental knowledge to conceptualize new devices while engaging in frameworks such as experience-based co-design [12]. By shifting power dynamics and empowering participants, researchers and participants engage in joint inquiry and open spaces for joint imagination, resulting in improved idea generation and decision making, encouraged collaboration and creative approaches, and improved users' satisfaction of the product [22] or technology. Despite these benefits to technology design, there are several challenges in adopting co-design and participatory design methodologies in HRI research [4], such as a lack of reliable robot platforms that users can live with in long-term in the target social context to support experience-based exploration and a limited set of methodologies and tools suited for exploring such long-term robot design. However, as co-design tools become more available from pioneering works and commercial robot platforms entering the market, co-design approaches to study robots in social contexts are becoming a more viable research option. In co-designing social robots, HRI researchers have engaged users in participatory design workshops [17], card sorting [5, 18], sketching [17], storyboarding [4], role-playing [4], and prototyping [4, 17], activities that also support research through design (RtD).

1.2 Research through Design

As more robots enter people's social contexts and we seek to address "wicked problems" in society [20], it is critical that researchers understand how people will engage with these robots in the given contexts [15]. The RtD paradigm in HCI [23] (originally from [9]) is one way to address wicked problems, applying it to contexts such as HRI. As HRI researchers address wicked problems, we must be mindful of our design space and stakeholders as we create these new technologies. RtD allows design researchers to identify opportunities for technologies and frame and reframe the problem space, creating artifacts as the process unfolds [23]. It also provides engineers with grounding and inspiration for technology development. After iteration and critique, the developed technology can be evaluated by the development process, invention, relevance, and

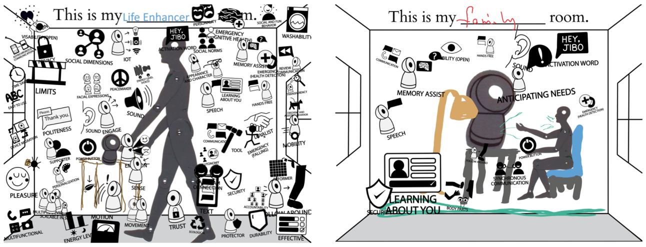

Figure 1: Participant images depicting how participants pictured their relationship with the robot and how they express their space occupied with the robot.

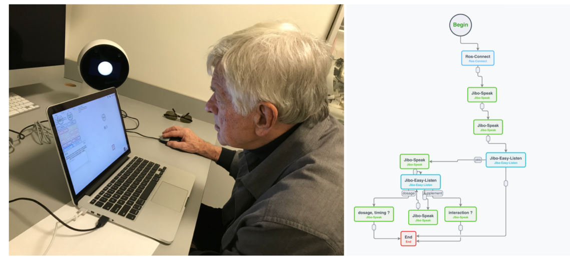

Figure 2: On the left is a participant programming an interaction. On the right is an example of their programmed interaction where the robot describes the days events and provides a reminder and any necessary help with medication.

extensibility [23]. In the next section, we present how older adults as social robot co-designers engaged in RtD activities, and how the activities were designed to probe on these four RtD criteria. As we move to conducting more HRI studies "in the wild", it is critical that we involve users in the design process through approaches that empower users and create a space for them on design teams when developing new technologies that will have implications on society.

2 Research Through Design Evaluation of Co-Design Process

Process: Research Through Design in Co-Design The main objective for our co-design process was to explore how older adults would design a social robot for various areas of their lives. The study investigation was structured around seven areas that roboticists are currently developing robotics solutions for including (1) memory assistance & monitoring, (2) exercise & physical therapy, (3) body signal monitoring, (4) connecting with others, (5) medication adherence, (6) emotional wellness, and (7) financial management. In addition to investigating the seven areas of interest, we wanted to understand older adults' initial perceptions of social robots, how lived experiences with a robot inform older adults' model and desires of social robots, how a long-term co-design process shapes knowledge growth and opinions, and how older adults believe social robots should be designed for the future. The robot used in this study was Jibo, a table-top robot with a touchscreen face and three degree-of-freedom expressive body. Throughout the co-design process, we designed the activities to provide varying levels of tactile engagement (i.e. art, programming, and oral activities) and to promote greater reflection. Lastly, we prioritized building rapport with our older adult participants and establishing relationship with them as one research team.

Twenty-eight older adults, ages between 70 and 94 (mean: 79.5, std: 7.8; female N=15), participated in the co-design process. All participants were recruited from the Untied States, 21 participants were local from Massachusetts and 7 participants partook in the sessions remotely from California and Texas. Our co-design process consisted of 7 stages:

(1) *Initial Interview*: The interview protocol evaluated perceptions of the seven outlined categories and a social robot in this context, older adults' initial thoughts about a social robot, and the desire for certain robot features.
(2) *Art-Based Image Making*: In this session, participants created artwork around their imagined relationship with the robot using 2D figures, robot and technology related icons, marks, and text.
(3) *Robot Hosting*: Participants hosted the robot in their homes for at least a month time. Some elected to keep the robot longer.
(4) *Robot Debrief*: Participants discussed their experiencing living with the social robot in their home.
(5) *Robot Rapid Prototyping*: Participants iteratively designed and edited their ideal interactions with a robot, programming the robot and seeing the interactions live.
(6) *Design Guideline Generation*: Participants met with each other and the researchers at MIT Media Lab to generate design guidelines for the next stage of the robot's development.
(7) *Reflection Interview*: The reflection featured the same questions from the initial interview. All seven categories were covered as before.

The process was structured over the course of a year to allow for participants to reflect on the previous session before the subsequent session and to disperse the time commitment over a longer period of time. All study protocols were approved by our institution's IRB and all participants completed a consent form and data collection preferences. After each session, participants were asked to reflect on the session, describing one thing they liked and one thing they would change.

Invention: Older Adults' Social Robot Designs This work revealed how older adults' desire social robots to be designed for specific areas, such as emotional wellness, and specific interactions, such as scheduling the days agenda. The art-based image making stage where older adults created an image depicting their relationship with the robot, required features of the robot (i.e. touch-based interface, mobility, etc.), and concerns around the technology (i.e. privacy, transparency, accountability, etc.). In the images (Figure1), the human-robot relationship was articulated as companionship, motivator to reaching a goal, and general "life enhancer". Older adults programmed interactions on the robot during the robot rapid prototyping stage (Figure2), depicting the ideal interaction design for the robot interacting with them over the course of the day. In the design guideline generation stage, older adults generated, evaluated, and selected design priorities for the robot as the interaction design progresses. The participant-driven design guidelines ranged from application areas (robot skills), interaction features, and ethical considerations.

Relevance: Amplifying Voices in HRI Our work's relevancy is rooted in the need for more long-term HRI engagement with communities when designing technologies and for more voices to be heard in the technology development process. Co-design with older adults has been well established as having benefit for both the evaluation of existing systems and the generation of ideas for newer technologies [7, 12]. While populations, such as older adults engaged in co-design may lack familiarity with technology, it is critical to consider the value that older adults' experiences add to co-design of technologies and to not reinforce negative stereotypes of aging. People's prior experiences and their living environment are key when conceptualizing new devices and co-design can be used in human-robot interaction as a model to engage people and their experiences when developing technology [2, 12]. People's experience with technologies, new and existing, can inform their expectations and ideals for future technologies. Older adults in our study were able to experience the technology and design their ideal robots and interactions based upon this experience, providing multiple outlets for them to express their perspectives and opinions.

Extensibility: Shifting Perceptions of Older Adults The final outputs from the study support the extensibility of this work. Older adults and researchers generated design guidelines for social robots that are being adapted into social robot interaction design. Their art-based image making and robot rapid-prototyping has contextualized concerns and interactions with robots, providing suggestions for how to balance ethical quandaries and the ideal. The sociotechnical and co-design perspective of this work amplified older adults' perspectives, opinions, and designs of social robots. As more and more HRI researchers engage in co-design work, especially with older adults, we can shift our perception of older adults by centering their desires, perspectives, and values in social robot design.

3 Conclusion

This paper describes a year-long co-design methodology to empower older adults in the technology design process with researchers and discusses designing the co-design process with regards to the RtD evaluation criteria. Our methodology demonstrates how older adults can be integrated into the design of social robots and amplify their voices in technology, leveraging their prior experiences with technology. With more work such as this supporting RtD practices, we can work to shift the narrative of social robot technology design from being researcher centric to user centric. We emphasize the need for, and the value of, co-design processes in HRI. Our successful deployment of the presented methodology in collaboration with our target users provides attestation of how users can be further embedded into social robot design, creating and testing interactions, and generating design guidelines and new conceptualizations of robots in social contexts.

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