Empowering Older Adults to Design Social Robots

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Abstract
As voice user interfaces (VUIs) enabled with artificial intelligence (AI) become more prominent in the home, we need to understand the effect these technologies have on people and their spaces and how people desire these technologies to be embodied in their home. Social robots are VUIs with enhanced social and physical presence and functions. Here, we focus on their potential to provide social and emotional companionship and assistance to older adults. However, the older adult population is often characterized as homogeneous and not desiring of technology; both of which are false. We present an approach to empower older adults to highlight their preferences, needs, and boundaries surrounding social robots, and the results we found. The work described in this paper highlights two long-term studies we have completed that demonstrate how participatory design methods can be used to investigate social robots for older adults.

Author Keywords
Social robots, older adults, human-centered design methods, participatory design

ACM Classification Keywords
[Human-centered computing User studies]

Figure 1: "Talking Machines" Design Kit used in two long-term studies with older adults.

Introduction

The world's population is aging, with the percentage of older adults to increase by 100% by 2050, composing 20% of the world's population[1]. The older population is diverse with a variety of background and technology experiences[1] and more older adults becoming increasingly open to new technologies[14]. Social robots offer a unique potential to support older adults who may be socially isolated; one of the largest threats to older adults' mental, physical, and psychological health[1]. These technologies can promote face-to-face human connection within communities for older adults who live independently or in assisted living.

Studies have demonstrated that social robots have the potential to enhance wellbeing, motivate engagement in activities such as physical exercises, and increase social interactions for older adults[9]. While the capacity for social robots to support wellbeing for older adults is promising, there are few examples of how to adapt human-centered design methodologies to older adults in the design process to understand their preferences, needs, and boundaries for social robots. Our studies demonstrate how older adults can be included in the social robot design process using participatory design methods to inform future social robot development.

Human-Centered Design with Older Adults

In the context of design methods with older adults, there are few examples of how to incorporate this population in design and to adopt traditional design methods to this population[5]. Several challenges exist when working with older adults, from entrenched beliefs of not being able to work with current technology[6] to tiring more quickly[10]. Human-centered design tools such as focus groups, surveys, interviews[7], card sorting[16], and verbalizing thoughts (i.e. "think aloud)[4] have been used to design with older adults. There are some shortcomings related to using some of these methods including lack of understanding, forgetfulness, and focus[4].

Human-Centered Design with Older Adults and Robots

There is a growing number of studies combining older adults with robot design. These vary based on how robots are introduced to older adults, where older adults are incorporated into the process, and the design methods used. Older adults who participate in robot design may have limited knowledge of robot technology. To bridge this knowledge gap, they are often required to imagine robot appearances and capabilities based on still photographs[3], videos[18], drawing a robot[7], or verbal explanations without any representation[2]. Some studies have older adults directly interact with robots[15], which has been connected to greater acceptance of the technology[2].

A variety of human-centered methods have been used to incorporate older adults into the front-end design stages to assess their attitudes and acceptances towards technology[7]. Studies that have incorporated human-centered design methods with older adults often focus on mobility assistive robots[8, 18]. Sabanovic et al.[15] and Lee et al.[11] have notably used participatory design methods, working with older adults diagnosed with depression to design social robots for daily life. As in these examples, previous works often focused on studying a subset of older adult population such as those with mobility issues or diagnosed with depression rather than studying the general population. Additionally, conducting long-term studies with robots has always been a challenge because of the lack of reliable robotic platforms that can be deployed in older adults' communities[12].

Figure 2: Initial preferences for voice-user interface actions of older adults for first study.

A Design Kit for Participatory Social Robot Design with Older Adults

After initial exploration of people's opinions of social robots in the home, a set of principles were established to guide the design kit development, including ensuring the design and development process was clear and tangible to participants, equipping participants with a "language" of the technology to increase participants' sense of purpose in the design process, and generating a holistic view of the technology with regards to participants' experiences with the technology.

The design kit is composed of four elements: (1) action cards, (2) theme cards, (3) personality cards, and (4) design tools (Figure 1). The focus of the following sections will be on the action cards. The action cards are divided into six categories: (1) reminders (i.e. meetings, lists), (2) information (i.e. weather, news), (3) suggestion (i.e. workout, eating healthy), (4) agent sharing something (i.e. playlist, jokes), (5) connecting with others (i.e. social sharing), and (6) others trying to reach the user (i.e. phone calls, urgent questions). For both studies, the participants categorized the action cards as "yes", "neutral", and "no" based on their desire for the technology to have the capability.

Long-term Studies with Design Kit

Two long-term studies were completed with older adults to understand their preferences, needs, and boundaries with social robots and reveal how long-term experience influenced their preferences. In the first study, 24 older adults were recruited from assisted living centers, senior community centers, government housing developments, and state elder services agencies (age mean= 70.2, sd= 9.2; female 85%). This is representative of the gender distribution in the community centers visited and previous technology studies with older adults [9]. Participants were given the option to engage in two sessions and host a social robot (Jibo) or an AI speaker (Amazon Echo Dot) in their homes. In each session, the participants completed the action-card activity. The first session was held before participants hosted a technology in their home for one month. Over the course of the month, participants tracked their usage of the technology in their home for the first two weeks. Participants did not track their usage for the last two weeks to normalize any bias from prompts of the usage sheets. The second session was held after hosting an agent in the home. A total of 24 participants completed the first session, with 12 participants also hosting one of the VUIs and completing a second session.

In the second study, 19 older adults were recruited from an assisted living center (age mean= 84.8, sd= 7.13; female 68%). This study had the added focus of understanding how a social robot could influence community connectedness[13]. A social robot (Jibo) was placed in the community common space for 3 weeks. Similarly to the first study, participants completed the action cards in sessions before and after the long-term experience.

Between the two studies, older adults ranged in age from 50 years old to 98 years old (the number of participants in each age range were: 50s (2), 60s (10), 70s (11), 80s (14), and 90s (6)). Classifying people in their 50s as older adults could be debatable, but we aimed at capturing the experience of participants who were at the earlier stages of aging and this decision is consistent with other older adult studies[19]. There was significantly more women (n = 34) than men (n = 9), which is characteristic of the larger population's gender distribution[9]. All participants volunteered to participate, completing an IRB approved consent form. No incentives were offered.

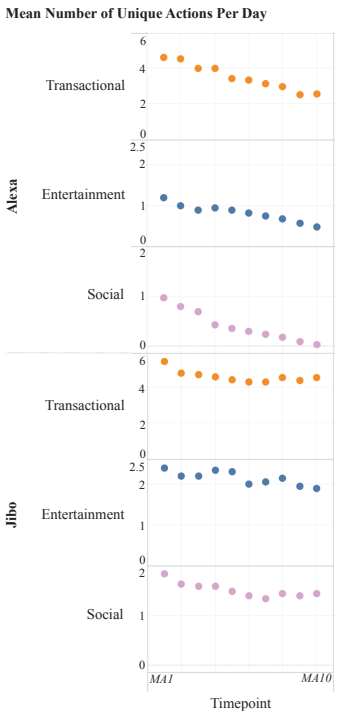

Figure 3: Usage for older adults hosting voice-user interface demonstrates higher usage of social robot.

Study 1: Long-term in the Home

From the first session, 24 older adults completed the action-card activity (Figure 2). Older adults were open for most VUI actions, except suggestions to take a nap, eat, or meditate. 12 older adults hosted one of the two agents and participated in the first and second sessions. Usage of the technology varied on whether older adults hosted Amazon Alexa or Jibo (Figure 3). Older adults used the social robot more frequently than the smart speaker (Amazon Echo Dot). After experiencing the technologies, older adults completed the action-card activity again, which demonstrated that participants become more accepting of all categories except suggestions (Figure 4).

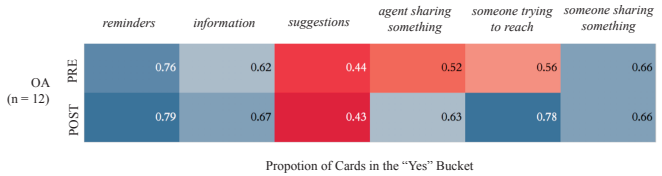

Figure 4: Preference comparisons in first study between before and after hosting voice-user interface demonstrates participants become more accepting of voice-user interfaces after experiencing them.

Study 2: Social Robot in the Community

Between the before and after the social robot was present in the community, older adults' preferences changed. Based on the action-card activity results in the pre session, participants were divided into three groups depending on their openness level to VUI technology using k-means clustering (k=3) (Figure 5). Over time, these preferences changed. Participants in the high and mid openness group generally became more open to the social robot (excluding the "mediating connections with people" that combined the "connecting with others" and "others trying to reach the user" categories). Participants in the low openness group remained less open to VUI technology.

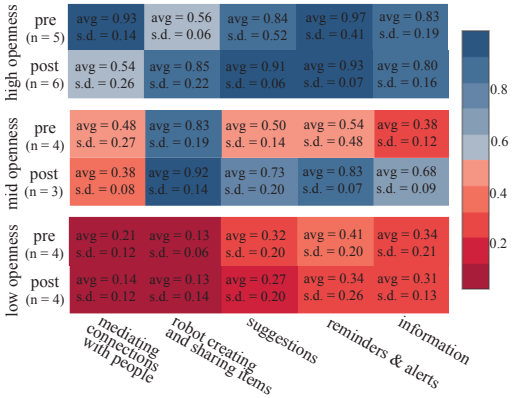

Figure 5: Preference comparison between different openness of participants over the course of the second study, demonstrating preference changes after experiencing the technology.

Insights & Learnings

Location Differences

In the first study that lasted for one month, participants hosted the voice-interface in their independent living space. In the second study that lasted for three weeks, the participants hosted the social robot in their community common space. Interestingly, there was a major difference in preferences for an agent mediating social connections with people. In the home study, the population became more accepting of having a voice-interface connect with people. However, in the community study, participants decreased in acceptance of the technology attempting to make direct social connection with people. This could

potentially be because the participants viewed the robot in a community space as a shared commodity and perceived the role of a social robot as a catalyst promoting social connection among residents rather than the robot making one-on-one connection with each person.

Another category that varied was suggestions. Participants in the home study and in the low-openness participants in the community study remained polarized around the topics, while mid and high openness participants became more accepting of suggestions from the technology. Additional studies are required to understand the nuances surrounding suggestions from VUIs.

Experience Changes Perception
For both studies, older adults' preferences changed between before and after living with the technology, emphasizing that for people to truly understand technology long-term studies are key.

Design Kit Reflection
By creating understandable and tangible design tools, older adults were empowered to share their preferences, needs, and boundaries of the technology. In addition to the quantitative results presented in this paper, we also collected qualitative transcripts of the sessions that reveal increased understanding of the technology and vocalization around preference changes[13, 17]. Our holistic design-method approach demonstrates how older adults can be incorporated in the social robot design processes through long-term settings that promote engagement and reveal critical design considerations.

Conclusions

Investigating people's preferences, needs, and boundaries for social robots is essential to promoting technology development that are closely integrated in people's lives. Human-centered design methodologies offer tangible and understandable means for older adults and other populations to engage in social robot design with researchers. Our work demonstrates how a design toolkit can be used to incorporate older adults into the design process, reveal preferences for future technology, and promote long-term experience-based studies. Our work highlights the needs of an under-represented, yet increasingly growing, population and demonstrates interdisciplinary methods applied to human-robot interaction.

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