Reactions to a Remote-Controlled Video-Communication Robot in Seniors' Homes: A Pilot Study of Feasibility and Acceptance

Adriana M. Seelye, M.S.,^{1,2} Katherine V. Wild, Ph.D.,^{1,3}
Nicole Larimer, B.A.,³ Shoshana Maxwell, M.P.H.,³
Peter Kearns, B.A.,³ and Jeffrey A. Kaye, M.D.^{1,3}

¹Layton Aging & Alzheimer's Disease Center and ³Oregon Center for Aging & Technology, Oregon Health & Science University, Portland, Oregon.

²Department of Psychology, Washington State University, Pullman, Washington.

Portions of this research were presented at the 64th annual meeting of the Gerontological Society of America, November 18–22, 2011, in Boston, Massachusetts.

Abstract

Objective: Remote telepresence provided by tele-operated robotics represents a new means for obtaining important health information, improving older adults' social and daily functioning and providing peace of mind to family members and caregivers who live remotely. In this study we tested the feasibility of use and acceptance of a remotely controlled robot with video-communication capability in independently living, cognitively intact older adults. **Materials and Methods:** A mobile remotely controlled robot with video-communication ability was placed in the homes of eight seniors. The attitudes and preferences of these volunteers and those of family or friends who communicated with them remotely via the device were assessed through survey instruments. **Results:** Overall experiences were consistently positive, with the exception of one user who subsequently progressed to a diagnosis of mild cognitive impairment. Responses from our participants indicated that in general they appreciated the potential of this technology to enhance their physical health and well-being, social connectedness, and ability to live independently at home. Remote users, who were friends or adult children of the participants, were more likely to test the mobility features and had several suggestions for additional useful applications. **Conclusions:** Results from the present study showed that a small sample of independently living, cognitively intact older adults and their remote collaterals responded positively to a remote controlled robot with video-communication capabilities. Research is needed to further explore the feasibility and acceptance of this type of technology with a variety of patients and their care contacts.

Key words: robotics, tele-operated, aging, technology, video-communication

Introduction

The U.S. population is aging at a rapid rate. In the next 25 years, the number of individuals 65 years and older will double to 72 million.¹ Despite the importance most older adults place on maintaining independence and “aging in place,”² older adults and those with cognitive impairment face significant challenges to living independently. In addition to functional decline, falls, decreased mobility, sensory impairment, caregiver burden, and social isolation all pose threats to independent living.³ Social relationships are an important factor for maintaining life satisfaction and subjective well-being in healthy older adults and those with cognitive impairments.⁴ Low social support is predictive of long-term mortality in older adults⁵ and can put severe strain on caregivers.⁶

Decreasing healthcare personnel and resources,⁷ rising healthcare costs,⁸ and advancing technology have fostered the development of monitoring and assistive technologies for older adults. Such technologies are poised to provide novel approaches to enhance older adults' physical health, well-being, social connectedness, and ability to live independently at home. Decreased costs associated with formal healthcare and assisted living placement are additional benefits of in-home monitoring and intervention technologies. Ubiquitous sensor networks that provide unobtrusive in-home monitoring of physical activity,⁹ complex activity recognition,¹⁰ context-based IADL reminder systems,^{11,12} home telecare,¹³ and physically or socially assistive robots^{14,15} are examples of smart environment assistive technologies.

Given the detrimental effects of social isolation on older adults, assistive technologies that promote older adults' interaction with others have gained recent interest. Two such technologies are socially assistive robotics (SAR) and tele-operated (remote control) robotics. SAR provides assistance to human users through nonphysical social interaction.¹⁶ A socially assistive robot is characterized by its physical nature, personality traits, emotional expression, human-robot dialog, and user-modeling. SAR devices have been used to decrease social isolation, increase compliance with medical treatments, and keep older adults functioning independently longer at home.^{11,16}

Tele-operated remote control robotics are controlled remotely and generally do not provide the same level of human-robot social interaction to users as SAR. However, given that they are controlled remotely, tele-operated robotics have the unique capability of allowing a user to be video-monitored by a caregiver or healthcare provider while living independently. It is important that tele-operated robots allow users to stay connected with family members or friends who live outside of the home through mobile

videoconferencing. These features have the potential to positively impact social functioning, quality of life, and ability to live independently.

Only one study to our knowledge has examined older adult and healthcare provider perceptions of an in-home robotic telepresence for community-dwelling older adults.¹⁷ In this study, participants reported that a robotic telepresence could help to monitor abilities in everyday life, enhance safety, reduce travel to healthcare visits, relieve caregiver burden, and facilitate communication. Healthcare providers had slight concerns that telepresence robots could lead to older adult isolation and loss of privacy. Overall, tele-operated robotics have the potential to improve older adults' social and daily functioning, while providing peace of mind to family members and caregivers who live remotely. No studies known to us have assessed the feasibility of in-home tele-operated robotics with older adults and individuals with cognitive impairment.

In the present study, we expand upon previous research by conducting a pilot study examining the feasibility and acceptance of a remotely controlled robot with video-communication capability in a sample of independently living healthy older adults. We were interested in exploring the attitudes and preferences of seniors and those of family or friends who communicated with them remotely via the device.

Subjects and Methods

PARTICIPANTS

Volunteers in the present study were drawn from a longitudinal cohort established to understand how various methods of pervasive home computing and other technologies may support or improve the health and independence of people as they age. These volunteers comprise the participants in the ORCATECH Living Laboratory (OLL), which is a community-based resource of volunteer seniors who have agreed to allow emerging technologies to be deployed and tested in their homes. These volunteers undergo semiannual standardized cognitive, functional, and neurological batteries and report weekly on changes to their health, medications, and life events. Broadband Internet connection was installed in each home. Secure Web-based software allows remote management of longitudinal data streams, the status of the sensor net, and the participants.

Although all participants were deemed not demented at time of enrollment (Clinical Dementia Rating scale < 1; Mini-Mental State Examination [MMSE] > 24), mild cognitive impairment (MCI) was not a criterion for exclusion. MCI was defined as objective cognitive impairment in at least one domain, in the presence of normal general cognitive function, minimal or no functional decline, subjective memory complaint, and absence of dementia diagnosis.¹⁸ Impairment on neuropsychological testing was defined as a score 1.5 standard deviations or more below the model-derived predicted mean values stratified by age, education, and sex. Normative data were based upon 3,268 cognitively normal individuals enrolled in 32 Alzheimer's Disease Centers.¹⁹

Participants were free of medical conditions that would cause physical disability or likelihood of death within 3 years, the duration

of the initial Living Laboratory recruitment. The eight volunteers for this project were living alone in their own homes and were able to identify a remote collateral individual who would be willing to participate. All volunteers signed written informed consent to participate in the project.

TELEPRESENCE ROBOT

The VGo robot system (VGo Communications, Nashua, NH) includes a remote telepresence robot, handheld local controller, 8-h battery, charging dock and power cord, and a remote driving controller. Technical requirements for the in-home user include 802.11 broadband wireless coverage, unsecured, WEP, or WPA2 security, and > 384 kilobits per second (Kbps) Internet upload speed. Technical requirements for the remote user include Vista, XP, or MAC, Dual Core 2.0 GHz, 1MD RAM, > 384 Kbps Internet upload speed, camera, microphone, and speakers.

MEASURES

For the purposes of this study two questionnaires were developed to record participant and collateral responses to their experience with the device. Based on an Alpha User Feedback Questionnaire utilized by VGo in the early stages of prototype development, the participant feedback questionnaire focused on six areas of interest: appearance, communications experience, driving experience, home experience, privacy, and applications. The remote user questionnaire was limited to installation and setup (of computer software), communications experience, and driving experience. The interviews all started by asking about the general impressions of the users, followed up by queries about specific aspects of the device and its operation. All participants were given the opportunity to make additional comments at the end of the interview.

PROCEDURES

Prior to deployment in participants' homes, the device was installed in the Oregon Health & Science University Point of Care Laboratory, a mock apartment set up in the Biomedical Engineering Department for initial testing. Following successful installation and manipulation of the system, it was then tested in the home of one of the authors (N.L.) for final evaluation before use in volunteers' homes (see *Fig. 1*). Minor software and device malfunctions were corrected through communication with the system's engineers.

System requirements were reviewed with potential participants prior to consent and installation. Participants were asked to identify a family member or friend with whom they communicate on a regular basis. For Living Laboratory volunteers, wireless coverage and other technical prerequisites had already been provided as part of their enrollment in that project. For collateral sources, broadband Internet access with appropriate upload speed and specified home computer capabilities were verified.

Once both the participant's and collateral's systems were installed, both were trained in the device's use. Users were trained in their home, to answer incoming calls, to make calls, to turn off the device, and to adjust the volume and on other technical elements. Seniors'

Fig. 1. The telecommunication robot in a study participant's home.

remote collateral participants were trained in initiating calls and moving the device as needed. Each senior had the device available for two complete days. During that time they received a daily call from the Oregon Health & Science University research team and up to two additional calls daily from the family member or friend who was trained in use of the device. After the device was removed, both users and collateral sources were interviewed regarding their impressions of the device and its potential long-term utility.

Results

Eight Living Laboratory participants and their remote collaterals were enrolled in this study. *Table 1* shows participants' baseline demographics. All participants were cognitively intact at study enrollment, although one participant progressed to a diagnosis of MCI after study completion. Participant and remote collateral responses to interview questions were reviewed and summarized by a licensed psychologist (K.V.W.) and a clinical psychology graduate student (A.M.S.). Recurring observations were tallied, and themes were identified by consensus.

PARTICIPANT FEEDBACK

Table 2 gives for examples of participant feedback. Participants rated the robot's appearance favorably. Most participants placed the robot and docking station in their main living space for the duration of the study. Communication experience was also rated positively by participants. Specifically, participants reported that it was easy to hear and answer calls and turn the robot on and off. The picture and volume were clear

Table 1. Baseline Demographics of Participants

DEMOGRAPHIC	VALUE
Gender	
Male	1
Female	7
Age (years)	
Mean $\pm$ SD	77.5 $\pm$ 8.4
Range	64–92
Education (years)	
Mean $\pm$ SD	12.6 $\pm$ 3.2
Range	7–18
Race (n)	
White	7
Black	1
MMSE	
Mean $\pm$ SD	27.2 $\pm$ 3.5
Range	19–29

MMSE, Mini-Mental State Examination.

and worked well. Participants reported slight confusion about how to use the handheld remote, and one person unplugged the robot because she was worried about a fire. Feedback on driving experience was mixed. Although most users drove the robot and said it was easy to operate, they expressed concern that driving hazards were not communicated clearly or obviously by the robot. In addition, transitions from solid flooring to carpeting were problematic. Home experience was rated positively for relatively easy and nonobtrusive movement of the robot throughout the home. Participants expressed little concern about privacy, although they highlighted the importance of having control and knowledge of who has access to call them through the device. The majority of participants stated that they would be willing to use the robot with friends, family members, and healthcare providers.

Table 2. Example Participant Feedback

- "It was nice that my daughter didn't always have to come over."
- "Gave me a sense of safety."
- "It was like another person. I was sad to see it go."
- "It would be good for checking on a sedentary person."
- "Not sure what the purpose is supposed to be."
- "It was too complicated...overwhelming."^a

^aParticipant who progressed to mild cognitive impairment.

Additional uses for the robot suggested by participants were to help people with everyday tasks and chores and to alert a caregiver if user was in danger or needed medical care.

Overall, participants reported that their experience using the robot was positive and enjoyable. Its appearance was rated favorably, and participants kept the robot in their main living spaces and in most cases were sad to see it go. Participants became more comfortable operating the robot with increased practice. Only one participant had a negative experience with the robot. She was confused by its purpose and function and requested that it be removed from her home. This individual progressed to a diagnosis of MCI after the study ended.

REMOTE COLLATERAL FEEDBACK

Table 3 gives for examples of collateral feedback. Collaterals rated the ease of installation and setup of the software positively. Communication experience was also rated very favorably. Specifically, collaterals commented that the calling interface was user-friendly and the video and sound quality were good. Collaterals particularly liked having the ability to move the robot around in their loved one's environment during calls. Feedback on driving experience was mixed. For example, some thought it was easy, others thought it became easier with practice, and others rated it as very difficult. Consistent with participant feedback, driving hazards were not obvious to collaterals and not clearly communicated in timely fashion.

Overall, collaterals rated their experience with installation and use and communication positively. Concerns about driving were expressed. Collaterals liked the mobility of the robot compared with stationary video-communication technology and commented that this type of technology would give peace of mind to family members.

Discussion

Responses from our participants indicated that in general they appreciated the potential of the telepresence robotic technology to enhance their physical health and well-being, social connectedness, and ability to live independently at home. This finding is consistent with previous research that has demonstrated that older adults respond positively to technologies that support their values of personal identity, dignity, independence, and maintenance of social ties.²⁰ Responses from remote collaterals were also positive and indicated that they appreciated the potential of the technology to increase their loved one's safety and social connectedness. This finding is consistent with previous research indicating that assistive technologies that

address safety and social isolation are considered of utmost importance to caregivers.²¹ Also, consistent with previous research,²² care contacts in the present study suggested that an in-home robot might be even more useful if it provided assistance with everyday tasks and chores as well as the detection of danger (e.g., falls) and provision of alerts for medical assistance.

There were nevertheless some reservations among this small sample about the robot's practicality. For example, operating the handheld remote was slightly confusing to some participants, and the device's wheels were not durable enough to handle transitions between rooms with different types of flooring. Consistent with our results, previous research has shown that barriers to technology acceptance in this population include devices that are physically obtrusive, are difficult to use and interact with, or function poorly.^{19,22,23} Longer and more detailed initial training with these types of technologies might address concerns about operation of remote controls and increase the users' sense of self-efficacy and confidence with the devices. Additionally, advances in user interface may enhance acceptance of such devices by older adults.

Our single participant who went on to develop MCI was unable to use the device and requested that it be removed. We are not the first to find that individuals with MCI have more difficulty with technology than healthy older adults. DeJoode et al.²⁴ found that cognitively impaired individuals had more difficulty managing everyday technology in their homes than intact individuals and that caregiver assistance is likely important to their uptake and use of new technology. Seelye et al.²³ examined the feasibility of training individuals with MCI to use electronic memory aids to compensate for memory loss. The authors found that although participants with MCI enjoyed the challenge of learning to use electronic aids, even seemingly basic devices proved too complicated, and participants stopped using them after the study ended. It should be noted that the types of technology examined in these studies were everyday technologies that were relatively familiar to participants, such as voice recorders and personal digital assistants. It is possible that the novelty of the robot was related to our one participant's negative reaction to it. Introducing a new technology as early as possible in the MCI process would give the user time to become familiar with it before cognitive impairment progressed and might increase acceptance and long-term use.

Conclusions

In summary, results from the present study showed that a small sample of independently living, cognitively intact older adults and their remote collaterals responded positively to a remote controlled robot with video-communication capabilities. One participant who later progressed to a diagnosis of MCI responded negatively to the robot. Participants expressed little concern about privacy, although they expressed desire to have control over who had access to contact them through the device. Possible barriers to acceptance of this device included difficulties maneuvering it around the environment. When designing tele-operated remote control robotics for older adults, attention should be given to device functionality as well as the unique physical, cognitive, emotional, and social needs of the

Table 3. Example Remote Collateral Feedback

- "Everyone that's older should have one."
- "It's a great tool that would give the family peace of mind."
- "When I felt like checking up on him I could just log on."
- "(It would be useful) to alert health care providers of anything dangerous like elevated heart rate."

population. Given that older adults may experience sensory, motor, and cognitive limitations, user interfaces should be large and intuitive to use, operation requirements should be simple and clearly communicated, and features should be modifiable based on individual preferences and lifestyle. Research is needed to further explore the feasibility and acceptance of this type of technology with cognitively impaired older adults.

Limitations of the present study include the small sample size, short study duration, and use of only qualitative data. In addition, we did not control for variables that may affect attitudes toward technology, such as depressed mood, chronic pain, and significant life events. Future quantitative studies are needed with larger samples of healthy older adults and individuals with MCI. Extended exposure to the device and collection of quantitative data would provide more robust findings about not only the acceptability but also the utility and perceived benefits of remote controlled in-home video-communication in healthy and cognitive impaired older adults. Additional applications of the device, as recommended by our participants and their friends or family have yet to be explored.

Acknowledgments

This research was supported by NIA grants P30AG08017, P30AG024978, and 1R01AG024059 and by VGo Communications.

Disclosure Statement

No competing financial interests exist. VGo Communications had no involvement in study design; collection, analysis, and interpretation of data; writing the report; or the decision to submit the report for publication.

REFERENCES

- Bharucha AJ, Anand V, Forlizzi J, Dew MA, Reynolds CF, Stevens S, Wactlar H. Intelligent assistive technology applications to dementia care: Current capabilities, limitations, and future challenges. *Am J Geriatr Psychiatry* 2009;17:88–104.
- Eckert JK, Morgan LA, Swamy N. Preferences for receipt of care among community-dwelling adults. *J Aging Soc Policy* 2004;16:49–65.
- St. John PD, Montgomery PR. Cognitive impairment and life satisfaction in older adults. *Int J Geriatr Psychiatry* 2010;25:814–821.
- Oppikofer S, Albrecht K, Martin M. Effect of increased social support on the well-being of cognitively impaired elderly people. *Z Gerontol Geriatr* 2010;43:310–316.
- Mazzella F, Cacciatori F, Galizia G, Della-Morte D, Rossetti M, Abbruzzese R, Langellotto A, Avolio D, Gargiulo G, Ferrara N, Rengo F, Abete P. Social support and long-term mortality in the elderly: Role of comorbidity. *Arch Gerontol Geriatr* 2010;51:323–328.
- Alm N, Dye R, Gowans G, Campbell J, Astell A, Ellis M. A communication support system for older people with dementia. *Hum Centered Comput* 2007;35–41.
- Salzhauer A. Is there a patient in the house? In: *Harvard Business Review*. Boston: Harvard Business School, 2005:1–3.
- Demiris G. Smart homes and ambient assisted living in an aging society. New opportunities and challenges for biomedical informatics. *Methods Inf Med* 2008;47:56–57.
- Kaye J, Mattek N, Dodge H, Buracchio T, Austin D, Hagler S, Pavel M, Hayes T. One walk a year to 1000 within a year: Continuous in-home unobtrusive gait assessment of older adults. *Gait Posture* 2012;35:197–202.
- Singla G, Cook C, Schmitter-Edgecombe M. Recognizing independent and joint activities among multiple residents in smart environments. *Ambient Intell Hum Comput J* 2010;1:57–63.
- Rudary M, Singh S, Pollack M. Adaptive cognitive orthotics: Combining reinforcement learning and constraint-based temporal reasoning. In: Greiner R, Schuurmans D, eds. *The 21st international conference on machine learning (ICML 2004)*. New York: ACM, 2004:719–726.
- Das B, Chen C, Seelye A, Cook D. An automated prompting system for smart environments. In: *Proceedings of the 9th International Conference on Smart Homes and Health Telematics*. Springer, 2011:9–16.
- Botsis T, Demiris G, Pedersen S, Hartvigsen G. Home telecare technologies for the elderly. *J Telemed Telecare* 2008;14:333–337.
- Broekens J, Heerink M, Rosendal H. Assistive social robots in elderly care: A review. *Gerontechnology* 2009;8:94–103.
- Brose SW, Weber DJ, Salatin BA, Grindle GG, Wang H, Vazquez JJ, Cooper RA. The role of assistive robotics in the lives of persons with disability. *Am J Phys Med Rehabil* 2010;89:509–521.
- Mataric MJ, Eriksson J, Feil-Seifer DJ, Winstein CJ. Socially assistive robotics for post-stroke rehabilitation. *J Neuroeng Rehabil* 2007;4:5.
- Boissy P, Corriveau H, Michaud F, Labonte D, Royer MP. A qualitative study of in-home robotic telepresence for home care of community-living elderly subjects. *J Telemed Telecare* 2007;13:79–84.
- Petersen RC. Mild cognitive impairment as a diagnostic entity. *J Intern Med* 2004;256:183–194.
- Weintraub S, Salmon D, Mercaldo N, Ferris S, Graff-Radford NR, Chui H, Cummings J, DeCarli C, Foster NL, Galasko D, Peskind E, Dietrich W, Beekly DL, Kukull WA, Morris JC. The Alzheimer's Disease Centers' Uniform Data Set (UDS): The neuropsychologic test battery. *Alzheimer Dis Assoc Disord* 2009;23:91–101.
- Forlizzi J, DiSalvo C, Gemperle F. Assistive robotics and an ecology of elders living independently in their homes. *Hum Comput Interact* 2004;19:25–59.
- Rialle V, Olivet C, Guigui C, Herve C. What do family caregivers of Alzheimer's disease patients desire in smart home technologies? Contrasted results of a wide survey. *Methods Inf Med* 2008;47:63–69.
- Faucounau V, Wu YH, Boulay M, Maestrutti M, Rigaud AS. Caregivers' requirements for in-home robotic agent for supporting community-living elderly subjects with cognitive impairment. *Technol Health Care* 2009;17:33–40.
- Seelye A, Howieson D, Wild K, Saucedo L, Kaye J. Living well with MCI: Behavioral interventions for older adults with mild cognitive impairment. In: Brougham R, ed. *New directions in aging research: Health and cognition*. New York: Nova Science Publishers, Inc., 2009:57–74.
- de Joode E, van Heugten C, Verhey F, van Bostel M. Efficacy and usability of assistive technology for patients with cognitive deficits: A systematic review. *Clin Rehabil* 2010;24:701–714.

Address correspondence to:

Katherine V. Wild, Ph.D.

Layton Aging & Alzheimer's Disease Center
Oregon Health & Science University
3181 S.W. Sam Jackson Park Road, CR131
Portland, OR 97239

E-mail: wildk@ohsu.edu

Received: January 27, 2012

Revised: March 2, 2012

Accepted: March 3, 2012