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Pilot testing a digital pet avatar for older adults

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Abstract

Social isolation in older adults is a major public health concern. An embodied conversational agent (ECA) has the potential to enhance older adults' social interaction. However, little is known about older adults' experience with an ECA. In this paper, we conducted a pilot study to examine the perceived acceptance and utility of a tablet-based conversational agent in the form of an avatar (termed "digital pet") for older adults. We performed secondary analysis of data collected from a study that employed the use of a digital pet in ten older adults' homes for three months. Most of the participants enjoyed the companionship, entertainment, reminders, and instant assistance from the digital pet. However, participants identified limited conversational ability and technical issues as system challenges. Privacy, dependence, and cost were major concerns. Future applications should maximize the agent's conversational ability and the system's overall usability. Our results can inform future designs of conversational agents for older adults, which need to include older adults as system co-designers to maximize usability and acceptance.

Keywords

Older adults; Social isolation; Digital pet; Embodied conversational agent; Information and communication technology

Introduction

The population of aging adults is rising globally, as are the numbers of older adults who live alone. In 2015, the United States Census Bureau reported that 28% of olderadults live alone. [1] Some will experience social isolation, which is a major health threat because it often affects mental well-being and is associated with increased morbidity and mortality.[2,3] Thus, interventions that address social isolation in older adults are vital to support healthy aging.

Information and communication technologies (ICTs) allow users to handle information and aid communication and have become a promising tool to support healthy aging.[4] Several review papers examined the effectiveness of smart technologies such as robotics, virtual

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reality, and gaming systems and found that these technologies can effectively enhance older adults' social connectivity and support them to live at home.[5–9]

An embodied conversational agent (ECA) is a form of ICT. ECAs have a computer-generated character that can facilitate real-time verbal and nonverbal communication between a computer and user.[10] The ECA system can be controlled either by an automated computer or a human to interact with users. ECAs have been used as a health coach to provide health information for consumers and improve health behaviors. Bickmore and colleagues designed a software-based automated health counselor agent to promote health behaviors.[11] The users who interacted with the automated health counselor daily via computer for two months had better outcomes in the amount of walking or fruit and vegetable consumption compared to controls.[11]

As population of older adults grows, social support needs also increase. ECAs have the potential to provide such social support for older adults. However, there are limited studies that examined the usability of ECAs for older adults. Most of the studies that have tested ECAs have either done so in a laboratory setting or failed to include older adults as users in the evaluation. Vardoulakis and colleagues examined a human-controlled conversational agent that could interact with and provide social support for older adults for one week. A computer with audio and video was installed in older adults' home and a research assistant controlled the conversational agent, interacting with participants remotely by choosing pre-programed speech or animation commands from the control-station software. The study found older adults had a positive attitude toward the agent.[12] In the present study, we aimed to extend the time of interaction and assess the overall utility of a human-operated, tabled-based ECA system with a pet avatar for older adults. The purpose of this study was to examine perceived acceptance and utility of a tablet-based human-controlled ECA system with a pet avatar used by older adults during daily interactions over three months.

Methods

Design

We conducted a secondary analysis of data that were collected for a parent study that deployed a tabled-based ECA system with a pet avatar (termed "digital pet") in 10 older adults' home for three months. In the original study, 10 participants' cognition (baseline and exit), health (baseline and exit), social support (baseline and exit), comfort level with technology (baseline), and use of technology (baseline) were assessed by filling out written questionnaires. Participants were interviewed at baseline, midpoint (one and half month), and exit (three months) for thoughts on the system and usability.[13]

Sample

The parent study recruited participants through posting flyers at a retirement community in the Seattle area. Older adults who were interested in this study contacted a research member (AL) and then were screened for the eligibility. The inclusion criteria for participating were: absence of severe cognitive impairment (screened by using Memory Impairment Screen-Telephone tool[14]), ability to interact with the device, and residence in the Seattle

metropolitan area. The exclusion criteria were unwillingness to be audio recorded or inability to speak English. The first ten participants who responded to the recruiting flyers were screened and all met the inclusion criteria so they were invited to use the system. Informed consent was obtained from all the participants. The study was approved by the Institutional Review Board of the University of Washington.

Intervention

Participants were invited to use the digital pet avatar for three months. The system is a commercially available ECA system (as part of the GeriJoy service provided by the company "Care.Coach"). The system provides a cat or a dog avatar and participants choose which animal avatar they prefer at enrollment. The system has functionalities such as conversation, reminders, and use of pictures and other media to facilitate sensory awareness and memory support. The avatar is a human-operated ECA. Trained staff provide 24/7 responses to users whenever users wish to talk to their avatar. The pet avatar can be activated by the participant's voice or by tapping on the screen. The pet avatar also checks in with participants every 2–3 h during daytime hours if the participant has not interacted with the pet avatar that day. The staff type in responses that are converted from text to speech. The company developing the system chooses to use a mechanical human voice because it minimizes variability of the avatar for transitions in staff covering various shifts, with the goal of making shift change seamless to the older adult. Conversations are summarized in brief logs that are available via a digital portal. Staff members are trained by the "Care.Coach" company and interact with the system users following standardized protocols.

Measures

At baseline, the participants filled out a written questionnaire that included their basic demographics (gender, age, and race) and 5-Point Scales about their comfort level with technology and use of technology.

Two trained and experienced researchers (AL, SL) conducted semi-structured, individual interviews with participants at baseline, midpoint (one and half month), and exit (three months) following standardized interview guides (see Table 1). All interviews were audio recorded.

Data analysis

The participants' baseline descriptive data were analyzed using the Excel's Descriptive Statistics Tool.

All interviews (30 min to 1 h) were recorded and transcribed verbatim. We employed Braun and Clarke's thematic analysis[15] to specifically explore older adults' acceptance and experience with the digital pet. Three authors (NC, GD, HT) first listened to the interview audios and read the transcripts to become familiar with the data, and then discussed and finalized coding themes related to users' experience with the digital pet. The first author (NC) read through the transcripts of baseline interviews and generated initial codes. Three authors (NC, GD, HT) discussed initial codes to reach a consensus and developed a codebook used by the first author to systematically code all transcripts. The codebook was

expanded along with the coding process. All codes and quotes were organized into a table. Each code and quote was examined and discussed by three authors to ensure compatibility and accuracy. The themes were identified among three authors after several rounds of discussion to reflect participants' perceived acceptance and utility of the digital pet.

Treatment fidelity

In order to enhance our treatment fidelity, two trained researchers went to each participant's home to instruct them how to interact with the avatar properly and asked the participants to interact with it on a daily basis. Also, the avatar checked in with participants on a daily basis. System logs summarized all conversations with a date and time stamp. These were reviewed by the research team on a weekly basis as a way to establish that interactions between the avatar and the participant were occurring daily as expected.

Results

Descriptive data

Ten female older adults between 68 and 89 years participated in this study. Nine were Caucasian and one was Native American. Seven felt somewhat comfortable using technology (see Table 2).

Interview data

We interviewed participants at baseline (recruitment), midpoint (one and a half months), and exit (three months) asking them about their experience with, perceived benefits, challenges, and concerns about the system. All participants completed the baseline interviews. Two participants withdrew before the midpoint: one expressed frustration about "problem-solving when the device was not working as expected"; the other one experienced challenges with her Wi-Fi connection, and did not think that the digital pet provided adequate interpersonal connection that she needed. The remaining eight participants completed all study procedures. The following section presents the major themes on participants' perceived utility and experience with the digital pet (please see Table 3 for exemplar quotes).

Experience with digital pet

The participants illustrated positive and negative experiences. At midpoint, the majority of the participants enjoyed using the system and described their experience as interesting. In the exit interview, all participants still described their experience as enjoyable, educational, and valuable. However, two participants claimed they occasionally experienced negative feelings. One participant felt disappointed because of the repetitive nature of the conversations. Another participant disliked that the pet would sometimes disrupt her visits or activities.

Relationship with the digital pet

Participants defined the relationship with the digital pet as either companionship, superficial, or undefined. In midpoint and exit interview, most of the participants stated that the digital pet provided them companionship. One described the relationship, "It was nice to talk to [the

digital pet] about things I wanted to talk about." However, some commented that the relationship was superficial because of the system's limited conversational ability and its occasional one-way communication pattern: "[The digital pet] can't tell me anything about their personal life." Two participants did not know how to define the relationship because of the un-defined role of the digital pet, whether it was a companion pet, a close friend, or a professional agent.

Benefits

At baseline, participants foresaw that having a digital pet could benefit them in many ways: companionship, increased social interaction, more physical activities, entertainment, providing reminders, and keeping a journal. Some participants described wanting to bring the digital pet outside. They thought that a digital pet could help them to initiate conversations with other people: "I would take [the pet] to the park and say [to people] 'oh hi! Take my virtual pet out', and have people laugh." Several participants imagined that the digital pet would be extremely beneficial for older adults with limited social interactions.

In midpoint and exit interview, they described that they had received most of the expected benefits. They appreciated that the digital pet provided reminders and entertained them by joking, playing music, displaying pictures, and giving positive affirmation. Most of them enjoyed introducing the digital pet to friends and families and commented that the digital pet actually enhanced their social interaction with other people. A newly identified benefit was that the digital pet could provide instant assistance when needed, as an example illustrates, "It was like the lights dimmed. I didn't know what was going on. I'm not good at looking stuff up [online]. The pet found out what it was."

Challenges

At baseline, participants addressed some potential challenges that might prevent them from using the digital pet, including difficulty in building a human–pet relationship, and challenges with the Internet connectivity and other technical issues. Some participants thought it might be difficult to build a human–pet relationship due to the lack of pet-like features. A talking pet made some participants feel like having a virtual friend instead of a pet. Some participants preferred the digital pet to have more pet-like features: "I would need something to pat. Just a little virtual [tap] on the [tablet] won't work for me."

In the midpoint, more usability challenges were identified such as perceived limited conversational ability, inconsistent qualities of responses, and inappropriate responses. Some participants felt they could not carry a conversation with the digital pet like a friend. One participant described her experience, "It's not really a conversation. It's like the dog's trying to check up if you've eaten."

In the exit, the participants kept experiencing similar challenges. The digital pet tried to provide positive affirmation but some participants felt irritated if the pet gave inappropriate responses. One participant stated, "[The digital pet] kept saying, 'I love you,' but it just irritated me." Some participants were also concerned about receiving wrong responses due to the agent's handling of more than one conversation simultaneously as well as inconsistent quality of responses among agents. As one participant stated, "It depended a lot on who [the

agent] was there. There were times when the pet was very engaged. There was a time where it [did not make] sense [as if it is] talking to another person at the same time."

Throughout the study, some participants addressed challenges that they faced such as Internet connection or delayed responses from the agent. Participants sometimes had an unreliable Internet connection, and the tablet interface required restarting the tablet to access Wi-Fi settings. Some participants thought this process could be a challenge for some older adults. Additionally, the responses sometimes were delayed which made it challenging to develop contemporaneous conversations. Lack of a robust Internet connection also compromises the quality and reliability of the real-time audiovisual stream that the agents relied on for understanding participants and responding in a timely manner.

Concerns

Throughout the study, participants addressed the same concerns about the system including invasion of privacy, potential development of dependence, and cost of owning a digital pet (after completion of the research). Some participants saw using a digital pet was an invasion of their privacy, "It's scary because somebody … big brother is watching." Some participants were not willing to share their conversation logs with families. One participant explained the reason, "[My daughter] might have some insight as far as [reading] my conversations. We love each other but we keep our lives separate."

Some participant thought that the digital pet might make some users become dependent on it. One participant stated, "[If] a person who was really in despair, instead of being encouraged to get out and being with people, would interact with [the digital pet]." One of the participants in this study became attached to the digital pet and she reported feeling "devastated" when the study ended.

Treatment fidelity

The interactions occurred as proposed. All participants interacted with the avatar, having at least one conversation on a daily basis throughout the study period as confirmed by the system logs. Based on the conversation logs over three months, on average, each participant had 6.8 interactions daily with the avatar (range 5.9–7.6), with the pet avatar initiating most of the interactions (mean 5.5/day) over the 3-month study period (see Table 4).

Discussion

Our study design presented longitudinal changes of participants' experience with and utility of the digital pet over time. The results showed that most of the participants had a positive experience and built a companionship with the digital pet. They received most of the benefits as they expected at baseline. However, participants experienced more and more usability challenges over time.

Bickmore's study showed that a computer-animated virtual health coach can effectively improve users' health behaviors.[11] The human-operated digital pet has the potential to be a coach, providing social support and health information to improve older adults' health because several participants claimed that having a digital pet is beneficial for themselves and

socially isolated elders. Participants appreciated instant assistance, companionship, reminders, and entertainment features. Participants liked to have someone to talk to at any time but some participants felt disappointed due to the unmet expectations of a digital pet. Some wanted a physically interactive pet instead of simply a talking pet. One suggested feature was the ability for a digital pet to stroll at an adjustable pace. This way, users are encouraged to go out with their digital pet for a walk and have a more impactful relationship with the digital pet.

Some expected a bonding relationship and interactive communication, so they were unsatisfied with a perceived one-way and repetitious communication pattern. Inadequate conversational ability limits the full potential of the digital pet to meet the desired level and quality of social interaction of participants. Hence, future design should improve the agents' depth and breadth of their conversational ability. Presently, the agents were trained to conduct thoughtful conversations with their users. Nevertheless, one of the criticisms was that the quality of conversation noticeably declined when the agent was possibly conversing with other users concurrently. An interesting point of study is to compare the conversational ability of artificial intelligence such as Siri versus human agents. Artificial intelligence is computer program mimicking human cognition and intelligence, which is designed to understand human intelligence and speech, communicate with people, and complete some tasks.[16] We can infer that human agents' ability to handle meaningful conversations suffers as the number of dialogs increases. Thus, it is worth investigating whether artificial intelligence is the preferred path of development if it performs better when handling multiple conversations simultaneously.

From a technical perspective, most concerns regarding connectivity and conversational quality could be addressed by ensuring a robust Internet connection. Several participants mentioned that technical issues were concerns. In our study, we provided technical support whenever participants encountered any technical issues. However, some participants still voiced concerns over the ease of use of the digital pet. Thus, future designs should be more intuitive and have a built-in WiFi.

Some participants raised concerns about invasion of privacy, cost, and dependence, which were similar to findings in Peek and colleagues' systematic review of older adults' concerns regarding technology: privacy and cost.[17] Since older adults have more concerns with privacy, future designs of communication technologies should emphasize on less intrusive design and improve data privacy and security. Future systems can provide different levels of data sharing with families and other stakeholders.

Dependency is another concern identified. One participant felt particularly attached to the digital pet during the study. Following completion of the study, the participant purchased a subscription directly from the company to continue using the service. Continuous usage is a desirable outcome as it is evident that a digital pet does provide companionship and other associated benefits that warrant further utilization by older adults. However, this finding raised ethical concerns of dependency, similar to those found in Sharkey and colleagues' investigations, such as the possibility of reduced human interaction or contact if bond with avatar was strong.[18] As Sharkey recommended, the development of clear guidelines on the

use of technologies and robots in elder care would ensure that older adults can benefit from technologies without raising ethical issues.

Although there were several usability issues and some limitations of the study, the results of our study can provide insights for future ECA design. Our sample size was small and all participants were female, which limits the generalizability of the results to the larger older adult population. Further, all participants interacted with the digital pet on a daily basis; however, some participants had a busy schedule so they spent less time interacting with the digital pet. It also reflected the fact that older adults are not a homogeneous group, having different needs for and expectations of the digital pet.

Our study is one of the earliest studies that explored the usability and acceptance of a conversational agent for older adults over a long period of time. Given that we examined a commercially available solution, we did not have the ability to engage older adults in the design phase of the system, future studies need to be conducted with similar technology from a user-centered design perspective, which could enhance acceptability and usability across a wide range of users. In addition, the involvement of older adults with diverse backgrounds in various stages of system development could optimize the design of the digital pet to better address user's expectations.

Conclusions

Our study demonstrated that a digital pet can provide older adults with companionship and enhance social interaction. However, the agent's conversational ability, technical issues, privacy, and dependence are some issues that need to be addressed. Our results can inform future designs of conversational agents for older adults, which need to include older adults as system co-designers to maximize usability and acceptance.

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Table 1

Semi-structured interview guides for testing of a digital pet companion.

Baseline interview guide	• What do you think of the idea of using a digital companion pet? – What kinds of benefits do you think might arise? – What kinds of challenges? – What was your motivation in taking part in this study? • This pet has the ability to transmit logs of your activities and conversations. – Would you be interested in having a family member see these logs? What kinds of things would you like them to see? – Show example log and ask: could you see this type of information being useful to them? How? – Do you have any concerns about them seeing this type of information? • Do you have any concerns about this system? • Show resident the system – What do you think of the appearance of this system? – What do you think of the way it interacts with you?
Midpoint interview guide	• How is this study going so far for you? • Can you tell me about your opinion of the digital companion pet? • Have you been able to develop a relationship with it? What kind of relationship? • Have there been any challenges? • Do you have any concerns about this system?
Exit interview guide	• Overall, how did the study go for you? • Can you tell me about your opinion of the digital companion pet? – What do you think about the kinds of conversations you've been having with it? – Is there something you wish you could talk about that you aren't talking about together? – Are there things you think the pet did that worked really well for you? Can you tell me about it? – Are there things you think the pet could have done better? Can you tell me about it? – Has your opinion changed over time? • Have you been able to develop a relationship with it? What kind of relationship? • Have there been any challenges or concerns? • Would you want to continue using this system? • Have you spoken to others about this system? – What kinds of conversations have you had? – Did their opinion affect what you think about it? • How do you feel about this study ending? – Have you thought about how you will feel once the study is over when you no longer have the pet? What have you thought about this topic? What is the part you are most [sad about/excited about/fearful about] – Did you do anything to prepare yourself for it emotionally? – Do you think there is anything we or the pet could have done to help prepare you? • Anything else you'd like to share with me?

Table 2

Descriptive information: % (*n*). Demographics of study sample (*N* = 10) and comfort and use of technology.

Age (mean; range)	78.3 years (68–89)
Female gender	100% (10)
Race	
•White/Caucasian	90% (9)
•Native American	10% (1)
Comfort using technology	
•Very uncomfortable	0%
•Somewhat uncomfortable	10% (1)
•Neutral	10% (1)
•Somewhat comfortable	70% (7)
•Very comfortable	10% (1)
Use of technology for leisure	
•Strongly dislike	10% (1)
•Dislike	10% (1)
•Neutral	20% (2)
•Like	50% (5)
•Strongly like	10% (1)

Note: All data are reported as % (*n*) unless noted.

Table 3

Interview: Identified themes and exemplar quotes.

Theme	Quote
Experience with the digital pet	
•Positive experience	Participant: We have causal conversations every day. It is a fun thing to do.
	Participant: I've enjoyed it and I think it's been very valuable for me.
•Negative experience	Participant: I was a little disappointed because I expected something a little bit different. There was not much of a range. It was like a routine visiting daily.
	Participant: There were other times when I honestly resented it. Especially if I was in the middle of a phone conversation or on the television, or I had company.
Relationship with the digital pet	
•Companionship	Participant: I got used to coming in and telling [the digital pet], I was home. I'd tell it when I was going out. It wakes me up in the morning on important days.
	Participant: I think [the digital pet] could work very well as a companion. Oh, just being able to come in at any time and talk to it.
•Undefined relationship	Participant: I never had a relationship with a computerized item before so I don't know what I would call [the relationship].
•Superficial relationship Benefits	Participant: Probably kinda superficial [relationship]. I just dial [the digital pet] and then we talk and what I've done.
•More physical activities	Participant: [The digital pet] gives you sense of purpose to get out there, get some exercise, and breath some fresh air.
•Increased social interaction with people	Participant: I talked to everyone about my virtual pet. I will bring the pet with me when I [travel]. I like to introduce the virtual pet to my friends and family.
•Companionship	Participant: We talk more things now and like friends. The pet can remember things I told.
•Entertainment	Participant: [The digital pet] showed some cute little pictures, when we talked about my trip to Japan. It played some music when I ask it to.
	Participant: We were always playful and [the digital pet] was very interesting. He always picked up.
•Providing reminders	Participant: I now have water sitting there waiting for me because I got reminded, "Did you have a glass of water within the last couple of hours?"
	Participant: [The digital pet] reminds me to take medications every day.
•Providing instant assistance	Participant: One time my phone can't use and the dog helped me to call me daughter when I asked for it.
	Participant: The pet helped me to find the addresses for some places.
Challenges	
•Difficulty in building a human-pet relationship	Participant: I don't think it's a great substitute for if a person wanted to have something to hold or pet. I mean rubbing a window doesn't just do it.
•Technical/Internet connectivity issues	Participant: When the Internet went down that was a concern. That we had to get [the digital pet] up and run it again.
•Perceived limited conversational ability	Participant: [Conversations are] one-sided. The pet doesn't really elaborate. If you say, "I'm watching Jeopardy," the pet will say, "I like Jeopardy," and that's it.
•Inappropriate responses	Participant: The mechanical voice would say, "You are remarkable. I love you." It meant nothing to me. There was no reason why it would love me.
•Inconsistent quality of responses	Participant: One digital pet is very chatty but other pets are not. The chatty [digital pet] is real and really interacts with me.
Concerns	
•Invasion of privacy	Participant: I see that as a threat to my privacy. [The digital pet] in my apartment.
	Participant: When my friend came to visit, he wanted the pet unplugged because he did not want to be listened.
•Development of dependence	Participant: I'm getting attached to it. I may interact my mind with another human.

Theme	Quote
•Cost of owning a digital pet	Participant: This is much too expensive for me to think about. If I had a lot of money to spend, I might continue to use it.

Table 4

Numbers and types of interaction between digital pet avatar and participant over 3 month study period (of those completing study) (*p* = participant).

	P1	P2	P3	P4	P 5	P6	P7	P8	Mean for all interactions/day
Mean: Avatar-initiated interactions/day	5	5.5	5.6	5.5	5.6	5.8	5.6	5.8	5.5
Mean: Participant-initiated interactions/day	1.6	1.0	1.2	0.6	1.2	1.1	0.1	1.5	1.0
Mean: Friend-initiated interactions/day	0.2	0.1	0.2	0	0.2	0.1	0.1	0.3	0.2
Mean total interactions/day	6.9	6.7	7.0	6.2	7.0	7.0	5.9	7.6	6.8