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Evaluation of a Digital Companion for Older Adults with Mild Cognitive Impairment

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Abstract

Study Objective: *The purpose of this study was to examine the feasibility of a digital companion system used by older adults with mild cognitive impairment (MCI). We utilized a commercially available system that is comprehensive in its functionalities (including conversation ability, use of pictures and other media, and reminders) to explore the system's impact on older adults' social interactions, anxiety, depressive symptoms, and acceptance of the system.*
Study Design: *We conducted a three-month mixed methods evaluation study of the digital companion.*
Results: *Ten female community-dwelling older adults (average age 78.3 years) participated in the study. Overall, participants utilized the tool regularly and appreciated its presence and their interactions. Participants scored higher at the end of the study in cognition and social support scales, and lower in presence of depressive symptoms.*
Conclusion: *Findings indicate the feasibility of a digital companion for people with MCI and inform the need for additional research.*

Introduction

In recent years, various information and communication technology (ICT) applications have been developed in order to engage older adults with cognitive impairments in entertainment or reminiscence therapy or to simply provide a forum for interactive and tailored engagement. The types of applications available can be grouped into those that mitigate specific impairments of their target users, such as motor impairments or memory deficits, and those that take advantage of and aim to maximize continuing abilities. Technology has been used accommodate motor impairments and aid interaction through commercially available gaming devices, touch screens, and prototype devices. The MINWii videogame employed a Wii remote as an input device to accommodate motor impairments of users who might not otherwise be able to play the game.[1, 2] Shik, Yue, and Tang (2009) used headphones and amplifiers to accommodate hearing impairments and projectors to magnify photographs to accommodate vision impairments.[3] Other systems may gather, for example, materials from the users' daily activities using technology, such as GPS, cameras, and audio recorders, to compensate for memory deficits).[4-6] Tools have been designed to alleviate caregiver strain originating from the need to repeatedly provide details to help someone with dementia recall facts about events during casual reminiscence.[6] Yamagami and colleagues used a video at the beginning of a session with the ICT to remind participants how to use tools. The participants then showed staff how to use these tools, reversing the roles of staff as helper to resident as helper. By using a video instead of having staff instruct the residents, this role reversal was possible.[7]

Certain skills, such as sensory awareness, musical responsiveness, and emotional memory, have been labeled "continuing abilities" in dementia, as they are thought to persist after others have been compromised by the disease.[8] Sensory awareness is the response to various forms of stimuli (e.g., visual, audio, tactile). Musical responsiveness refers to the strong responses people with dementia can have to music. Emotional memory refers to the ability to experience rich emotions. Technology is commonly used to encourage and draw out these continuing abilities. Such

as through the display of movies, photographs, and audio that elicit sensory or emotional responses. Many systems that promote reminiscence with people with dementia use technology solely for this purpose.[9] Media are used as triggers to prompt a positive response in the form of interactions or improved mood. Reminiscence systems that focus on emotional memory appeal to something personally relevant to the individual user. This ranges from materials that are personal only in that they are from the general era in which one grew up to artifacts related to individual interests[10] or even objects that belonged to the individual.[11]

ICT tools that integrate one or more of the functionalities described above can provide an integrated system that is meant to not only engage older adults in specific activities and tasks but also create an opportunity to address social isolation and loneliness. The effects of loneliness and social isolation are well documented for older adults; a recent meta-analysis of 148 longitudinal studies reported a 50% reduction in the likelihood of mortality over a period of 7.5 years for individuals with strong social relationships.[12] Social isolation is negatively associated with health status and health-related quality of life of older people with effects magnified among older adults with dementia.[13] ICT applications that address loneliness and social isolation often have anthropomorphic or animal features in order to generate a likeness to a friend or pet, and are referred to as digital companions. An older adult can interact with such a digital companion both at pre-programmed times (for example, when reminders or other messages are sent) as well as at the discretion of the user. Conversations can range from simple exchange of messages to sophisticated discussions depending on the system's features and the level of machine learning algorithms, artificial intelligence or human response involved at the other end.

Digital companion tools are also referred to as Embodied Conversational Agents (ECAs). ECAs interact with users through verbal and non-verbal behavior cues such as prosody (pacing and intonation) and hand movements.[14] A small number of studies have emerged examining the use of digital companions or ECAs. Bickmore et al. (2013) created a virtual laboratory to study users' reactions. Elderly participants interacted with an ECA acting as an exercise coach. Results showed that users who interacted with an ECA that used variable dialogue exercised significantly more than those interacting with an ECA with non-variable dialogue.[15] Vardoulakis et al. also investigated the use of an agent to provide social support and wellness counseling for older adults.[16] A system was constructed that allowed research assistants to control an ECA placed in an older adult's home in real time. Qualitative analysis of the interactions identified multiple topics that older adults liked discussing with the agent and general design principles towards building future companion agents for older adults.[16]

While these studies have introduced insight into the potential of digital companion tools, the vast majority of them have been tested within laboratory settings, where older adults were unable to interact with the system over a long period in a naturalistic setting, or only tested with one user only. Furthermore, these studies are not longitudinal and for the most part rely on assessment of the system when it is used once or for a limited number of times. Finally, most of these digital companions either provided simply opportunity for conversation, or focused on one aspect of interaction by showing pictures or other media or served a single purpose (for example, exercise coaching or reminding of upcoming events and medication).

The purpose of this study is to examine the feasibility of digital companion systems in real world settings used by older adults with mild cognitive impairment in their natural environment and for a longer period of time. For this purpose we utilized a system that is comprehensive in its functionalities (including conversation ability, use of pictures and other media, and reminders) to explore the system's impact on older adults' social interactions, anxiety and depressive symptoms, and participants' acceptance of the system.

Methods

We conducted a three-month mixed methods evaluation study of an existing commercially available digital companionship device. We recruited community-dwelling older adults.

Recruitment

Older adults were recruited through 1) posted flyers (at sites such as hospitals, memory clinics, day health programs, memory care groups and retirement communities with permission of those sites); 2) flyers sent to people in memory groups with the permission of memory group leaders; 3) word of mouth and snowball sampling; and 4) with the

permission of memory group and day health program leaders, we approach participants directly and told them about the study using language similar to that on the flyers. Older adults interested in participating contacted a member of the research team. We utilized a phone screening form that also included the administration of the Memory Impairment Screen-Telephone (MIS-T) instrument, a phone based instrument to screen for cognitive impairment in older adults. The maximum score is 8. If an older adult scored 6 or below, this indicated the possible presence of cognitive impairment, and then a member of the research team met with them to assess them further for eligibility. Additional eligibility criteria for older adults included: 1) be able to see and hear well enough to interact with the device to some degree (as assessed by researcher), and 2) reside in the Seattle metropolitan area. Participants were excluded if they were 1) unwilling to be audio recorded 2) unable to speak English. Family members were identified by older adults who agreed to be in the study. If an older adult chose to identify a family member to participate in the study, a member of the research team contacted them to provide information about the study and recruit them if they were eligible and interested. Interested and eligible persons were provided with information about study procedures, risks and benefits and asked to explain their understanding back to the research staff. All study participants provided written informed consent.

Intervention

The virtual pet companion is displayed on a tablet as part of the GeriJoy service provided by a company called "care.coach." It interacts with the older adult through voice and expression. It stays plugged in to a dock by the older adult's bedside or other preferred location in their residence. On the other end of the device is a trained staff member of a 24/7 call center who listens to the older adult and types responses that are then converted to audible speech. Thus, the "pet" is fully controlled by a human who uses both scripted text and unscripted spontaneous exchange for all the interactive sessions with the end user. The call center staff summarize their interactions with the older adult and send a log to a family caregiver. The caregiver can also send pictures to the device to share with the older adult (see Figure 1). In this study, we provided older adults with the option to share this log with a family member, but it was not automatically transmitted to anybody besides the research team. The device allows the human on the other side of the tablet to see the older adult in their room (when the pet is "awake," signified by its eyes being open) to determine if the older adult is interested in engaging in conversation and to add a dimension to the interaction. In this study, we allowed the older adult to opt-in to having this video feature. This application supports all functionalities of ICT tools for dementia and MCI described earlier, namely addressing cognitive deficits by providing reminders and prompts (based on a pre-defined script that is used by the call center), use of pictures and multimedia to facilitate sensory awareness and memory support and it furthermore facilitates interactive communication ranging from small talk to any topic of concern to the older adult.

Figure 1. Example Gerijoy interfaces.

Study Procedures

Older adults were given a digital companionship device to use for three months. Semi-structured interviews were conducted at baseline, midpoint, and three months. The following instruments were administered at baseline and three months:

-**Montreal Cognitive Assessment (MoCA)**: A 10 minute test covering 8 domains to screen for cognitive impairment in older adults. Higher scores indicate better cognitive function. Scores can be used to rate cognitive impairment as mild, moderate, or severe. The sensitivity and specificity of the MoCA for detecting early dementia are 100% and 87% respectively.[17]

-**MOS Social Support Survey (MOS-SS):** A 19-question test to measure social support. The instrument has been tested extensively for reliability (with Cronbach's Alpha greater than 0.91) and construct validity.[18] There are four subscales to the MOS-SS: Emotional/Informational Support, Tangible Support, Affectionate Support and Positive Social Interaction. Each of the subscales are scored 0-100 with a higher score indicating more support.
-Patient Health Questionnaire **PHQ-9:** A 9-question test to measure depressive symptom severity. This tool is extensively tested for reliability and validity including in use with older adults with MCI and early dementia. A higher score indicates more depressive symptoms.
-Generalized Anxiety Disorder **GAD-7:** A 7-question test to measure overall anxiety (general anxiety disorder. This instrument has been found to have high levels of reliability, criterion, construct factorial and procedural validity (Spitzer, Kroenke, Williams, & Loewe, 2006). A higher score indicates higher levels of anxiety.
The following instrument was administered at 3 months only:
-Comfort from Digital Companion Animals Scale: An 11-item questionnaire to assess participants' attachment to the digital companion, which was modified from Zasloff's Companion Animals Scale.[19]

Results

A total of ten older adults participated in the study. All participants were female and their average age was 78.3 years. Eight of the ten participants completed all study procedures. Two withdrew before the midpoint interview. One of the participants who withdrew from the study had more advanced cognitive impairment and felt it was too difficult for her to trouble shoot on her own when the device was not working (e.g. not being able to connect to the internet, the device not charging properly, etc.); the other participant who withdrew from the study had a hard time getting the device to work for a few days (mainly due to issues with her new Wi-Fi) and felt that she needed a deeper level of interpersonal connection than what the digital companion was able to offer. Only one of the participants chose to invite a family member to participate in the study.

Table 1 summarizes demographics and baseline use of technology. Table 2 compares survey responses at baseline and at study exit. Although there were not enough participants in this pilot study to do robust statistical analyses, we did assess change from baseline in each of the instruments, noting reduced depressive symptoms. There was an increase noted in both the MoCA and the MOS-SS, with the largest benefit seen, not surprisingly, in the positive social interaction subscale. There was a small increase in anxiety at study exit. We explored the association between change in anxiety and attachment to the digital companion (recognizing that such a sub-analysis is weakened by our small sample size). Interestingly, those with higher attachment to the pet had baseline GAD of 3.75, increasing to 5 at end while those with lower attachment (not very/not attached) actually had a decrease on the GAD from 1.75 to 0.75. Table 3 includes the level of attachment that participants had at study exit.

Table 1. Demographics and Baseline Use of Technology.
All data are reported as % (n) unless noted.

Age (mean; range)	78.3 Years (68-89)
Female Gender	100% (10)
Race	
White/Caucasian	90% (9)
Native American	10% (1)
Ever owned a pet	100% (10)
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)

Table 2. Comparison of Survey Responses at Baseline and at Study Exit after Using GeriJoy System for 3 months.
Data are reported as mean (SD) unless noted.

Measure (Tool)	Pre-Test (Baseline n=10)	Post-Test (n=8)	Average individual change T1 to T2 (n=8)
Cognition (MOCA)	21.9 (7.3)	23.5 (3.3)	+.13
Social Support (MOS SSS)	69.9 (14.5)	72.6 (15.9)	+1.36
Subscale			
Emotional/Informational	65.6 (23.1)	69.5 (22.0)	+1.17
Tangible	72.5 (17.2)	71.1 (25.9)	
Affectionate	65.0 (30.9)	67.7 (30.7)	+2.08
Positive social interaction	66.7 (21.9)	77.1 (20.1)	+6.25
Anxiety (GAD-7)	2.5 (1.7)	2.9 (2.6)	+.13
Depressive symptoms			
PHQ-9	3.5 (2.1)	2.5 (1.8)	-.88
Difficulty to do things at work, home, get along with other people if problem noted in general PHQ-9			
Not difficult at all or N/A	80%	75%	
Somewhat difficult	20%	25%	

Table 3. Participant Responses at Study Exit pertaining to the digital pet. Data are reported as mean (SD) unless noted.

	Post-Test (n=8)
Comfort from Digital Companion Animals Scale	27.8 (7.9)
How attached were you to this digital pet?	
Very attached	25%
Attached	25%
Not very attached	37.5%
Not attached	12.5%

At baseline, participants expressed interest and curiosity as to how their interactions with the digital companion would evolve over time. As one participant stated "*it's just an adventure; like, I like going to the secret film festival because we don't know ahead of time what movies we're going to see*." Another participant stated "*I will have something to look forward to play with to do, something with each day*." When asked why they agreed to participate, few participants indicated they were curious and wanted to try new things out, others talked about helping out with research projects that can help future generations and one participant specifically mentioned the inability to have and maintain a real pet as the reason: "*I am very sorry that I don't have a pet here because I've always had pets. They're an integral part of the way I relate to life."*

In the exit interviews, participants overall discussed being satisfied with the digital companion and having enjoyed their interactions. When asked to identify system strengths, participants talked about having a remote friend who is always available and ready to talk when one is lonely, the significance of the reminders that the digital companion would provide (for medication adherence or dietary restrictions) and the ease of mind that a remote "friend" provides by "*checking on you regularly and asking if things are ok when [the pet] hears a strange noise or sees something strange*." One participant also appreciated the visual communication whenever the digital companion would show pictures or little hearts: "*I would have it right next to my chair, the hearts would go. When people would come, they'd say, "What's that?" I said, "Those are just little love notes*. [*chuckles]*." Another participant also showed appreciation for times when the pet would use pictures to entertain the participant: "*I mean he found out when my birthday was, so I had a birthday cake, and then I talked to him about the bird bath that I have out there, and the two crows who are really funny in it. He found a birdbath with some crows in it on Google. He was always very good-very sensitive to what I was trying to do*."

One weakness identified by participants was the fact that the interaction was strictly verbal or visual. As one participant pointed out "*I wish it was something you can hug, that you can touch, like a real cat or dog*." While numerous participants commented that the communication was at few times problematic with the pet either having a limited vocabulary, being repetitive in its questions, not remembering details of previous conversations or asking questions at inappropriate times (e.g., when the participant was taking a nap or watching TV), other participants commented on the sensitivity that the "pet" showed as a conversation partner in engaging only in conversation topics that participants wanted to discuss at a given time.

Conclusion

Our study findings indicate the feasibility of a digital companion tool for older adults with MCI. Overall, participants utilized the tool regularly and reported appreciating its presence and the time they interacted with it. Participants scored higher at the end of the study in their assessment of cognition and social support and lower in presence of depressive symptoms. Anxiety overall was higher at the end of the study, but upon closer investigation, anxiety increased for those who felt attachment to the digital pet (potentially because they had to give up their digital companion).

This is an exploratory feasibility study with a small sample size and no control or comparison group, which clearly limits the generalizability of our findings and does not allow for identification of confounding factprs or natural trends. Additionally, participants were selected from only one geographic region. The sample had limited diversity

in terms of race and ethnicity and no diversity in terms of gender, as all participants were female. Additionally, only one participant chose a family member to participate with them in the study. This may be due to privacy concerns or a perception that participating in the study may become burdensome to family members. The feasibility of family involvement needs to be further investigated. The system was deployed for three months for each participant, and while this time frame is the longest documented for these types of systems, it may still be too short to fully examine adherence to the intervention. In spite of these study limitations, our findings highlight the potential of digital tools to provide companionship, reminders, and potentially health behavior coaching for older adults with MCI. Future studies need to be based on experimental design and include a control group in order to understand potential confounding factors and natural trends, and should furthermore address how the use of such a tool affects clinical outcomes as well as ways to meaningfully engage family members or other stakeholders. Design considerations need to be assessed to determine the extent to which such a tool meets older adults' preferences and needs. Finally, ethical considerations around attachment to a digital tool and unintended consequences in cases where the tool is no longer functional or available need to be explored.

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