Results from a Field Study: The Need for an Emotional Relationship between the Elderly and their Assistive Technologies

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Abstract

Many of the elder-care giving responsibilities of the aging population fall on the shoulders of adult children. Caregiver burnout is one of the top reasons for the transition from independent living to costly nursing homes or other care-giving facilities. As a result, technologists are rushing to find tools that can assist caregivers and augment the elder's ability to age in place. For a generation whose introduction to technology includes the black and white television, where the metaphors of windows and desktops are not automatically understood, the blitz of PDAs, smart homes, and voice recognition systems can be confusing, intimidating and stressful. Add to this the elder's need for companionship to ward off isolation and dementia, and the design problem transpires to a much bigger challenge than designing around physical limitations of the elderly. The idea of companionship provided by technology is not new. From the simple rule-based Tamagotchi pets to Sony's sophisticated AIBO, there is a large body of evidence that shows that the owners of these robotic pets form genuine and meaningful emotional bonds. However, few solutions combine 'purposeful utility' with entertainment and companionship. Solutions that are 'purposeful' are predictable and seldom achieve the level of autonomy that captures the interest of and engages the user, while solutions with high entertainment value often lack functions that directly aid the elder with daily functions. We describe the details of a smart home field test, and examine focus group discussions that were conducted with both the participants and their adult children caregivers. We identify discussions from focus group transcripts that are related to the user's social behaviours and emotions towards the technology, and changes in the user's interaction with his/her caregiver caused by the introduction of the technology. We describe some aspects of the "personality" the participants projected onto the smart home despite the intended lack of physical character embodiment of the system, and relate this to existing theoretical work from human-human interactions and human learning theory. Finally, we offer insight into how these observations might translate into functional implementations to reap the benefits of assistive technology as a means to both reduce the burden of caregivers and provide companionship.

1 Introduction

As automation becomes more complex and sophisticated, there is increasing evidence that we treat it with the same set of expectations we bring to interactions with other complex, autonomous, social agents (e.g., Reeves and Nass, 1996). There are a number of efforts that are introducing theories from human-human interaction into computer science, including the A.L.I.C.E. chatbot (www.alicebot.org), Carmen's Bright Ideas (Marsella et al., 2003), and KISMIT (Breazeal, 2000). Some are beginning to leverage human-human interaction and emotional intelligence to address social aspects in the health-care domain (Picard, 2001). We describe a smart-home project whose goal is to support independent living for the elderly, and discuss the tendency of users to anthropomorphize technology and its implication for future technology designers.

1.1 Why is Affective Computing Particularly Important to the Elderly?

Affective computing is pertinent to this section of the demographic due to three major reasons. Firstly, emotions play a significant role in cognitive and physical health, which in turn greatly influences an elder's ability to live independently, more so than other age groups. Secondly, elders often lack an understanding of the metaphors used by technology and the technology's intent. Some pedagogic theories may explain tendencies for the personification of technology. Thirdly, irrespective of age, humans who are lacking or desire social interactions tend to actively seek social interactions, even when the interaction is not reciprocal as is the case of inanimate objects.

Due to the potential significant cost savings that can be attained by delaying in-home or nursing home care, technologists are rushing to provide solutions that promote independent living. Everything from ergonomically

designed can openers and countertops, to chemical analysis toilets and human washing machines have been proposed or are becoming available. At the high technology end of this spectrum, and showing perhaps the greatest promise, are integrated home monitoring and aiding systems—"smart homes"—that may serve to let the elderly maintain their independence and remain in their legacy homes longer or reduce the need for professional assistance, extending the capabilities of those engaged in it. Smart homes technologies such as Georgia Institute of Technology's Aware Home Research Initiative[1] and Honeywell's Independent LifeStyle Assistant I.L.S.A.™(ILSA) have the primary objective of extending the level and duration of independence of elders. The most common reasons elders are admitted into nursing homes are caregiver burden and the elder's inability to perform Activities of Daily Living (ADLs)[2] and Instrumental Activities of Daily Living (IADLs)[2] (Miller and McFall, Kasper et al., 1990). Solutions for augmenting an elder's cognitive abilities include time and event based reminders and alarms for both the elders and their caregivers, but technologists are beginning to turn their attention to 'preventative' measures. Regular social interaction has been known to maintain emotional health and relationship development between patients and caregivers have been associated with a number of benefits, including improved treatment compliance, improved physiological outcomes, fewer malpractice suits, and more detailed medical histories (Bickmore et al., 2005). Neglect, loneliness, and isolation are often causes for an elder's transition into a nursing home or an independent living facility. The National Elder Abuse Incidence Study (NEAIS), the first study to estimate the national incidence of elder abuse and neglect in the U.S., found that a total of 449,924 elderly persons (adults ages 60 and over) were reported to have experienced some form of abuse or neglect in domestic settings in 1996 (NEAIS, 1996). According to the American Medical Association, thirty-five percent of elder abusers are adult children, and 13 percent are spouses. Elder maltreatment can be intentional or unintentional. Unintentional maltreatment is usually due to caregiver ignorance, inexperience, or inability to provide the necessary care (AMA, 1999). As technology slowly takes on the roles of a caregiver, it must provide more than task-oriented support and address the issues related to the emotion well being of its patients.

Much of the elder generation have lived their childhood and adult life outside of the computer technology sector, and lack a basic understanding of the metaphors used in today's user interfaces. Computer scientists have leveraged anthropomorphism for the development of teaching tools for several decades (Solomon, 1976). In Papert's work with children and the teaching of the Logo programming language[3], a turtle-shaped icon was introduced into the user interface as a means to convey the heading and movement of the "turtle". Papert contends that the children readily projected human characteristics onto the turtle to create an ego-syntonic relationship with it, thus encouraging the Piagetian concept of decentering and eventually bridging the gap between the language of mathematics (used by LOGO) and a means to verbalize it (Rieber, 1994). Although these concepts have traditionally been associated with learning in children, they may also be applicable to "gerogogy" (after Pearson and Wessman[4]). As we will see later, anecdotal evidence suggest that during the learning process, different aspects of a *personality* may be projected onto the technology as a level of abstraction and a means to circumvent the sometimes unnecessary explanations of underlying detail or inexplicable reactions from the technology.

Humans have inherent social needs, regardless of age. The elderly are especially prone to loneliness and depression brought on by Empty Nest Syndrome or neglect, either intentional or not. A means of alleviating the feelings of loneliness is to transfer it to solitude by means of introducing activities or hobbies. As we will explain later in greater detail, companionship through pets has been found to be extremely helpful to elders. The same principles may apply to collectors through the anthropomorphism of things, who will talk to and interact with his/her inanimate objects.

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[1] See http://www.cc.gatech.edu/fce/ahri/ for more information.

™ Independent LifeStyle Assistant (I.L.S.A.) is a registered trademark of Honeywell.

[2] See the National Center for Health Statistics (http://www.cdc.gov/nchs/) for definitions of ADL and IADL.

[3] See http://el.media.mit.edu/logo-foundation/logo/index.html for more details.

[4] Pearson M, Wessman J (1996). Gerogogy (ger-o-go-gee) in patient education. In Home Healthcare Nurse. 1996 Aug; 14(8):631-6.

1.2 Etiquette, Trust, and User Compliance

In a sophisticated automation system such as a smart home, a large number of interactions between the system and the human user fall into the class of ***directives*** (after Searle[5]). In any directive, the speaker is directing the hearer to perform a task, though we realize that the compelling force of that directive may vary (e.g., command vs. request vs. instruction vs. advice vs. observation) and may come from a variety of sources or motivations (e.g., beseeching, coercing, remonstrating, instructing). There is both theoretical and empirical evidence "etiquette" and "politeness" can impact human performance—specifically, trust, regard and decisions to accept directives. The building of trust and its impact on the human's decision to accept or reject advice has many implications that are the same between human-human and human-machine interactions. Parasuraman and Riley (1997) and Lee and See (2003) provide comprehensive reviews of the impact of trust, perceived reliability, etc. on the acceptance or rejection of advice, as well as the development and tuning of trust. When an agent (human or machine) behaves in a manner which is familiar or pleasing to us, we tend to provide it, through simple affective methods, with attention, trust, and a greater probability of following its directives (cf. Norman, 2004). Parasuraman used the Multiple Aptitude Task (MAT) Battery to experiment with human responses to varying levels of the user interface's "politeness" and accuracy (Parasuraman and Miller, 2004). In one test, he found that human subjects believed the "polite" system to be more accurate, even when it was in fact less accurate. This suggests that etiquette variables can have a profound effect on user compliance, and that designers should use a level of etiquette appropriate to the accuracy of the system, especially when dealing with faulty automation.

1.2.1 Framework for Etiquette

A seminal body of work in the sociological and linguistic study of politeness is the cross-cultural studies and resulting model developed by Brown and Levinson (1978; 1987). Brown and Levinson were interested in cataloging and accounting regular deviations, across languages and cultures, from Grice's (1975) *conversational maxims*. Grice had formulated four "rules" or maxims that characterized efficient conversation. These were:

1. *Maxim of Quality*: Speak truthfully and sincerely
2. *Maxim of Quantity*: Be concise; say neither more nor less than required to convey your message
3. *Maxim of Relevance*: Don't introduce topics at random, follow the conversational "flow"
4. *Maxim of Manner*: Be clear in your statements, avoid ambiguity and obfustication.

Brown and Levinson noted that there is at least one way in which people across cultures and languages regularly depart from the efficient conversation characterized by Grice's Maxims. For example, a caregiver may ask of his/her patient, "Please take your medicine." The use of "please" in that sentence is unnecessary for a truthful, relevant or clear expression of the caregiver's wish and it in fact explicitly violates the Maxim of Quantity since it adds verbiage not required to express the caregiver's propositional intent. Over years of cross linguistic and cross cultural studies, Brown and Levinson collected and catalogued a huge database of such violations of efficient conversation. Their explanation for many of these violations is embodied in their model of politeness. The Brown and Levinson model assumes that social actors are motivated by a set of wants including two important social wants based on the concept of face (Goffman, 1967) or, loosely, the "positive social value a person effectively claims for himself" (cf. Cassell and Bickmore, 2002, p. 6). Face can be "saved" or lost, and it can be threatened or conserved in interactions. Virtually all interactions between social agents involve some degree of threat to the participants' face—what Brown and Levinson call Face Threatening Acts (FTAs). This is especially true for directives, since the speaker is both demanding the attention of the hearer by the act of speaking, as well as directing the hearer to perform a task, which threatens the hearer's autonomy. Brown and Levinson claim that the degree of face threat is a function of the social distance between the speaker and the hearer, a relative power that the hearer has over the speaker, and the ranked imposition of the raw act itself.

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[5] Searle, J., (1969). *Speech Acts: An Essay in the Philosophy of Language*. (Cambridge, UK.; Cambridge University Press). See also: Searle, J. (1985). *Expression and Meaning: Studies in the Theory of Speech Acts.* (Cambridge, UK.; Cambridge University Press).

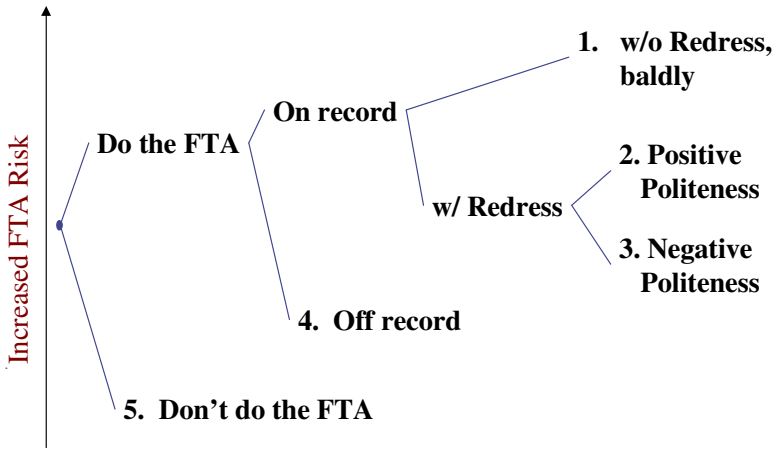

Figure 1. Universal FTA Redress strategies ranked by Brown and Levinson, (1987).

FTAs are potentially disruptive to human-human relationships, and Brown and Levinson offer 5 broad redressive strategies to mitigate the degree of face threat. These are illustrated in Figure 1, and ranked from the most to the least threatening.

The first strategy involves the speaker making the request baldly with no redress. The second strategy, positive politeness, places emphasize on common ground between the speaker and the hearer by invoking in-group identity, by joking and assuming agreement and/or by explicitly offering rewards/promises. The third strategy, negative politeness, strategies focuses on the hearer's negative face needs—independence of action and attention. It minimizes the impact on the hearer by being direct and simple in making the request, offering apologies and deference, minimizing the magnitude of the imposition and/or explicitly incurring a debt. The forth strategy, off record, is the least threatening strategy if the speaker is to conduct the FTA at all. This strategy involves doing the act with a sort of "plausible deniability" by means of innuendo and hints, thus avoiding an overt request or any action from the part of the hearer. The fifth strategy is to avoid the FTA altogether. At some threshold, in some contexts and cultures, it will simply be too threatening for some FTAs to be performed, regardless of the amount of redress offered. Details regarding the strategies used for the prototype system can be found in Miller et al., 2004.

2 The I.L.S.A. System

Haigh et al. (2004) describe the details of the I.L.S.A. system deployment. There are two separate interfaces for the elderly participants and their caregivers. We briefly describe the elder user group and the available interactions with the I.L.S.A. system for this user group below.

2.1 Participant Demographics

The I.L.S.A. system was installed in 11 single occupant homes of elderly participants for a duration of 4 to 6 months. The average age of the participants was 83.42, ranging from 76 - 96. None of the participants had problems associated with dementia, and all were competent in all ADLs. The minimal education level of the group was the completion of high school. As part of the study, each subject was required to identify a family member as a designated caregiver willing to participate in the study.

2.2 Device Suite and User Interaction

2.2.1 Devices

There were slight variations in the set of sensors used in each participant's home due to differences in floor plans and room configurations. The typical sensor suite instrumented a one bedroom apartment, and consisted of one or more passive motion sensors in each zone (living room, dining room, bedroom, kitchen, hallway, and bathroom), a "med caddy" with a contact sensor, and a contact sensor on the entry door. Motion sensors were calibrated to ignore the movement of pets.

2.2.2 User Interface and System Reporting

A Honeywell touch screen WebPAD™ internet appliance was included in each installation for browsing the web-based graphical user interface. Figure 2 shows a screen shot of the ILSA Reminders page. The participant's existing telephone was also used for reporting purposes. The graphic user interface consisted of a set of web pages reporting on the following items:

- Reminders
- Mobility for today and yesterday (amount of motion detected)
- Medication for today and yesterday

Additional controls and information include:

- Controls
  - Changing System Modes (on, off, away)
  - User Configuration and Set Up
- List of Caregivers
- Help

Figure 2 Sample Web Page of User Interface (from Haigh et al., 2004)

The participants were free to review the items above at any time. Automatic reminders and alerts were sent to the participant's home telephone. The messages used in the phone system were a combination of a pre-recorded human voice and computerized voice synthesis (for date, time, and numerical information). Participants interacted with the telephone system using the telephone keypad. Depending on the perceived severity of the message, the I.L.S.A. server may also call the caregiver.

3 Focus Group

There were a number of different approaches used in the analysis of sensor and web usage data, as well as cognitive metrics for the subjects and monthly surveys for both the subjects and their caregivers (see ILSA). Below we discuss topics related to ethopoeia (after Nass and Moon[6]), the social needs of the participants, and how ILSA affected the participant's interaction with their caregivers. The focus group was conducted with a subset of the participants and their designated caregiver.

3.1 Focus Group Questions

A user survey designed to assess the politeness of variations of a medication reminder is described in Miller et al. 2003. Discovering the impact on the emotional states and needs of participants was not an explicit goal of the focus group during the time of the study, thus there were little investigator-initiated questions regarding the personality or politeness of the ILSA system. Nonetheless, the flexible, open format of the focus group allowed the subjects to discuss ILSA's "social" characteristics, and allowed the investigators to respond to this concept, and devise questions as the focus group progressed.

A number of open-ended questions acted as guidelines for the discussion. General topics include the subject's perception of the system's impact on safety, independence, caregiver burden, system accuracy and acceptable financial costs of such a system. Note that the initial phrasing of the focus group questions used gender neutral language when referring to ILSA. However, the pre-recorded human voice on the phone system was female.

In the Section 3.2, we select comments regarding the participant's 'social' interaction with ILSA, and how it affected their relationship with others. As the focus group questions were initially categorized using a different scheme, answers do not fall neatly into the two topics we have identified. Regardless, we present a small subset of the focus group questions in the following subsections.

™ WebPAD is a trademark of Honeywell

[6] Nass, C.L., & Moon, Y.(200). Machines and mindlessness: Social responses to computers. Journal of Social Issue, 56(1), 81-103.

3.1.1 Interaction with System

Sample questions asked in the focus group include:

- Did you feel like you were checked on more frequently than you were without ILSA?
- Will you miss ILSA after it is uninstalled from your home?
- What is your comfort level with current ILSA sensor suite?

3.1.2 Social Interaction with Others

Sample questions include:

- How has ILSA affected your relationship with caregivers/elders?
- Did having ILSA mean that people intruded into your life less or more? Was their checking less intrusive? If so, was this a good or bad thing?
- Did you experience a change in behavior as a result of ILSA?

3.2 Focus Group Answers

Below we present some comments from the focus group, as divided into two general topics, (1) the subject's interaction with the system and (2) the impact of the system on the subject's interaction with his/her friends and caregivers.

3.2.1 Interaction with System

"[I checked the ILSA data daily because] I wanted to make sure she was behaving." – Elder subject

In agreement with results from the analysis of webpage usage, we found that most subjects checked their status almost daily, especially reports regarding medication and mobility.

"I tried to find ways to beat the box." – Elder subject

At least two subjects independently invented methods to prevent the system from generating reminders and alerts.

"… I played solitaire." – Elder subject

At least one subject used the WebPAD for games outside of the ILSA interface. There was a general consensus on the need for more features, such as games and email.

"I would be nice if it said a cheerful Good Morning!" – Elder subject
"I would hang up as soon as I heard ILSA's voice." – Elder subject

There were a number of comments regarding the personality and friendliness of the telephone system. In general, subjects found the tone of the telephone voice to be disagreeable, and desired a richer set of interactions.

"It would be nice to get some re-assurance when I'm not feeling well." – Elder subject

Although ILSA had some user modeling capabilities including medication usage and mobility, it did not model external aspects such as hospitalization or illness, factors that dramatically influence the subject's overall well-being. Nonetheless, participants thought it would be useful for the system to offer some of the emotional support usually provided by human caregivers.

"Anything to keep the mind going would be helpful." - Caregiver

One caregiver suggested that the subject's involvement in the field test was helpful as it was a form of cognitive exercise.

3.2.2 Social Interaction with Others

"My son says I get up a lot at night – [I know] he's looking at it." – Elder subject

Several participants and their caregivers reported using the system as an objective third-party observer and used its reports to discuss issues that the participant would otherwise not disclose to his/her caregiver. For example, during the course of the study, one subject had an abnormal change in mobility, but did not discuss this with his/her caregiver out of fear of 'being a nuisance'. The caregiver initiated a conversation with the subject based on ILSA's 'comments', and later found that the abnormality was due to a new medical problem.

"I wanted to see what [ILSA] was telling [the caregiver]." – Elder subject

Although participants were curious about the information made available to the caregivers, there was a lesser emphasis on privacy concerns than initially anticipated. This may be because there was minimal personal information displayed on the user interface, and the participants did not see any apparent damaging consequences if unauthorized individuals were to see the subject's mobility and medication patterns. However, subjects were still concerned about the information being disclosed, and examined the caregiver web page with the same amount of frequency as the mobility reports to study the type of information made available to their caregivers.

"[ILSA] was something for [the subject] to talk about with her friends." - Caregiver

Comments throughout the focus group session suggested that participants enjoyed discussing the ILSA system with their friends and family members. This may be a product of the novelty of the project, or of the feeling of possessing an elite status due to their involvement in the study.

4 Discussion

The inclusion of social characteristics in healthcare technologies is not new. Cassell and Bickmore have been exploring the concept of creating a *working alliance* between a computer agent and its user through the MIT FitTrack project (Bickmore, 2002). Johnson's work on Carmen's Bright IDEAS (Marsella et al., 2003) uses an avatar to teach problem solving to parents of children with leukemia. Lisetti et al. (2003) has taken a different approach by including the detection of emotional states for user modeling in affective interfaces in telehealth and tele-home health care. There was ample anecdotal evidence that subjects projected a personality onto the ILSA system. This is consistent with Reeves and Nass's findings on the tendency for humans to anthropomorphize computer software (Reeves and Nass, 1996). Subjects assigned characteristics to ILSA and interacted with it with the same level of etiquette they perceived was possessed by ILSA. Subjects also referred to ILSA as 'her' and talked about her and 'her thoughts' with their friends and family members, as opposed to 'the system' and 'its reports'. In fact, in one case, the friend of a participant believed ILSA to be a home care nurse until the friend visited the subject's home and saw the system of sensors and the WebPAD. Below we discuss some of the above comments in greater detail, and draw parallels with existing theories.

4.1 Interaction with System

4.1.1 Politeness and Etiquette

In general, the participants regarded the voice of the telephone system as ILSA, and had the notion that some virtual embodiment of ILSA was examining the same user interface to review the subject's status. An analysis of the sensor data revealed that despite the consensus that ILSA phone reminders and alerts were found to be useful, subjects would usual 'hang up on ILSA', and very rarely heard the message in its entirety. This may be due to the subject's lack of understanding about how to use the system, frustrations with the limited interactions available, inappropriate length of message or the perceived impoliteness of the ILSA telephone system (i.e. 'machine-like' tone of voice, lack of a cheerful greeting, and incapable of turn-taking). Comments from the focus group lead us to

believe the latter to have the most influence on the subjects' acceptance of the voice system. Subjects were especially opposed to voice synthesis, explaining that it sounded 'cold and insincere'. Some suggestions to resolve this problem include the introduction of small talk, such as starting the voice message with a personalized greeting or asking about the subject's day. Research suggests there may be factors beyond tone that affect a hearer's impression of a synthetic voice (Nass and Lee, 2001), but they were not explored in the focus group due to time constraints.

Subjects also commented on the inappropriateness of phone calls for missed medication reminders. We believe there are two reasons for this. Firstly, almost all the subjects had a highly variable day-to-day schedule, and were often outside the home, thus reminders would be received by answering machines or remained unanswered until the system timed out. However, we believe the same complaint would exist even if the phone reminders were routed to mobile phones due to a second, perhaps more important reason. Although medication compliance was viewed as important, subjects did not view it as possessing enough urgency to warrant a phone call. Subjects in the field test were highly independent elders who relied on their own makeshift systems for medication reminders, such as placing medication in a high traffic area, using pill boxes etcetera. The introduction of a phone reminder may have been viewed as intrusive to their existing lifestyles and threatened their sense of independence. Subjects expressed appreciation for medication reminders when medication was forgotten, but suggested more subtle mechanisms for reminders, such as a light on the top of the med caddy.

Several subjects exhibited behaviors that can be conceived as a byproduct of mistrust. This may be related to the perceived impoliteness of the ILSA telephone system and may support the concepts of trust and etiquette (Parasuraman & Miller, 2004). Without requests from the investigators, most subjects regularly reviewed the reports regarding medication and mobility. Some subjects were vigilant with noting when the said reports were inconsistent with their own activity logs or when the reports were incorrect. Subjects also appeared to take satisfaction in identifying incidents when ILSA 'made a mistake'.

Due to the general dislike of ILSA phone calls, multiple subjects invented ways to prevent the system from generating phone messages. For example, one subject would open and close the med caddy without taking her medication, and then remember on her own to take the medication later. Ironically, the desire to 'beat the box' may have provided the cognitive activities the same subject was seeking when she searched the WebPAD for games.

4.1.2 Increase User-System Interaction Functions and Entertainment Value

While current technology does not allow users to have free form conversations with the system, there was an overwhelming desire for mechanisms with which subjects can provide feedback and personal status. Subjects wanted the capability to verbalize answers to the phone system, but also wanted to provide feedback in other forms. As a simple example, participants suggested the use of physical buttons by the door to indicate when they were leaving the home.

Subjects also reported that the capability for ILSA to provide reassurance would be a valuable function. Subjects did not provide suggestions on specific methods for providing reassurance, nor when it should be provided, but this is an interesting idea that can provide significant value to elders with minimal emotional support from human caregivers.

Most subjects appeared to spend a great deal of time and energy trying to understand the underlying mechanisms of the system, and would sometimes vary their routines to see how ILSA reacted. However, it is conceivable that the process of recruiting subjects for this study favored those who are curious by nature, and that the general public would not react to the system in this way. Subjects found it rewarding when they discovered some of the basic logic in the system's algorithms. Their reactions and comments led us to believe that they enjoyed the mental challenge. This is further supported by the fact that at least one subject used the web pad for its built-in games, and others iterated the desire for card or word games as part of the system.

4.1.3 Interaction with Human Caregivers and Peers

Although the field test was relatively short (4 to 6 months), we believe the subjects' involvement with the study may have increased their social interaction with their human caregivers and peers. Barker (1999) reviews research efforts that have found similar findings in the field of animal therapy research, where a pet can promote the social interaction of the owner with other humans. Further work is needed to investigate whether increased positive socialization will be sustained even after the novelty of the system subsides.

A surprising use of ILSA was as a third party observer who provided 'objective' reports on the subject's actions and status. The caregivers used ILSA's measures as a tool to initiate conversations regarding changes in a subject's level of mobility or number of system reminders generated that may be signs of or may lead to potential problems. This usage model may also be of considerable value to formal caregivers, as the accuracy and amount of information from office visit conversations often rely heavily on the patient's memory, and there lacks automated metrics for comparing a patient's general well being over time.

5 Future Work: Bridging the Gap between Smart Home Capabilities and Social Needs

Elders have difficulties using the typical interaction devices employed in smart home designs (i.e. touch screens, computer interfaces, telephone interfaces, and even panic buttons) because of both physical and psychological barriers. Perhaps more importantly, current smart home systems do not provide the emotional support needed by independent elders. The study revealed that elders would appreciate greater interactivity with a smart home system, especially in entertainment and social aspects, but industry has thus far taken an approach similar to the traditional medical profession – where the patient is observed rather than acts as an active participant in the selection of treatments. Communicating directly with the elder may be the best method to gather information about his/her well being, but voice recognition capabilities and the ability to extract computer-usable information from casual conversations are not readily available.

Within the field of animal-assisted therapy, hundreds of clinical reports show that when animals enter the lives of aged patients with chronic brain syndrome (which follows from either Alzheimer's disease or arteriosclerosis) that the patients smile and laugh more, become less hostile to their caretakers and become more socially communicative. Other studies have shown that in a nursing home or residential care centre, a pet can serve as a catalyst for communication among residents who are withdrawn, and provide opportunities (petting, talking, and walking) for physical and occupational rehabilitation and recreational therapy. More generally, the research literature has established that the physiological health and emotional well-being of the elderly are enhanced by contact with animals (Beck & Katcher, 1996; Center for the Human-Animal Bond). However, many elders live in places that either prohibit pets or are not conducive to animals due to the physical layout of their buildings. In addition, some physiological conditions, such as Alzheimer's disease, may make animal ownership difficult for the individual and unsafe for the animal.

The use of a robotic pet as an addition or alternative to traditional graphical user interfaces may provide the desired increase in emotional support, as well as the means for an elder to communicate with the system. Several projects are underway to develop a robotic pet that can both monitor an elderly user and act as a companion (Center for the Human-Animal Bond; Lavery, 2000; Necoro). A user's communication model with a robotic pet is very similar to that of real pets—and is therefore familiar, effective and comfortable for elders. The challenge to designers will be to create a set of robotic behaviors that can parallel human-pet interactions in the real world while also providing an aid that an elder needs in order to remain independent.

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References

AMA (American Medical Association), Elder Maltreatment and Neglect: 1999, http://www.medem.com/MedLB/article_detaillb.cfm?article_ID=ZZZE61CTWAC&sub_cat=357.

Barker, Sandra B. (1999). Therapeutic Aspects of the Human-Companion Animal Interaction. Psychiatric Times, Feb 1999 Vol. XVI Issue 2.

Beck, Alan and Katcher, Aaron. (1996). Between Pets and People: The Importance of Animal Companionship (Revised Edition). West Lafayette, IN: Purdue University Press.

Bickmore, T. (2002). "When Etiquette Really Matters: Relational Agents and Behavior Change." Proceedings of the AAAI Fall Symposium on Etiquette for Human-Computer Work, November 15-17, Falmouth, MA.

Bickmore, T., Gruber, A., and Picard, R. (to appear) "Establishing the Computer-Patient Working Alliance in Automated Health Behavior Change Interventions" Patient Education and Counseling.

Breazeal, C. (2000), "Sociable Machines: Expressive Social Exchange Between Humans and Robots". Sc.D. dissertation, Department of Electrical Engineering and Computer Science, MIT.

Brown, P. & Levinson, S. Politeness: Some Universals in Language Usage. Cambridge Univ. Press, UK. 1987.

Center for the Human-Animal Bond, http://www.vet.purdue.edu/chab/. Accessed March, 2005.

Goffman, E. Interaction Ritual: Essays on Face to Face Behavior. Garden City; New York. 1967.

Grice, H.P., Logic and Conversation, In P. Cole and J. Morgan (Eds.), Syntax and Semantics, vol. 3., Speech Acts, Academic Press; New York, 1975, pp. 41-58.

Haigh, Karen Zita, Kiff, Liana M., Myers, Jane, and Krichbaum, Kathleen (2004). "The Independent LifeStyle Assistant™ (I.L.S.A.): Deployment Lessons Learned. In The AAAI 2004 Workshop on Fielding Applications of AI, July 25, 2004, San Jose, CA. Pages 11-16.

ILSA (Independent LifeStyle Assistant), http://www.htc.honeywell.com/projects/ilsa/about_introduction.html.

Lavery, Anne (2000). Robo-cat makes purrfect companion. http://news.bbc.co.uk/1/hi/sci/tech/652293.stm. Accessed March 2005.

Lisetti, C.L., Nasoz, F., Lerouge, C., Ozyer, O., and Alvarez, K. (2003). Developing Multimodal Intelligent Affective Interfaces for Tele-Home Health Care. International Journal of Human-Computer Studies Special Issue on Applications of Affective Computing in Human-Computer Interaction, Vol. 59 (1-2):245-255.

Marsella, S., Johnson, W. L., and LaBore, Catherine M. (2003). Interactive Pedagogical Drama for Health Interventions. In *11th International Conference on Artificial Intelligence in Education*, Australia, 2003

Miller, Baila & McFall, Stephanie. Caregiver Burden and Institutionalization, Hospital Use, and Stability of Care. US Department of Health and Human Services. Report, prepared by University of Illinois.

Miller, C., Wu, P., Krichbaum, K., Kiff, L. (2004). "Automated Elder Home Care:Long Term Adaptive Aiding and Support We Can Live With", in proceedings of the AAAI Spring Symposium on Interaction between Humans and Autonomous Systems over Extended Operation, 22-24 March 2004. Stanford, Palo Alto, CA., U.S.A.

Miller, C., Wu, P., Krichbaum, K., Kiff, L. (2003). Etiquette and Effectiveness: How Should a Smart Home Interact? In *Proceedings of the International Conference on Aging, Disability and Independence*, December 4-6; Washington, DC.

Nass C. & Lee, K. M.(2001). Does computer synthesized speech manifest personality? Experimental tests of recognition, similarity-attraction, and consistency attraction. Journal of Experimental Psychology: Applied, vol. 3, pp. 171-181, 2001.

NEAIS (The National Elder Abuse Incidence Study), conducted by the National Center on Elder Abuse at the American Public Human Services Association (formally known as the American Public Welfare Association) and the Maryland-based social science and survey research firm, Westat, 1996.

Necoro, http://www.necoro.com/ Accessed March 2005.

Parasuraman, R. & Miller, C. (2004). "Trust and Etiquette in High-Criticality Automated Systems". In C. Miller (Guest Ed.), special section on "Human-Computer Etiquette". Communications of the ACM. 47(4), Apr. 2004.

Picard, R. W. (2001). "Affective Medicine: Technology with Emotional Intelligence". Chapter in "Future of Health Technology," IOS Press.

Reeves, B. & Nass, C. (1996). The media equation: how people treat computers, television, and the new media like real people and places. Cambridge University Press, Stanford, CA.

Rieber, L.P. (1994). Computers, graphics, and learning. Madison, Wisconsin: Brown & Benchmark.

Solomon, C. J. (1976). Teaching the Computer to Add: An Example of Problem-Solving in an Anthropomorphic Computer Culture, MIT Artificial Intelligence Lab.