Automated Elder Home Care:
Long Term Adaptive Aiding and Support We Can Live With

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Abstract

We have been working on home automation to support eldercare. This is an instance of long term human-automation interaction in very intimate and personal settings with a potentially difficult user population. We report our design philosophy and some of the lessons learned relative to that philosophy from a six month field test with representatives of this user community. As a separate research thread, we report on the importance of "etiquette" in human-automation interactions in this domain, along with some initial models and findings about how to configure human-automation reminder interactions to support long-term "livability".

Introduction

The Independent LifeStyle Assistant ™ (I.L.S.A.) is a Honeywell Laboratories program to develop innovative, high-potential technology for elder homecare applications that will be integrated, context-aware, adaptive and serve in either an autonomous role, or as an autonomous intermediary between the elder and his or her caregivers. Elder home care is, in some ways, a unique and challenging problem for an automated support system since elder activities are extremely varied and unscripted, the user population itself is highly diverse in its skills, capabilities, and in its knowledge and tolerance of technology. Finally, we were seeking a technology that elders could live with "full time" in their home and leisure environments. This abstract discusses design philosophies for I.L.S.A, how they guided the implementation of an initial feature set, and the results from a six month field test in clients' homes and apartments that provided feedback on our design and implementation. We also present a second, more detailed study of the "etiquette" which such a system should exhibit in interaction with human operators and a theory of politeness that may be used to inform such interactions.

ILSA Design Philosophies

Aims and objectives

A list of key impedances to independent living was identified through home-care analysis, interviews with geriatric experts, discussions with adult children caregivers, and literature reviews. Chief among these were safety monitoring, "panic button" alerts to caregivers and medication monitoring and reminding. We also used data and impressions collected from this process to produce a set of high-level design "philosophies" to guide I.L.S.A. implementation. These philosophies were, in essence, our hypotheses about what would constitute a good, useful, livable automated aid. A set of initial I.L.S.A. features intended to address the major functions described above was determined using a combination of engineering feasibility and rated user needs and desires. Implementation plans consistent with these philosophies were then created for the feature set. Our design philosophies include the following:

A. Wherever possible, the physical appearance and components used by the I.L.S.A. system should not be intrusive to the client.
B. Direct communication between the client and the system should be limited to the telephone and web pad. I.L.S.A. should also minimize it's communication of system and client status such that the interference on the client's lifestyle can be lessened.
C. The client should not be required to directly provide data about his/her own status. I.L.S.A. should make use of available data from the client's interaction with the system to determine the client's status.
D. I.L.S.A. should avoid demanding excessive effort (especially cognitive effort) from the client (e.g., for system setup).

These philosophies led us to the following implemented design decisions:

A. The LED indicators of motion sensors were disabled so that I.L.S.A. feedback outside of the

web and phone interfaces was minimized. Interactive devices such as switches were avoided for the same reason.

B. I.L.S.A.'s status is not reported to the client, although the client may initiate an inquiry through the web pad. By default, only telephone reminders for medication are sent to clients if missed medications were not detected. Functional modes were introduced to allow for the suppression of I.L.S.A. communications.
C. ILSA deduced client status entirely from passive interactions, with the exception of indicating home/away status, and acknowledging telephone reminders.
D. Clients are not required to train I.L.S.A. Clients need to contact caregivers to change initial settings such as sleep time and medication times.

Method

A prototype I.L.S.A. system which adhered to the above design philosophies was implemented, tested for reliability, and then implemented in the homes of volunteer elders. The field test included subjects living at home and at an independent care facility. Age and computer literacy varied widely across the population. We installed sensors in each subject's home, equipped each with a web pad, and provided one to three hours of training and orientation. Clients and their caregivers were requested to submit monthly and weekly surveys to report any anomalies and changes in attitude towards I.L.S.A. Participants were invited to attend two Focus Group sessions, and had access to technical support during normal business hours. SF-36 and Mini-Mental cognitive evaluations were administered to the clients regularly to monitor their health and cognitive levels, respectively. In addition to data collected from these activities, software components recorded the client's physical activity within his/her home, as well as web activity through the I.L.S.A. web server, and phone interaction activity.

Results

Web interactions with the client provided interesting insight into their interest and understanding of the interface and the data presented. They were more comfortable with the interface than with the tablet-style device used for presentation. Some cognitive scores improved during the test period.

Many of our design philosophies and implementations were validated through this limited evaluation, but some have been challenged in interesting ways. For example, Focus Group comments suggest that many elders would like some greater degree of "intrusiveness" from I.L.S.A.—at least to the degree of understanding when and how it is working. Similarly, most elders were unaware of setup features that they did have access to and expressed a desire for more of them—implying that we may have been overly cautious in our implementation of Design Philosophy D above.

Conclusion

- Automated telephone systems are disturbing to lifestyle and cognitively overwhelming, violating both the intrusiveness and cognition design precepts.
- Clients want more interaction with the system on their terms, but this feature needs to be adjustable to client capability and desire.
- Passive operation is required, even for healthier and more cognitively able clients because of aversion to change, but this should be matched by the opportunity to inspect, understand and modify system behaviors.
- Clients want to contest the conclusions presented by the automation and provide direct feedback.

Etiquette for I.L.S.A. Interactions

In more detailed work related to the I.L.S.A. project described above, we explored whether a model of politeness in human-human interactions can be used to develop medication reminders for an automated system to deliver. Both the effectiveness and the politeness of various reminders are examined. Our data examine whether perceptions of politeness differ between elders and baseline populations, and between human-human and human-machine interactions for this application.

Introduction

There is increasing evidence that even moderately complex automation evokes "social" responses from humans who use it (Reeves and Nass, 1996). It is, therefore, not hard to believe that these social responses can either enhance or inhibit not just the human experience of interacting with a machine system, but also the overall effectiveness of the human + machine system (e.g., Miller, 2002; Norman, 2002; Parasuraman and Miller, forthcoming). What is largely missing is data about how to design human-machine interaction "etiquette" so that it evokes appropriate, accurate and effective behaviors, actions and intuitions in human users. In this study, we report the results of an attempt to use a model of human-human politeness to guide the design of spoken and textual reminders provided to elderly clients by a medication reminder system.

Method

Extensive cross cultural sociolinguistic work has been used by Brown and Levinson (1987) to produce both a theory of the role of politeness in human-human interactions, and a specific model of how to construct utterances that will be regarded as more or less polite in context. Brown and Levinson characterize several alternate utterance strategies as being increasingly impolite (see Figure 1). We have

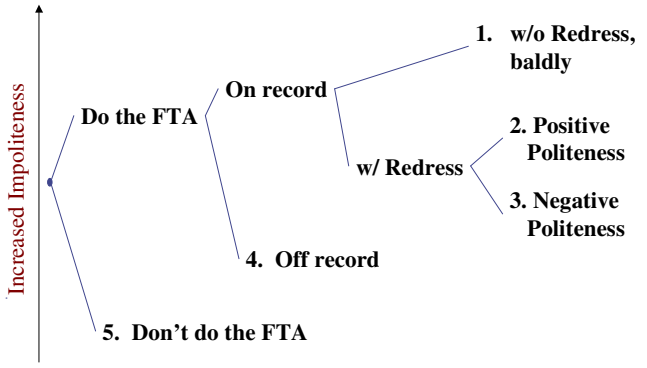

Figure 1. Brown and Levinson's (1987) model of speech act strategies and their perceived politeness.

used this model to construct several alternate utterances (with associated predictions for their perceived politeness) for an automated medication reminding system to issue when it detects (perhaps erroneously) that its human "client" has missed a dose of medication. A series of simple questionnaires will pose these alternatives to a variety of audiences in a variety of contexts including: elders familiar with a specific medication reminding system, elders not familiar with automated medication reminding systems, a baseline population of individuals ranging from 20-50 years of age with no specific familiarity with the system, and the system's engineers themselves. For the most part, we will examine responses to these utterances as coming from a machine reminding system, but at least one alternative presentation will check our use of Brown and Levinson's model by posing the alternative reminders as coming from one human to another. Finally, data was gathered by questionnaire, focus group and in-home sensing devices from a small group of elders who used one such medication reminder system (the Honeywell I.L.S.A. system) for a period of up to 6 months and will be used to compare to the questionnaire data from the other groups.

Results

Initial results, primarily from program engineers (see Figure 2), indicate that Brown and Levinson's model provides an accurate indication of perceived politeness for

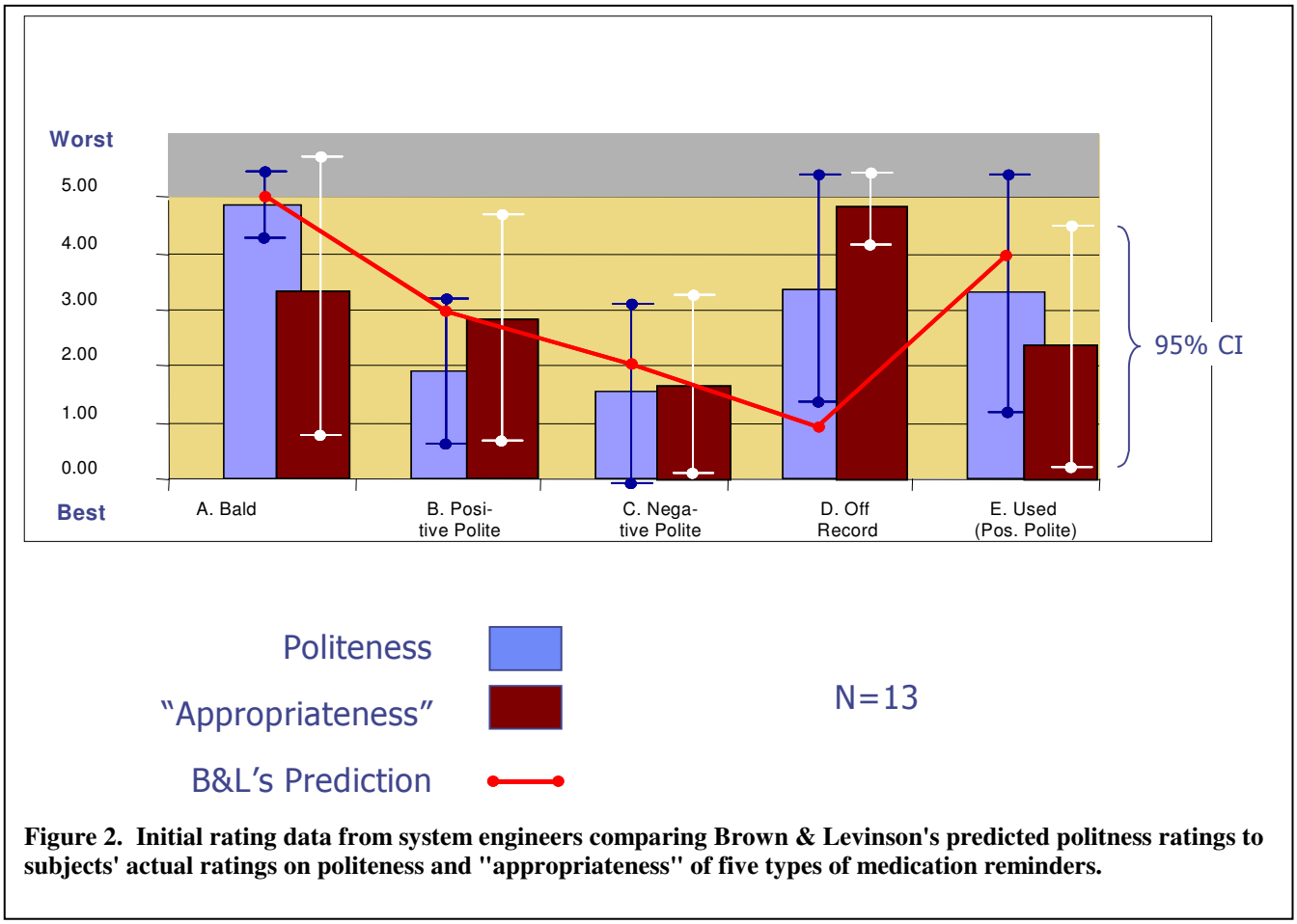

Figure 2. Initial rating data from system engineers comparing Brown & Levinson's predicted politness ratings to subjects' actual ratings on politeness and "appropriateness" of five types of medication reminders.

all but one class of utterances which Brown and Levinson label "off record" utterances. In human-human conversation, these are intended to be highly indirect (or oblique) and context dependent, providing the speaker with plausible deniability for having made a request at all. We hypothesize, therefore, that it may therefore be difficult or impossible for a machine to accurately produce, or for a human to recognize them when coming from a machine. Future data will be analyzed to support comparisons between the different subject populations. Data on medication compliance and its change during the use of our reminder system will provide some evidence on the effectiveness of one type of reminder utterance.

Conclusion

Our anecdotal and focus group data imply that at least some elders are very likely to personify home automation and reminding systems of this sort. Elders are also sometimes less comfortable with advanced technological systems. A polite system may therefore enhance and elder's interaction experience. On the other hand, compliance with reminders might or might not be enhanced more by an impolite (or at least more commanding) one. At any rate, we suspect that the perceived etiquette of the reminding system will be an important variable in its successful design. Nevertheless, we find this to be an extremely understudied topic, especially with regards to elder interaction with technology. The results of this study should be a first step in addressing that deficiency. We will conclude with recommendations for designing and incorporating appropriate etiquette into reminder systems for the elderly.

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Related publications and associated research links may be found at the following URL. http://www.htc.honeywell.com\projects\ilsa

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