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Progress Report Summary – Georgia Tech Research

a. Specific Aims

The specific aims of the proposed research are to: Identify and evaluate needs and barriers to meeting the needs for technologies that can promote health, independence, and active engagement of older persons; Specify the variables that facilitate or inhibit the symbiotic relationship that must exist for smart technology to be effective; Determine critical factors that define the construct of privacy; Understand variables that independently and interactively influence trust in collaborative human-machine systems; Determine the characteristics of display design for support of task actions and interpretative judgments; Develop design standards for collaborative systems designed for older adults.

b. Studies and Results

There are four major projects and we will describe our current and planned research activities for each project:

1. Taxonomy of In-Home Support Needs and Perceived Benefits

Technology focus group. The goal of this study is to gain an understanding of the adoption and the use of new technology by older adults. Last year we conducted focus groups with 52 older adults and collected information via questionnaires to explore older adults' technology and computer experience. There was a wealth of data and we have spent this year developing different qualitative coding schemes to best represent the findings. We focused on technology use in different types of activities: communication, work, healthcare, learning, home, transportation, shopping, financial management, and leisure & entertainment. We have quantified the likes and dislikes of older adults, training preferences, and general attitudes towards technology. Portions of this research were presented at APA last year and will be presented at APA and GSA this year. These data provide valuable insights into understanding of technologies older adults use, how they are first introduced to them, what their positive and negative features are, what types of problems are typically encountered with them, and whether additional training with technology items is needed.

Medication adherence. Last year we surveyed 422 adults over age 60 to examine the strategies they use to remember to take their medications (or medical products), and the perceived effectiveness of these strategies. Location, visibility, pill caddy, and association strategies were the strategies most frequently endorsed by the respondents. Furthermore, over 65% of the sample reported using more than one strategy to remember to take medications. We are in the process of writing a journal article on these findings. In addition, we are using these data to develop a medication complexity index. We are developing a method to quantify the type, amount, and regimen complexity of the medications that older adults must remember to take on a daily or weekly basis. This index will be very valuable for understanding medication regimens, predicting which older adults will need assistance with this activity of daily living, and guiding the development of memory augmentation systems. We will present this at the Cognitive Aging Conference.

Planning and prospective memory. One aspect of everyday memory that has received minimal study is the planning component of prospective memory. We completed two studies to understand the role of planning in the performance of prospective memory tasks. More specifically, we were interested in whether planning differs as a function of the age of the participant or the type of task. We are in the process of writing journal papers to report the findings of these studies. In short, older adults report using planning strategies more often than younger adults particularly for the domains of work/volunteering, health, and finances. Moreover, in a simulated situation where they could use their experience and usual methods of planning, age-related differences in performance were minimized.

Homes maintenance and services. We are in the development phase of designing a focus group study to understand older adults' home maintenance problems and concerns. One of the primary conditions for aging-in-place is ensuring that one's home can accommodate one's changing needs. We will interview older adults about their recognition of the need to modify their homes, the availability of technologies and services to support such modifications, and their concerns about their ability to age in place.

2. Understanding Privacy Concerns

Privacy interview study. The purpose of this study was to explore the privacy concerns that older adults had about a home equipped with visual sensing devices. Using a scenario-based structured interview approach we investigated how the type of images the home captures as well as the physical and mental health of the residents affected privacy concerns as well as perceived benefits. Results suggest that although most older adults expressed concerns about using a visual sensing device in their home, the potential benefits of having such a device in specific circumstances outweighed their concerns. We are currently writing this paper.

Defining Privacy. We are currently developing a focus group study to understand folk beliefs about privacy. The construct of privacy is conceptually underdeveloped and the goal of this study is to understand the "typical" concerns people have about privacy across contexts. We will provide separate focus groups of older and younger adults with scenarios about potentially intrusive events (e.g., a camera in an intersection, a public portal for storing photographs) and record the group discussions. This topic is particularly appropriate for a focus group format because we want to generate as much discussion as possible.

3. Acceptance in Collaborative Systems

Costs of reliance. Automation is quickly entering into new environments, many of which involve high-risk decision making. We must understand in what situations people will or will not rely on the recommendations of automated decision aids to inform design of these aids to minimize accidents and errors and in turn maximize performance. Last year we investigated the effects of age and costs in a human-automation collaborative system on automation reliance to see if individuals can behave optimally with an automated decision aid. Older and younger adults did not show significant differences in reliance behavior but seemed to be influenced by costs differently from each other, with younger adults more likely to change their reliance based on these costs. We are currently writing this paper.

Expectation effects. This study is designed to investigate how user expectations of automation performance influence reliance and how expectations interact with types of automation failures. We conducted an initial calibration study with 54 younger adults wherein participants were assigned to a low or high expectation group. The high expectation group expected the system to perform higher than the low expectation group. Based on these findings we have developed a study to test the role of expectations in the context of a human-automation collaborative system. Participant expectations will be manipulated before they interact with an automated system. We have developed a program wherein participants are managing a warehouse with the support of a decision aid system. Our hypothesis is that expectations will translate into reliance differences between the low and high expectation groups. Data collection is currently underway.

The role of experience. A human-automation collaboration can be viewed as a social team. One critical variable that affects team performance is a shared mental model whereby both the human and the automation represent the context in the same way. Presumably once individuals have experience with a system they will be better able to identify when automation recommendations are reliable (or not). We are developing a study to examine the relationship between mental model quality and collaborative system performance. We have designed a map reading task and are currently pilot-testing the research protocol. The research questions are as follows. Does the quality of a user mental model affect performance with an automated system? Do user mental models affect reliance and compliance? Does a vague mental model degrade performance more than having no experience at all (i.e., no mental model)?

4. Technology Support for Task Actions and Interpretive Judgments

Virtual keyboard design. We have conducted four studies to examine the affordances of a virtual keyboard shape and layout as they affect text entry using a rotary controller. One general finding is that for adults of all ages, an alphabetic layout is superior to a "qwerty" layout. With respect to keyboard shape, older adults appear to benefit from the visual anchoring cues provided by a plus shape (compared to an oval or rectangular shape). We have submitted one paper to Ergonomics in Design and are currently preparing another paper from this research.

Attentional demands of graphical displays. Graphs are a prevalent form of data communication, and line graphs are a useful tool in conveying changes in data over time. While there are many proposed theories of graph comprehension, none directly address the role of readers' limited attention resources in graph comprehension. We have designed a dual-task paradigm to explore the degree to which graph processing demands verbal and/or spatial resources in general and specifically for trend comparison and point estimation tasks. We are currently collecting data for this study

The role of feedback. Systems may collect almost unlimited amounts of data on performance during learning. However, we need to provide the data that most promote learning; too much or the wrong type of feedback can hinder learning. We have conducted a series of studies to identify feedback principles based on an understanding of the cognitive needs and limits of the learner. We have tested 90 participants across four studies and are currently analyzing the data. The key finding is that the most beneficial feedback seems to depend on the characteristics of the task in conjunction with the characteristics of the learner.

Pictorial displays. One component of providing technology support is the methods used to convey information. This study is designed to understand the characteristics of pictures that can be used to convey warning information to younger and older adults with varying levels of product experience. We are currently in the development phase of this project.

CREATE Battery

This year 175 participants have completed the entire CREATE battery. We plan to test 85 this summer.

Pilot Grant

The Georgia Tech pilot grant was awarded to Olivier Blanson Henkemans from Delft University and TNO. Oliver spent August-December 2006 in our lab conducting a study as part of his dissertation research. We designed an adaptive computer assistant for the personalized supervision of diabetes patients' self-care. The computer assistant monitors the patient's electronic diary, electronic patient record, as well as the environment. Accordingly, it provides context aware feedback on the self-care activities. Twenty older adults evaluated the usability of the adaptive computer assistant in comparison with a fixed one. The adaptive computer assistant was more effective in dealing with normal and health critical situations, and, generally, it led to more time efficiency. Use of an adaptive computer assistant facilitated diabetes patients' ability to integrate self-care activities in their daily life, thus maintaining quality of life, enhancing health literacy, and positively contributing to medical adherence. We have submitted a paper for publication.

c. Significance

The results of the research conducted in the four different projects will converge to provide guidance for the development of technology to support the functional independence of older adults. Moreover, this research will contribute to the development of frameworks to describe constructs such as privacy and trust in technology. The house is not just a physical structure; it is a living, changing, dynamic entity and living at home consists of engaging in collaborative systems. In this research we assess both the human characteristics as well as the machine characteristics that influence the symbiosis between humans, namely older adults, and machines. In sum, this research is critical to determine what technology should do – not what it can do. This information is critical and it relates to the other components of CREATE II because collaborative systems will be part of telework and telemedicine. Humans and machines must work together in a collaborative system to solve the problems surrounding the maintenance of functional independence of older adults. We need to understand the support needs for health maintenance, as well as general home and work activities.

d. Plans

The plans for the upcoming year are described above in the context of each project.

e. Publications for 2006-present

Bisantz, A., Kirlik, A., Gay, P., Walker, N., and Fisk, A. D. (2006). Knowledge versus execution in dynamic judgment tasks. In A. Kirlik (ed.), *Adaptive Perspectives on Human-Technology Interaction.* NY: Oxford University Press.

Blanson Henkemans, O. A., Caine, K. E., Rogers, W. A., Fisk, A. D., Neerincx, M. A., de Ruyter, B. (in press). Medical monitoring for independent living: User-centered design of smart home technologies for older adults. *Med-E-Tel: The International Educational and Networking Forum for eHealth, Telemedicine and Health ICT* (pp.). .

Boron, J. B., Rogers, W. A., & Fisk, A. D. (2006). Medication adherence strategies in older adults. *Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting*. Santa Monica, CA: Human Factors and Ergonomics Society.

Caine, K. E., Fisk, A. D., & Rogers, W. A. (2006). Benefits and privacy concerns of a home equipped with a visual sensing system: A perspective from older adults . *Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting*. Santa Monica, CA: Human Factors and Ergonomics Society.

Caine, K. E., O'Brien, M. A., Park, S., Rogers, W. A., Fisk, A. D., Van Ittersum, K., Capar, M., Parsons, L. J. (2006). Understanding acceptance of high technology products: 50 years of research. *Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting*. Santa Monica, CA: Human Factors and Ergonomics Society.

Czaja, S. J., Charness, N., Fisk, A. D., Hertzog, C., Nair, S. N., Rogers, W. A., & Sharit, J. (2006). Factors predicting the use of technology: Findings from the Center for Research and Education on Aging and Technology Enhancement (CREATE). *Psychology and Aging, 21*, 333-352.

Ezer, N. Bowles, C. T., Fisk, A. D., & Rogers, W. A. (2006). The use of similes to enhance inferencing and memory of unfamiliar product hazards. *Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting*. Santa Monica, CA: Human Factors and Ergonomics Society.

Fisk, A. D., & Rogers, W. A. (in press). Attention goes home: Support for aging adults. In A. Kirlik & A. Kramer (Eds.), *Festschrift for Chris Wickens*. Champaign, IL: Beckman Institute.

Hancock, H. E., Bowles, C. T., Rogers, W. A., & Fisk, A. D. (2006). Comprehension and retention of warning information. In M. S. Wogalter (Ed.), *Handbook of warnings* (pp. 267-277). Mahwah, NJ: Erlbaum.

Hickman, J. M., Caine, K. E., Stronge, A. J., Pak. R., Rogers, W. A., & Fisk, A. D. (2006). Doctor-patient communication: Guidelines for improvements. *Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting*. Santa Monica, CA: Human Factors and Ergonomics Society.

Hickman, J. M., Rogers, W. A., & Fisk, A. D. (in press). Training older adults to use new technology. *Journal of Gerontology: Psychological Sciences.*

Mayer, A. K., Sanchez, J., Fisk, A. D., & Rogers, W. A. (2006). Don't let me down: The role of operator expectations in human-automation interaction. *Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting*. Santa Monica, CA: Human Factors and Ergonomics Society.

McLaughlin, A. C., Rogers, W. A., & Fisk, A. D. (2006). How effective feedback for training depends on controlled learner resources and task demands. *Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting*. Santa Monica, CA: Human Factors and Ergonomics Society.

McLaughlin, A. C., Rogers, W. A., & Fisk, A. D. (2007). Helping patients follow their doctor's instructions: Matching instructional media to task demands. In D. C. Park & L. L. Liu (Eds.), *Social and cognitive perspectives on medical adherence* (pp. 251-267). Washington, DC: American Psychological Association.

Melenhorst, A. S., Rogers, W. A., & Bouwhuis, D. G. (2006). Older adults' motivated choice for technological innovation: Evidence for benefit-driven selectivity. *Psychology and Aging, 21*, 190-195.

Melenhorst, A. S., Rogers, W. A., & Fisk, A. D. (2007). When will technology in the home improve the quality of life for older adults? In H. W. Wahl, C. Tesch-Römer, & A. Hoff (Eds.), *New dynamics in old age: Individual, environmental, and societal perspectives* (pp. 253-269). Amityville, NY: Baywood.

Mitzner, T. L., & Rogers, W. A. (2006). Reading in the dark: Effects of age and contrast on reading speed and

comprehension. *Human Factors, 48*, 229-240.
Mitzner, T. L., Mayhorn, C. B., Fisk, A. D., & Rogers, W. A. (2006). Ergonomics and aging. In W. S. Marras & W. Karwowski (Eds.), *Fundamentals and assessment tools for occupational ergonomics* (pp. 17-1 – 17-22). Boca Raton, FL: CRC Press.
Nichols, T. A., Rogers, W. A., & Fisk, A. D. (2006). Design for aging. In G. Salvendy (Ed.), *Handbook of human factors and ergonomics (3rd ed.*, pp. 1418-1445*).*
O'Brien, M. A., Rogers, W. A., & Fisk, A. D. (2006). Text entry on a virtual keyboard: Evaluating shape and practice effects. *Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting.* Santa Monica, CA: Human Factors and Ergonomics Society.
O'Brien, M. A., Rogers, W. A., & Fisk, A. D. (in press). Evaluating design features that affect older adults' performance on common computer tasks. *2nd International Conference on Technology and Aging* (pp.).
Pak, R., Rogers, W. A., & Fisk, A. D. (2006). Aging and visual attention: The effect of perceptual load on dual-task performance. *Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting*. Santa Monica, CA: Human Factors and Ergonomics Society. ****Winner of the HFES Aging Technical Group Arnold Small Best Student Paper Award***.
Pak, R., Rogers, W. A., & Fisk, A. D. (2006). Spatial ability sub-factors and their influences on a computer-based information search task. *Human Factors, 48*, 154-165.
Rogers, W. A., & Fisk, A. D. (2006). Cognitive support for elders through technology. *Generations: Journal of the American Society on Aging, 30(2)*, 38-43.
Rogers, W. A., & Spieler, D. H. (in press). Attention and aging. In D. C. Park & N. Schwarz (Eds.), *Cognitive aging: A primer* (2nd ed.). Philadelphia: Psychology Press.
Rogers, W. A., Essa, I., & Fisk, A. D. (in press). Designing a technology coach. *Ergonomics in Design.*
Rogers, W. A., Mayer, A. K., & Bailey, C. L. (in press). Understanding the relevance of human factors/ergonomics to neuropsychology practice and the assessment of everyday functioning. In T. Marcotte, & . Grant (Eds.), *Neuropsychology of everyday functioning* (pp. -*)*. NY: Guilford Publications.
Rogers, W. A., McLaughlin, A. C., & O'Brien, M. A. (2006). Selection and design of input devices for assistive technologies. *Proceedings of the 9th International Conference on Control, Automation, Robotics, and Vision* (pp. 92-97). New York, NY: IEEE.
Rogers, W. A., Pak, R., & Fisk, A. D. (2007). Applied cognitive psychology in the context of everyday living. In F. T. Durso, R. S. Nickerson, S. T. Dumais, S. Lewandowsky, & T. Perfect (Eds.), *Handbook of applied cognition (*2nd ed., pp. 3-27*)*. Chichester: Wiley.
Rogers, W. A., Stronge, A. J., & Fisk, A. D. (2006). Technology and aging. In R. Nickerson (Ed.), *Reviews of human factors and ergonomics* (Vol. 1, pp. 130-171). Santa Monica: HFES.
Sanchez, J., Bowles, C. T., Rogers, W. A., & Fisk, A. D. (2006). Human factors goes to the golf course: Knowledge engineering of commercial mowing. *Ergonomics in Design, 14,* 17-23.
Sanchez, J., Ezer, N., Rogers, W. A., & Fisk, A. D. (2006). Estimating reliability of automated aids: Effects of age and system reliability changes. *Cognitive Technology, 11,* 5-13.
Sanchez, J., Fisk, A. D., & Rogers, W. A. (2006). What determines appropriate trust of and reliance on an automated collaborative system? Effects of error type and domain knowledge. *Proceedings of the 9th International Conference on Control, Automation, Robotics, and Vision* (pp. 98-103). New York, NY: IEEE. ****Finalist for Best Paper Award***
Stronge, A. J., Rogers, W. A., & Fisk, A. D. (2006). Web-based information search and retrieval Effects of strategy use and age on search success. *Human Factors, 48,* 443-446.
Stronge, A. J., Rogers, W. A., & Fisk, A. D. (2007). Human factors considerations in implementing telemedicine systems to accommodate older adults. *Journal of Telemedicine and Telecare, 13*, 1-3.

f. Project-generated resources

g. Invention and patents (n/a)