Understanding technology usage in older adults

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***Abstract*— Previous research has identified age-related differences in the use of computers and technology, with adoption mediated by cognitive variables and psychological factors [1]. Yet, the finding that younger adults used the Internet for significantly more activities than older adults suggests that other factors may be more important than ability differences alone. In this paper, we report preliminary findings on technology usage from data collected by the Center for Research and Education on Aging and Technology Enhancement (CREATE). We analyzed technology usage patterns across domains and types of technology to assess relationships between user characteristics and technology variables. We compared our findings with those from other research to identify potential implications for gerontechnology research and design.**

I. Introduction

Previous research has identified age-related differences in the use of computers and technology, with adoption mediated by cognitive variables and psychological factors [1]. Yet, the finding that younger adults used the Internet for significantly more activities than older adults suggests that other factors may be more important than ability differences alone. For instance, older adults may adopt different sets of technologies due to differential perception of costs and benefits [2]. There may also be identifiable subgroups of older adults whose adoption patterns mimic younger adults [3].

Experts project that as baby boomers age, they will be more reliant on technologies for communication and activities of daily living. It is unclear, however, how higher technology fluency and usage during their most productive working years will translate into future technology acceptance as these baby boomers age. A more detailed understanding of usage across a variety of technologies in the current cohort of older adults could guide gerontechnology researchers and designers in experimental design, testing, training, and product development now and for future cohorts.

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In this paper, analysis was based on a qualitative model of technology acceptance developed to explore factors that affect users' decisions to accept different technologies [4]. This qualitative model proposes two types of factors that can affect technology acceptance: individual user characteristics and technology characteristics. Detailed data were collected for both factors by the Center for Research and Education on Aging and Technology Enhancement (CREATE) for 819 adults across the lifespan. We examined these factors in detail to identify relevant usage patterns. This analysis was supplemented with findings from other recent U.S. surveys to provide a more complete picture of current usage. We close the paper by discussing potential implications for research, training, and design.

II. Method

Demographic and technology experience questionnaires were administered over the years 2006-2007 in three geographically separate and ethnically diverse areas of the United States as part of the CREATE research program. Data was collected separately by laboratories at participating CREATE universities according to a standard protocol. Participants were screened for cognitive impairment according to the Short Portable Mental Status Questionnaire (criterion: ≤ 2 errors; [5]) and the Weschler Memory Scale (Logical Memory subscale; age-adjusted criterion; [6]).

From this participant group, we selected 233 older adults (aged 65 and older) for our analysis. These older adults live independently in the community and are generally in good health. This sample is fairly educated, with 35% reporting some college and 40% reporting finishing at least a college degree. 74% of participants were Caucasian and 17% were Black. 63% of the participants were female. Of participants reporting income, 47% reported income under $30,000, 24% reported income between $30,000 and $60,000, and 20% reported incomes greater than $60,000.

III. Results

A. User Characteristics

Before investigating non-age demographic characteristics, we first wanted to develop a high-level picture of technology use by older adults. Overall, older adults appear to be adopting a variety of technologies, including more complex systems such as the Internet. As shown in Fig. 1, Internet usage by older adults (65+) in nearly half of surveyed functions is greater than 50%. This usage level is higher than found in a 2004 survey of American adults. In that 2004 survey by the Pew Internet and American Life Project, 77% of 18-29 year olds, 58% of 50-64 year olds, and 22% of adults 65 and older reported Internet use [7]. Based on both sets of data, older

adults appear to be the fastest growing segment of Internet users in the U.S.

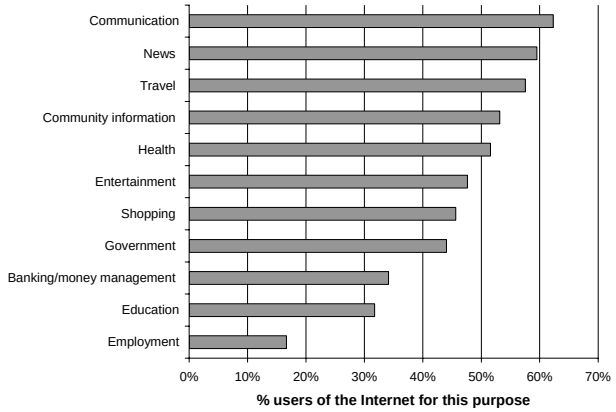

Fig.1. Graph shows Internet usage across functions by older adults in the CREATE dataset. Note that in nearly half of the domains, older adult usage is greater than 50%.

Next, we examined age differences across other demographic variables including education, income, and gender. As several other studies have also reported, lower incomes and education level were significantly related to lower technology usage [8], [9]. For example, only 15% of older adults with incomes less than $20,000 a year reported ever having used on the Internet [8]. These levels increase to 40% for incomes between $20,000 and $49,000 a year, and further to 65% when incomes exceed $50,000 [8]. Similarly, education level is a strong predictor of Internet usage. Only 18% of older adults with no more education than a high school degree are Internet users, compared to 45% of those with some college and 60% of those with a college degree [8].

In the CREATE dataset, Chi-Squared analysis ($p<.05$) only showed that older adults with incomes greater than $60,000 had significantly higher technology usage across most technologies and activity domains than other income segments. Analysis of the CREATE dataset did, however, uncover educational differences in usage in several domains. For example, 17% of older adults with no more education than a high school degree, 45% of those with some college, and 66% of those with at least a college degree reported shopping on the Internet. Similarly, almost 29% of older adults with no more education than a high school degree, 55% with some college, and 63% of those with a college degree used the Internet for health care searches. These data suggest that higher income and education levels may help older adults reduce the technology gap with younger adults.

Several other studies also report technology usage differences due to gender that may be based on different interests and preferences rather than abilities. For instance, men across age groups are more likely to use the Internet as a recreation vehicle than women, e.g., reading online, fantasy sports leagues, or watching videos [9]. Men also reported using the Internet more than women for bill paying, auctions, and stock trading though a gender difference was not found in Internet banking [9]. On the other hand, women reported using the Internet more to search for items related to personal interests such as health and religion. Women also reported using Internet support groups and personal email exchanges more, activities that facilitate a reported Internet benefit for connecting with others [9]. When efficiency is the main criterion for medium selection such as buying tickets, though, men and women were equal in usage [9].

In the CREATE dataset, we additionally examined how gender differences compared across functions and activity domains. As shown in Fig. 2 we found that in some cases, such as for Internet shopping, more males than females reported usage. In other cases such as for technology-based games, however, no significant gender differences were found as both 29% of males and females reporting playing computer/video games.

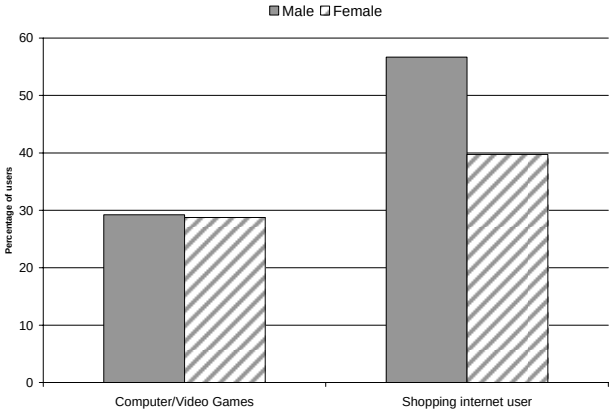

Fig. 2. Graphs show technology usage across genders older adults in the CREATE dataset for computer/video games and Internet shopping. Note that males reported significantly more Internet shopping, but no significant gender differences were found for computer video games.

Selection of technology for these discretionary activities may to some degree be based on general attitudes (toward shopping, for instance), but they may also be induced by marketing and product development that uses different approaches for different age groups. This trend was examined in a *New York Times* article discussing an increase in video gaming in older people [10]. This article suggested that older people are using video gaming as a tool to keep their motor and mental skills sharp, though controlled research to examine the effects of specific game playing on cognitive abilities has been inconclusive [11]. Video game makers such as Nintendo are capitalizing on the aging population to develop games geared toward older adults such as Brain Age and Wii sports. Nintendo has even donated Wii consoles to twelve retirement communities in a specific effort to capture this target market [12]. The effect of increased experience with even one video game system such as the Nintendo Wii console may actually facilitate new methods of experimentation as demonstrated in a psychological study conducted at the University of Memphis with this device [13].

A final demographic variable that may predict the type and extent of technology usage is the participant's family and social structure. The Intel Corporation, for instance, reported that the size and nature of the social network of friends and family is a predictor of whether an older person will adopt certain technologies (as cited in [14]). In Japan, the influence of living with other people on mobile

phone usage was specifically examined in a questionnaire and usability study [15]. Questionnaire results showed that individuals living with only a spouse used mobile phones less than individuals living alone or with children or grandchildren. Usability tests conducted with a subset of questionnaire participants demonstrated that participants living with their grandchildren learned a broader set of new technologies than participants living with only a spouse. Thus, researchers have concluded that social support can facilitate technology adoption and learning of more complex features by older adults to enhance usage for even simpler functions.

B. Technology Characteristics

To investigate how technology characteristics may influence technology adoption, we first examined technology usage in two domains where we expected that interests and functional needs might be relevant for older adults: communication and shopping. Table II shows results from the CREATE dataset.

Table II.
Reported technology usage by older adults in the CREATE dataset for activities in the communication domain.

Technology	Older Adults
Answering machine	85%
Fax machine	58%
Internet	67%
Mobile phone	81%
Telephone	96%

Notice in Table II that older adults reported using new technologies like the Internet and mobile phones at substantial levels, as well as continuing to use older technologies like answering machines and fax machines. Thus, many older adults seem to perceive additional usefulness for newer technologies that makes them complementary to traditional communication mediums.

Other research supports this conclusion that the Internet and mobile phone are not merely replacement technologies but also offer new benefits. The annual Gadget Survey by the Pew Internet and American Life Project in 2006, for instance, found few age differences in frequency of Internet and email access: 66% of 18-25 year olds who use the Internet or email at least occasionally reported having used these systems yesterday vs. 59% of those 65 and older [16]. Among older adults who went online, 34% considered email and 33% considered the Internet an important part of their lives and would not want to be without it [9]. Of those email users, 56% said that it makes it convenient for them to stay current with their loved ones [8]. From these reports, it appears that older adults perceive the relative advantage of email over traditional mediums in some cases as well as the compatibility of this tool in achieving their overall goals.

These technology characteristics may also explain why there are more usage differences in the domain of shopping as shown in Fig. 3. Traditional technologies of credit cards and telephone continue to be used for shopping at substantial rates, and television shopping continues to be used by a small group of older adults. The newer technologies, however, show a larger adoption rate than the simpler television. Additional analysis is needed to better understand if older adults identify specific times or types of purchases that influence when newer technologies are generally used, but adoption levels of >40% suggest that clearly some benefits can be found for these users. Most interestingly, usage rates of nearly 60% for the relatively recent in-store kiosks suggest that older adults may voluntarily adopt newer technologies if they can and if the new device provides important benefits like convenience. Thus, factors such as compatibility with their goals and pattern of daily activities may also increase the likelihood of adoption for older adults.

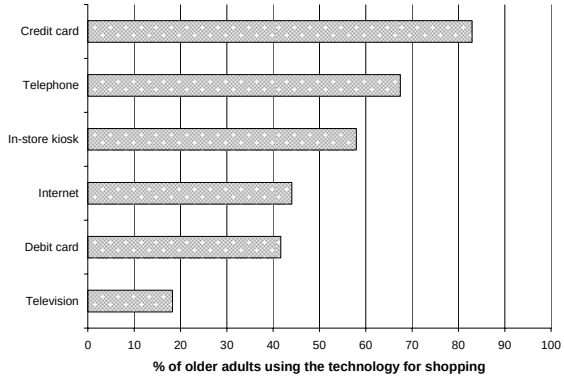

Fig. 3 Graph shows technology usage for shopping by older adults in the CREATE dataset. Traditional technologies of credit cards, telephone, and television show the highest and lowest levels of adoption, but more recent technologies are also being used by some older adults.

For some of these newer technologies, though, a technology's complexity may limit adoption or at least reduce the breadth of features or activities for which the technology is used. Research by [17] suggests a "technology generation" effect on technology adoption such that individuals must use a specific technology before age 25 for fluent usage. According to this theory, the current cohort of older adults may demonstrate lower usage for Internet and debit cards in shopping because they were unavailable during their formative years and are not as well integrated into their lifestyles. If this is the case, technologies that are easy to use and useful for older adults may still show low adoption because of perceived costs of modifying current activities that already deliver adequate results.

We investigated this alternative by examining frequency of usage of technologies with similar levels of complexity by older adults. Table III shows this comparison using microwave ovens, personal computers, ATMs, and MP3 players/iPods. For the first two technologies, over 50% of older adults reported frequent usage with relatively few non-users of these devices. For ATMs and MP3 players/iPods, however, only 22% of older adults are frequent ATM users, 41% are non-users of ATMs, and 94% are non-users of MP3 players/iPods. These data support the idea that older adults can use more complex technologies but are choosing not to do so. Anecdotal reports by older adults provide some explanation. Visiting the bank on a weekly basis, for instance, may support

achievement of social goals to see other people while conducting business and may reduce an individual's perception of risk in entrusting money to a bank because they personally know at least one bank teller. These same individuals, however, may keep an ATM card at home to bring on vacation for emergencies. Thus, as long as adoption is voluntary, usage may not reach the levels of younger adults due more to individual user characteristics and goals than to technology characteristics alone.

Table III. *Comparison of reported usage frequency for selected technologies by older adults in the CREATE dataset.*

	Frequent user	Occasional user	Non-user
Microwave ovens	81%	14%	4%
Personal computers	50%	19%	26%
ATMs	21%	35%	39%
MP3/iPods	1%	5%	89%

IV. DISCUSSION

Gerontechnology researchers and designers need to understand factors affecting technology experience among older adults in general, as well as facilitators and inhibitors for this experience more specifically. The technology acceptance model can facilitate the investigation of usage by highlighting the effects of two types of factors: individual usage characteristics and technology characteristics [4]. In this paper, we have used this model to conduct preliminary analysis of older adults in our CREATE dataset and to compare these results with other published research. Future analyses will be comparative to other age groups, particularly younger adults.

A. User characteristics

Our analysis demonstrated that income, education level, gender, and social support appear to affect technology adoption. Overall, we found that older adults are adopting technologies across many domains, with adoption of the common Internet as a platform by over 50% of older adults in some domains. We also found that higher income and education levels may help older adults to reduce the technology gap. Gender differences may be related to overall attitudes, preferences, marketing efforts, and product availability. The presence of social support may also increase technology adoption by leveraging friends and family to teach and encourage broader usage.

B. Technology characteristics

Our analysis also demonstrated that the usefulness, compatibility, complexity, technology generation, and relative advantage of a technology are important characteristics that influence adoption. Older adults seem to perceive additional usefulness of new technologies beyond traditional mediums and seem to include the new technologies in the range of potential technologies used for common activities and functions. Compatibility of the technology with existing goals and lifestyles may also facilitate increased adoption. On the other hand, technology generation effects may limit adoption by older adults if unavailability of that technology early in an individual's life limited integration and fluency. For these individuals, the costs of changing their lifestyle may also limit adoption. Adoption of similarly complex technologies suggests, however, that participants may be able to use some technologies but choose not to because other goals are more important than the potential benefits offered by these technologies. In these cases, adoption may be based on an interaction of user and technology characteristics.

C. Potential Implications

Understanding current adoption of technologies by older adults is complex but is critical for guiding effective research and design. This paper has shown that many older adults use a variety of technologies, with technologies such as microwave ovens, mobile phones, and personal computers particularly showing high usage. Researchers can expect that many adults will be able to quickly transfer this experience to an experiment, training activity, or new product. However, some adults, particularly those with lower incomes and educational levels, may not have this experience and may require additional system training. Otherwise, experimental and usability results may be confounded by experience effects. Questions regarding current usage should also allow participants to indicate whether they can use a technology type (e.g., kiosk devices like ATMs) vs. whether they are using them. Although fluency may be affected in either case, training requirements may differ.

Gerontechnology researchers can also leverage technologies for which participants have experience and positive attitudes to better evaluate human capabilities and limitations. For instance, marketing efforts such as those for the Wii system may even enable researchers to develop experiments on a technology for which younger and older adults have similar experience. Techniques developed now to identify current technology usage in participants for effective experimental design and training/ product development is critical to ensuring that research continues to be generalizable outside of laboratories.

REFERENCES

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

[2] A. S. Melenhorst W. A. Rogers, and D. G. Bouwhuis, "Older adults' motivated choice for technological innovation: Evidence for benefit-driven selectivity," *Psychology and Aging*, vol. 21, pp. 190-195, 2006.

[3] Pew Internet & American Life Project, (2003). *Consumption of Information Goods and Services in the United States*, [Online]. Available: http://www.pewinternet.org/pdfs/PIP_Info_Consumption.pdf

[4] K. Van Ittersum, W. A. Rogers, M. Capar, K. E. Caine, M. A. O'Brien, L. J. Parsons, and A. D. Fisk, "Understanding technology acceptance: Phase 1 – literature \ review and qualitative model development" (Technology Report HFA-TR-0602). Atlanta, GA: Georgia Institute of Technology, School of Psychology, Human Factors and Aging Laboratory, Jan. 2006.

[5] R. I. Pfeiffer, (1975). “A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients,” *Journal of American Geriatrics Society*, vol. 23,pp. 433-44, 1975.
[6] D. Wechsler, *Wechsler Memory Scale III. (3rd ed.)*. San Antonio, TX: The Psychological Corporation, 1997.
[7] S. Fox, Pew Internet & American Life Project. (2004, March 28). *Older adults and the Internet*. [Online] Available: http://www.pewinternet.org/PPF/r/117/report_display.asp:
[8] Kaiser (2005). *E-health and the elderly: How seniors use the internet for health information*. [Online] Available: www.kff.org/entmedia/upload/
[9] Pew Internet & American Life Project. (2001). *Wired seniors: A fervent few, inspired by family ties*. [Online] Available: http:www.pewinternet.org /PPF/r/40/report_display.asp
[10] S. Schiesel, (2007, March 30). “Video games conquer retirees,” *The New York Times*. [Online] Available: http: //www.nytimes.cpm/2007/03/30/30seni.
[11] “Exercising to keep aging at bay,” *Nature Neuroscience*, vol. 10, p. 263, 2007.
[12] R. Brown, (2007, June 16). “Games seek to bring seniors to their feet,” *Boston Globe*.[Online] Available: http://www.boston.com/news/local/articles/2007/06/16/games_seek_to_bring_seniors_to_their_feet/
[13] R. Dale, J. Roche, K. Snyder, and R. McCall, “Exploring action dynamics as an index of paired-associate learning,” PLoS ONE, *3*, e1728. doi:10.1371/ [Online] Available: www.pubmedcentral.nih.gov .
[14] E. W. Boehm, (2007). *Designing interactions for an aging population*.[Online] Available: www.forresterpanel.com/go?docid=42827
[15] K. Mori, and E. T. Harada, “Is learning a family matter?: Effects of family structures on older adults’ learning to use cell phones,” presented at the 11th Cognitive Aging Conference, Atlanta, GA, April 10-13, 2008.
[16] Pew Internet & American Life Project. (2006, April 6). *Annual Gadget Survey 2006*. [Online] Available: www.pewinternet.org
[17] M. Docampo Rama (2001). *Technology Generations: Handling Complex User Interfaces*. Eindhoven, TheNetherlands: Technical University of Eindhoven, 2001.