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More than a Servant: Self-Reported Willingness of Younger and Older Adults to having a Robot perform Interactive and Critical Tasks in the Home

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Abstract

Many companies are developing robots for the home, including robots specifically for older adults. There is little understanding, however, about the types and characteristics of tasks that younger and older individuals would be willing to let a robot perform. In a mailed questionnaire, participants were asked to indicate their willingness to have a robot perform each of 15 robot tasks that required different levels of interaction with the human owner and different levels of task criticality. The responses of 117 older adults (aged 65–86) and 60 younger adults (aged 18–25) were analyzed. The results indicated that respondents of both groups were more willing to have robots perform infrequent, albeit important, tasks that required little interaction with the human compared to service-type tasks with more required interaction; they were least willing to have a robot perform non-critical tasks requiring extensive interaction between robot and human. Older adults reported more willingness than younger adults in having a robot perform critical tasks in their home. The results suggest that both younger and older individuals are more interested in the benefits that a robot can provide than in their interactive abilities.

INTRODUCTION

Robots for the home are no longer only the product of science fiction. Technological advances have demonstrated that domestic robots, such as the vacuum cleaning robot Roomba, can be viable commercial products. Indeed, the International Federation of Robotics (2008) estimated that between 2008 and 2011 about 12.1 million personal and domestic service robots will be sold. Although most of these robots will be designed to perform simple household tasks, such as mowing the lawn, or for entertainment, future advances in technology may allow domestic robots to perform more complex collaborative activities with humans (Dautenhahn, et al. 2005). These collaborative activities could include tasks such as helping a person learn a new skill, keeping track of health, or acting as a social partner. Older adults may especially benefit from domestic robots that assist them in accomplishing activities of daily living (e.g., medication management), which can allow them to continue living independently in their own home.

Despite the increasing interest in developing advanced domestic robots, few studies have examined the types of tasks that individuals would be willing to let a robot perform in their home. We have not been able to identify any studies that examined the types of tasks older adults would be willing to let robots perform. This gap in knowledge is of concern because it has long been assumed that individuals will be fearful of robots that display some level of human-like intelligence or appearance (Kaplan, 2004, Nomura, Kanda, Suzuki, & Kato, 2004). If this is the case, then it is unlikely that individuals would be willing to let robots perform tasks that require some amount of advanced intelligence and social interaction. Assistive robots could have a tremendous positive impact on an older adults' life, for example by helping them to remember to take their medication, learn how to use other types of technology, provide security, and reduce social isolation (Cesta et al., 2007, Dario, 1999). Older adults generally have less experience with technology than their younger counterparts, and this lack of experience may be related to computer anxiety (Czaja, et al., 2006). If older adults are fearful of robots performing these tasks, then the benefit of assistive robots may not be realized.

On the other hand, when individuals see a benefit of new technology they may accept it more readily (Davis, 1989). Although age appears to be negatively related to new product acceptance (Kelley & Charness, 1995), there is evidence that older adults are willing to accept technology in their home if they see the benefit of that technology outweighing the costs, such as loss of privacy and effort to learn how to use the new technology (Caine, Fisk, & Rogers, 2007; Melenhorst, Rogers, & Bouwhuis, 2006; Sharit, Czaja, Perdomo, & Lee, 2004). Therefore if older individuals perceive the usefulness of robots for assistive tasks, they may be willing to accept them.

The studies that have assessed the tasks individuals would want robots to perform in their home have generally found that individuals think of robots as advanced appliances. For example Dautenhahn, et al. (2005) found that young and middle-aged individuals thought that robots should perform chore-type tasks such as vacuuming. In another study, Khan (1998) found that 21–60 year old individuals living in Sweden wanted robots to assist them with polishing windows, cleaning the ceiling and walls, general cleaning, wet-cleaning, and moving heavy things. The respondents generally did not want a robot to help them with tasks such as babysitting, reading aloud, watching their pets, performing tasks of a butler, cooking food, and taking care of kitchen goods.

At face value, the results of these studies would suggest that robots should be designed only to perform monotonous tasks. The studies, however, do no not help to explain the underlying reasons why individuals would be more willing to let robots perform some tasks over others. One explanation could be that individuals may not want to interact with a robot. Another explanation could be that the tasks that were presented to participants in the mentioned studies were just not critical enough (i.e., they did not present enough of a perceived benefit to participants). In many ways it is more important to understand the characteristics of tasks that influence robot acceptance, rather than simply producing a list of tasks which individuals would want robots to perform. This knowledge would be useful in predicting the attitudes individuals may have for future robot tasks. With respect to age, it is also important to uncover the characteristics of these tasks that make them more or less appealing to younger and older adults. For example, an older adult with health concerns may see more benefit in a robot performing health-related activities than a younger adult without these concerns. Other influences on acceptance of robots for various tasks may be related to technology experience and familiarity with existing commercial robots.

A questionnaire study was conducted to investigate the expectations of and attitudes toward a robot in the home by younger and older adults. Part of the questionnaire was designed to explore the reasons why individuals would be more willing to let a robot perform certain tasks in their home over other tasks. Age-related differences in health, technology experience, and robot experience were also considered. If technology experience is a critical predictor, we would expect that older adults would, in general, be less willing than younger adults to have a robot perform the 15 tasks that were presented. Moreover, if the degree of benefit is the critical predictor of preferences, both younger and older adults should be more willing to have a robot perform more critical tasks (i.e., those with clear benefits) than less critical tasks. However, general expectations of what robots can do might lead to preferences for having robots perform only mundane, repetitive tasks.

METHOD

Sample

Questionnaire packets were mailed to 2500 younger adults (aged 18–28) and 2500 older adults (aged 65–86) in the Atlanta Metropolitan area and surrounding counties. The sample was drawn from an age-targeted list acquired from a survey sampling company with an age-accurate hit rate of 65%. Forty-three packets were returned as undeliverable. A total of 310 packets were mailed back from respondents. Of these, 177 were completed and answered by individuals in the targeted age groups (110 packets only had sweepstakes entry forms and 23 respondents were not within the targeted age groups or did not indicate their age). Thus, the effect rate of return was 5.6%. There were 60 younger adult respondents (M = 22.7 yrs, SD = 3.2) and 117 older adult respondents (M = 72.2 yrs, SD = 5.7).

Almost all participants reported living independently either in a house, apartment, or condominium. Older adults living in assisted living facilities or nursing homes were not represented in the sample of respondents. Older adults, however, were much more likely than younger adults to indicate they lived by themselves, $\chi^2(1, N = 175) = 9.81$, $p = .001$, 31% vs. 10%.

Questionnaire

The questionnaire consisted of four sections: 1) Views about Robots, 2) Robot Tasks, 3) Technology/Robot Experience, and 4) Demographics and Health. The Views about Robots section will not be discussed for the purposes of this paper.

Robot Tasks—In the Robot Tasks section of the questionnaire participants were presented with 15 possible tasks that robots could perform in the home. These particular tasks were selected to represent five different categories of activities: 1) entertainment-related tasks (e.g., playing games), 2) everyday service tasks (e.g., housework), 3) education/self-enhancement tasks (e.g., learning a new skill), 4) general home health/self-care tasks (e.g., forming exercise schedule), and 5) emergency assistance tasks (e.g., notifying doctor of medical emergency).

The tasks varied along two dimensions. The first dimension was in the amount of interaction robots would have with the human owner; an example of low level interaction would be a robot chasing away an intruder and a high level of interaction might be a robot having a conversation with the owner. The second dimension was in the criticality of robot tasks. Criticality ranged from low, as in the case of entertainment-related tasks to high, as in the case of emergency assistance- related tasks. Participants were instructed to indicate how willing they would be to let a robot perform each task in their home on a Likert-type scale from 1 = "not at all" to 5 = "to a great extent"; a "don't know" option was also provided.

Technology and Robot Experience

The technology experience part of the questionnaire consisted of 20 items asking participants about their use of technology over the past year. The items were selected to be representative of technologies that are used in work, communication, and home domains. They included both "older" technologies (e.g., washing machine) and "newer" technologies (e.g., MP3 player/iPod). Participants were instructed to indicate how often they had used each technology in the past year on a Likert-type scale from 1 = "not at all" to 5 = "to a great extent (several times a week)"; a "don't know what this is" category was included for participants to indicate if they were not familiar with the technology.

The robot experience part of the questionnaire consisted of six items asking participants about their experience with categories of existent robots: manufacturing, lawn mowing, mopping, vacuum cleaning, guarding, and entertaining. Participants were instructed to indicate their level of experience with each robot category on a Likert-type scale from 1 = "no experience with this robot" to 5 = "I have and use this robot"; an "I'm not sure" category was also included.

Demographics and Health

The last section of the questionnaire contained questions about demographics and health. The health portion of the questionnaire had six questions asking participants about their general health, general limits as a result of health, activity limitations due to health, medical conditions, frequency of taking prescription medication, and number of current prescription medications taken.

Procedure

The questionnaires and supporting materials were printed and mailed by a survey research center. Recipients of the questionnaire were given four weeks to answer and return the questionnaire. They were mailed a reminder postcard two weeks after the initial mailing. To increase response rate a sweepstakes was created, in that recipients could mail back an entry form to win one of fifty $50 checks, regardless of whether or not they answered the questionnaire. Late questionnaire were accepted for three weeks after the due date.

RESULTS

Technology and Robot Experience

Each participant was given a technology experience score based on the mean of their responses to their self-reported usage of 18 technologies. Two technologies, home medical device and non-digital camera, were not significantly correlated to any of the other items, and were thus excluded from the technology experience score. For this scale, a score of 1.0 would indicate no experience and a score of 5.0 would indicate daily experience with the 18 technological items in the scale. The mean score on the scale was 3.61 ($SD = .67$). A one-way ANOVA with age as the independent variable and technology experience as the dependent variable revealed that younger adults ($N = 60$, $M = 4.05$, $SD = .441$) had significantly more experience than older adults ($N = 115$, $M = 3.38$, $SD = .664$), $F(1, 175) = 48.9$, $p <.001$, $\mu_p^2 = .22$.

Each participant received a mean score on the robot experience scale. For the robot experience scale, a score of 1.0 would indicate no experience and a score of 5.0 would indicate extensive experience with (i.e., ownership and use of) the six robot items in the scale. The mean score on the scale was 1.92 ($SD = .74$). Overall, participants indicated minimal experience with the six robot types presented. A one-way ANOVA, with age as the independent variable and robot experience as the dependent variable, indicated that younger adults ($M = 2.20$, $SD = .73$) reported slightly but significantly more robot experience than older adults ($M = 1.77$, $SD = .71$), $F(1,175) = 14.3$, $p <.001$, $\eta_p^2 = .08$.

Health

Each participant was given a health-complexity score as a composite of their answers to questions about their health. The internal reliability of this scale was assessed using Cronbach's alpha reliability, which was found to be modest but acceptable ($\alpha = .79$). The minimum possible health-complexity score was 16, indicating self-described excellent general health, no limits in activities due to health, no medical conditions, and no prescription medications. Individuals with health-complexity scores above 40 generally indicated poor overall health, several limits in activities due to health, current or previous medical conditions, and frequent use of prescription medications. The mean score on the overall health-complexity scale was 26.5 ($SD = 6.45$). An ANOVA, with age as the independent variable and the health-complexity score as the dependent variable, was performed. Older adults ($M = 29.0$, $SD = 6.10$) had significantly greater health-complexity scores than younger adults ($M = 21.7$, $SD = 3.94$), $F(1,141) = 55.3$, $p < .001$, $\eta_p^2 = .28$.

Robot Tasks

Participants' self-reported willingness to let a robot perform each of 15 tasks in their home was submitted to a principle axis factor analysis procedure with a promax rotation (kappa = 4) to investigate the underlying factors. The procedure followed guidelines described in Gorsuch (1983). Factor loadings with absolute values under .4 were suppressed. The factorability of the 15 items was determined acceptable with a KMO measure of sampling adequacy value at .89 and a significant Bartlett's test of sphericity, $\chi^2(105, N = 178) = 1099.25$, $p <.001$.

The factor analysis resulted in a three-factor model, as no other factors with eigenvalues above 1.0 were present. The first factor accounted for 43% of the initial eigenvalues and the second and third factors accounted for 9% and 8%, respectively. Thus, the total variance accounted for by the three-factor model was 60% of the initial eigenvalues and 51% of the extraction sums of squared loadings. The initial factor extraction required 17 iterations and the rotation converged in seven iterations. The pattern matrix with factor weights for the three robot tasks factors are presented in Table 1. The factor correlation matrix for the three factors is presented in Table 2.

The three task factors appeared to differ by the interaction that would be required between robot and human user as well as by how frequently those tasks would be performed. The first factor was largely composed of tasks in which the robot would need to be actively engaged with the user (e.g., have conversations with the user). The second factor included tasks that would greatly help the user but that would not be performed by the robot frequently (e.g., warn the user about a danger in the home). The third factor included tasks that the robot would perform frequently, but the robot would interact with the human only as a servant (e.g., bringing objects from another room to the user). The three factors were thus labeled "interactive tasks", "infrequent tasks", and "service tasks".

Each participant was given a mean score for each of the robot task factors. Figure 1 shows the means scores of older and younger adults for each factor. Overall, participants indicated a moderate to large interest in having robots perform interactive, infrequent, and service tasks.

Paired sample t-tests, with a Bonferroni correction at the p = .0167 level, were conducted to assess differences in means between the three task factors. The mean score of willingness to let robots perform infrequent tasks was significantly greater than the mean score of willingness to let robots perform service tasks, $t(177) = 6.98$, $p < .001$; the mean score of willingness to let robots perform infrequent tasks was significantly greater than the mean score of willingness to let robots perform interactive tasks, $t(178) = 16.47$, $p < .001$; the mean score of willingness to let robots perform service tasks was significantly greater than that of interactive tasks, $t(179) = 4.60$, $p < .001$. Thus, participants were most willing to have robots perform infrequent, albeit critical, tasks, followed by service tasks, and least willing to have robots perform interactive tasks with them.

The effect of age group on willingness to have robots perform different types of tasks was investigated with a MANCOVA, with age group (younger, older) as the dependent measure and robot tasks (interactive, infrequent, and service) as the dependent variables. Technology experience, robot experience, health-complexity, and living situation (living alone or with others), were included as covariates. Box's M test was non-significant, *Box's M* = 8.89, $p = .20$, indicating assumption of equality of the covariance matrices between groups was met.

The MANCOVA analysis indicated that with technology experience, health experience, health, and living situation controlled for, age had a significant effect on the types of tasks that participants were willing to let robots perform in their home, Pillai's Trace statistic $F(3, 131) = 5.52$, $p = .001$, $\eta_p^2 = .11$. The univariate analysis indicated that older adults' scores on willingness to have robots perform infrequent tasks were significantly greater than those for younger adults, $F(1,133) = 6.88$, $p = .01$. The mean willingness scores for interactive tasks, $F(1,133) = 034$, $p = .85$, and for service tasks, $F(1,133) = 1.48$, $p = .23$, were not significantly different between younger and older adults. None of the covariates had significant relationships with willingness scores on the three robot tasks factors.

DISCUSSION

The purpose of the study was to investigate the types of tasks that younger and older adults would be willing to let a robot perform in their home. The results suggest that individuals may be more willing to have robots perform infrequent, but critical tasks such as emergency notification, over service tasks, and may be least willing to have robots perform interactive tasks. Still, the majority of participants indicated interest in having robots perform all three types of tasks. This may be particularly true for older adults, who indicated more willingness than younger adults to have robots perform critical monitoring tasks that would require little interaction between the robot and the human. This may be because older adults see more of a benefit to having a monitoring-type robot than do younger adults.

These results contradict the belief that older adults are less willing to have a robot in their home than younger adults. Previous research has suggested that older adults may be more fearful of robots (Scopelliti, Giuliani, & Fornara, 2005). The present sample may have been skewed towards individuals who were interested in robots; nevertheless, the older adult respondents were just as willing as the younger adult respondents to have a robot perform service and interactive tasks in their home. They were more willing than younger adults to have monitoring robots or robots for emergency situations. Older adults should not be excluded when it comes to the implementation of domestic robots.

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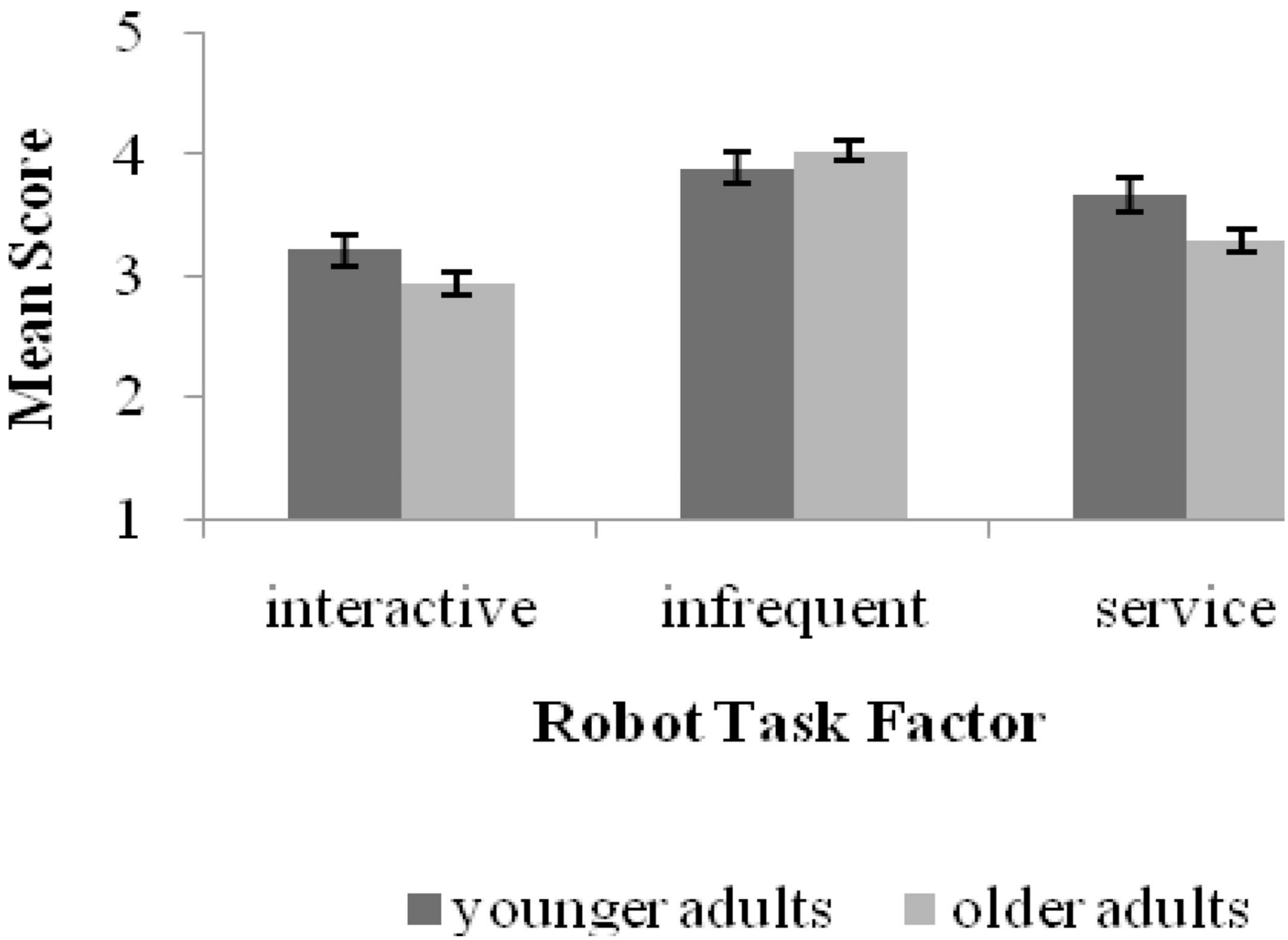

Figure 1.
Mean scores of younger and older adults for the three robot task factors: interactive, infrequent, and service tasks. Error bars are standard errors of the mean.

Table 1

Factor Weights Based on a Principle Axis Analysis with Promax Rotation for Fifteen Items of Robot Tasks

Item	Interactive Tasks	Infrequent Tasks	Service Tasks
Teach me more about a hobby or topic of interest	0.89		
Give me information about the weather, news, etc.	0.76		
Have a conversation with me	0.74		
Help motivate me to exercise	0.67		
Play games with me	0.54		
Help me stick to a diet	0.50		
Teach me a new skill	0.46		
Remind me to take my medication	0.46		
Warn me about a danger in my home		0.81	
Scare away an intruder		0.70	
Show me how to use other technology	0.42	0.43	
Inform my doctor if I have a medical emergency		0.42	
Bring me things I need from another room in my home			0.80
Make meals or cook for me			0.57
Help me with housework			0.52

[1] Factor weights <.4 are suppressed

Table 2

Factor correlation matrix for robot task factors

Factor	1	2	3
1	--	.668	.465
2		--	.429
3			--