When older adults start and stop to use technologies: Long term study on technology usage, computer attitudes and cognitive abilities of Japanese older adults

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Purpose Technology usage by older adults has been studied statically, in rather short periods such as one specific point in time1. In order to understand the nature, causes, and influencing factors of technology usage by older adults, longterm investigations are essential. The purpose of this study was to investigate the adoption and discontinuation of technological products and services by older adults, as well as to clarify relationships among older adults' computer attitudes, cognitive abilities, and usage changes. **Method** Older adult volunteers aged 60 and older, residing in a Tokyo metropolitan area and its suburb participated in this investigation. The total number of participants was 166. A questionnaire probing their technology usage and computer attitudes, which was originally developed by the Center for Research and Education on Aging and Technology Enhancement (CREATE)2 and then modified by the investigators, was sent to the participants every year between 2003 and 2009. They were asked to complete the questionnaire at their own pace and send it back to the investigators by post. Adoption or discontinuation was identified by comparing the daily usage of technologies listed in the questionnaire for every two consecutive years. An attitudes-towardcomputers questionnaire3 was employed as a part of the questionnaire to assess seven dimensions of participants' computer attitudes: comfort, self-efficacy, gender equality, control, dehumanization, interest, and utility. The participants were also invited to join into an investigation of cognitive abilities every year. Some of them agreed to participate in the on-site investigation sessions every year. Spatial abilities, associative memory, perceptual speed, and field independence were measured with the sections selected form the kit for factor-referenced cognitive ability tests4. **Results & Discussion** A series of t-tests and repeated-measures ANOVA were conducted to investigate whether there were significant changes of computer attitudes and cognitive abilities when the adoption or discontinuation of technology products occurred. Preliminary results showed two dimensions of computer attitudes–gender-equality and interest–increased when older adults started to use technology products or services. On the other hand, significant decreases in three areas related to computer attitudes, i.e. interest, utility, and control, were observed when older adults stopped to use technological products. For non-computerized products, no changes on computer attitudes were observed. With regard to cognitive abilities, no consistent patterns were observed. In this investigation on technology usage of older adults over several years, computer attitudes were found to be correlated with dynamic changes in technology usage, in addition to the usage status that has been reported in previous studies. On the other hand, cognitive abilities did not show a clear correlation with usage changes, although this relationship was reported in previous studies.

Keywords*: older adults, technology adoption, computer attitudes, cognitive ability*

INTRODUCTION

Technological advancements have become widespread, and their implementation into products of everyday use is accelerating. Now more and more information and communication technology products and services are appearing in our lives. Especially, in the past 30 years, computer, the Internet and mobile phone prevailed among people of all ages.

On the other hand, the world population is growing older. Japan, for example, is estimated that the aging population aged 65 and over will reach 35% in 2050. With the development of technology, older adults start making use of those products inevitably.

Although technology has the potential to improve the lives of older adults by increasing their independence in daily life and enhancing communication with their family, older adults are often considered not to be capable of adapting those fast-developed technologies. Therefore, supporting the elderly in making use of new technologies has become increasingly important.

Meanwhile, the process of adoption and discontinuance of a technology for older adults is more complex than it was estimated. When a new technology product is launched, older adults may hesitate to try it. Or even if they ever tried, they may stop using it soon. These might be due to the willingness or ability of older adults to adopt the product. Gradually with the penetration of the product among population, older adults may also be influenced by their friends,

family members, or participation in a training course, and then they may restart using it. On the other hand, however, with the decline of their physical or cognitive abilities, older adults may stop using the product again. It is a dynamic process for older adults to adopt a new technology. In many of previous studies, researchers have not focused on this dynamic process very much and studied technology usage by older people as states, assuming that older adults are the same with younger adults; once they start using a technology, they continue using it. In order to understand the nature, causes, and/or influencing factors of dynamic changes of technology usage by older adults, long-term investigations are essential.

In this study, therefore, older adults' dynamic changes of using technology were investigated. In this study dynamic change refers to a specific time point when older adults started or stopped to use a certain technology product. Dynamic changes of using, i.e. adoption or discontinuance of a product were recognized by comparing the participants' reports of daily usage of technologies for every two consecutive years.

One factor likely to influence the dynamic change of technology usage is people's attitudes towards it. Older adults' computer attitudes have been studied in relation to computer and other technology products usage. Rogers and her colleagues[1] claimed that when older adults received new information about computer, their attitudes toward computer might increase. Umemuro and Shirokane[2] demonstrated a positive attitude was a reliable predictor of actual computer usage in the long term of one year. However, relationships between attitudes and dynamic changes in usages of technologies have seldom been studied. One reason could be that most of studies were conducted in a rather short period, such as several weeks or a year. It is difficult to observe dynamic changes happen. Therefore, if the data are collected in a longer period such as years, it might become possible to track the dynamic changes in usage of technology products by older adults.

Other possible factors that are thought to influence technology usage are cognitive abilities. Cognitive abilities are a multifaceted construct, and considered to change with aging. Findings from Umemuro's[3] study suggested that some of cognitive abilities are important predictors of computer use. Among cognitive abilities that have been studied, spatial ability, associative memory, perceptual speed, and also a cognitive style of field independence have been reported to relate with the usage and learning of computer skills.

In spatial abilities, there are two different yet similar factors: spatial visualization and spatial orientation. Visualization is the ability to manipulate or transform the image of spatial patterns into other arrangements. Orientation is the ability to perceive spatial patterns or to maintain orientation with respect to objects in space. Spatial orientation requires only mental rotation of the configuration, while visualization requires both rotation and performing serial operations. Pak[4] suggested that spatial ability is important in the performance of computer-based tasks because of menu hierarchies that require users to navigate to the desired information.

Associative memory is the ability to recall one part of a previously learned but otherwise unrelated pair of items when the other part of the pair is presented. This memory involves the storage and retrieval of information form intermediate term memory. Umemuro[3] claimed that associative memory is considered to play an important role in remembering interface presentations and user goals in association with operation procedures.

Perceptual speed involves primarily the temporal parameters of a visual search through a field of specified elements. Perceptual speed is also considered to be important for usage of technologies including computer, because some new technologies such as computers often present large amounts of information to users and also require visuomotor control in their operation.

Field independence appears to be related to the cognitive ability called "flexibility of closure". It is the ability to hold a given visual percept or configuration in mind so as to dissemble it from other well defined perceptual material.

The purpose of this study was to investigate the adoption and discontinuance of technological products and services by older adults for a long term of years. This study also aimed to clarify relationships among older adults' computer attitudes, cognitive abilities and usage changes. Based on the above arguments, two hypotheses were derived for this study:

Hypothesis 1: if older adults start adopting a technology product, their computer attitudes increase; if older adults stop using a technology product, their computer attitudes decrease.

Hypothesis 2: if older adults start adopting a technology product, their cognitive abilities increase; if older adults stop using a technology product, their cognitive abilities decrease.

METHOD

Participants

Older adults aged over 60 years old residing in Tokyo metropolitan area and its suburban area in Japan participated in this investigation voluntarily. They participated in this research in response to recruitment advertisements on local newspapers. Total number of participants was 166. Of these, 84 were

male (age: *M* = 74.37, *SD* = 4.98) and 82 were female (age: *M* = 72.91, *SD* = 5.98) in 2009.

Procedure

A questionnaire probing their technology usage and computer attitudes, which was originally developed by the Center for Research and Education on Aging and Technology Enhancement (CREATE)[5] and then modified by the investigators to match the goal of this study, was sent to the participants every year since 2003 until 2009. They were asked to complete the questionnaire with their own paces and then send it back to the investigators. The participants were also invited to participate in on-site investigation of cognitive abilities which was held every year. The number of participants agreed to participate in the investigation varied year to year.

If participants answered the same questionnaire in two consecutive years, it was considered as one valid case. Then, dynamic changes of usage, i.e. adoption or discontinuance of a product were recognized by comparing the daily usage of technologies listed in the questionnaire for every two consecutive years, as shown in Figure 1. There is the case that an older adult frequently started and stopped using a product during 2003 and 2009, then the first time he started and the last time he dropped the product were recognized and other changes in between were removed in the remaining analyses.

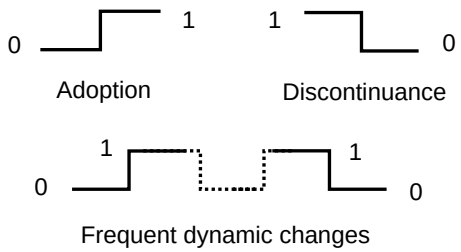

Fig. 1 Definition of dynamic changes

Measurements

Technology usage was assessed by a questionnaire asking participants their daily usage experiences of products and services based on modern technologies. They were: touch screen type automatic teller machine (ATM), car cruise control, car navigation system, mobile phone, computer, computerized catalog in a library, copier, fax, home security system, digital camera, video camera, video game, video player/recorder (VCR), DVD player, DVD recorder, ticket vending machine, answering machine, CD player, microwave oven, self-service gas station and IC card.

Participants' computer attitudes were investigated using the Attitudes Toward Computers Questionnaire (ATCQ)[6]. ATCQ is a 35-item multidimensional scale to assess seven dimensions of participants' computer attitudes: comfort, self-efficacy, gender-equality, control, dehumanization, interest and utility. Participants responded to items on a five-point Likert scale from 1 (*strongly agree*) to 5 (*strongly disagree*).

Cognitive abilities and cognitive style were measured with the sections selected form the Kit for Factor-referenced Cognitive Ability Tests[7] developed by Educational Testing Service. Five test batteries were selected and applied: spatial visualization, spatial orientation, associative memory, perceptual speed and field independence.

RESULTS

Computer Attitudes

A series of paired *t*-tests were conducted to investigate whether there were significant differences in computer attitudes between the two consecutive years when usage changes of technology products occurred. The results were summarised in Tables 1 and 2.

As seen in Table 1, older adults' computer attitudes increased significantly when older adults started to use some technology products or services. For example, older adults' interest increased significantly after they started using digital camera. When older adults started to use copier and computerized catalog in a library, their gender equality also increased significantly.

On the other hand, significant declines of computer attitudes were observed when older adults stopped to use some technological products (Table 2). When older adults stopped using home security system, their computer attitudes of utility declined significantly. Older adults' interest toward computer dropped significantly when they stopped using digital camera. Also when they stopped using DVD recorder, their computer attitudes of control declined.

For other technology products, i.e. ATM, car cruise control, car navigation system, mobile phone, computer, fax, video camera, video game, VCR, DVD player, ticket vending machine, answering machine, CD player, microwave oven, self-service gas station and IC card, significant changes in computer attitudes were not observed.

Table 1. Means and standard deviations of computer attitudes when older adults adopted technology products

Product	Variable	*n*	Before adoption		After adoption		*t*
			M	*SD*	*M*	*SD*	
Copier	gender equality	10	3.00	0.41	3.26	0.55	-2.41*
Computerized catalog in a library	gender equality	24	3.08	0.56	3.24	0.53	-2.39*
Digital camera	interest	28	3.67	0.51	3.84	0.49	-3.06**

*Note: *p < 0.05, **p < 0.01*

Table 2. Means and standard deviations of computer attitudes when older adults discontinued using technology products

Product	Variable	*n*	Before discon-tinuance		After discon-tinuance		*t*
			M	*SD*	*M*	*SD*	
Home security system	utility	11	3.76	0.35	3.52	0.32	2.95*
Digital camera	interest	9	3.64	0.53	3.44	0.58	2.68*
DVD recorder	control	10	3.90	0.37	3.60	0.31	3.31**

*Note: *p < 0.05, **p < 0.01*

Cognitive abilities

A series of paired *t*-tests were also conducted to investigate whether there were significant differences in cognitive abilities between two consecutive years when usage changes of technology products occurred. The results were summarized in Tables 3 and 4.

As seen in Table 3, older adults' spatial visualization, spatial orientation and field independence declined significantly when older adults started using microwave oven, mobile phone, IC card and ATM. Older adults' associative memory and perceptual speed increased significantly when they started using copier, IC card and computerized catalog in a library.

On the other hand, as seen in Table 4, when older adults stopped using copier, computerized catalog in library, video player/recorder and ATM, their cognitive abilities such as spatial visualization, spatial orientation and field independence increased significantly. Older adults' perceptual speed declined when they stopped using CD player.

To summarize the results above, with regard to cognitive abilities, no consistent patterns could be observed when usage changes of technologies occurred.

Tab. 3. Means and standard deviations of cognitive abilities when older adults adopted technology products

Product	Variable	*n*	Before adoption		After adoption		*t*
			M	*SD*	*M*	*SD*	
Mobile phone	spatial orientation	6	14.33	11.89	10.00	12.59	3.08*
Copier	associative memory	7	21.29	4.65	23.86	6.28	-2.47*
Microwave oven	spatial visualization	4	9.00	3.19	6.63	3.17	3.45*
Microwave oven	field independence	4	12.00	8.68	8.50	7.55	5.42*
Computerized catalog in a library	perceptual speed	8	55.13	6.85	58.50	6.44	-4.47**
ATM	field independence	5	14.00	4.06	10.90	5.66	3.82*
IC card	associative memory	12	18.08	5.20	23.00	6.62	-3.34**
IC card	spatial orientation	12	13.00	11.08	4.92	8.11	3.11*

*Note: *p < 0.05, **p < 0.01*

Table 4. Means and standard deviations of cognitive abilities when older adults discontinued technology products

Product	Variable	*n*	Before discontinuance		After discontinuance		*t*
			M	*SD*	*M*	*SD*	
CD player	perceptual speed	16	56.00	9.32	51.88	8.72	2.31*
Copier	spatial visualization	5	3.80	3.72	7.55	3.55	-3.05*
Computerized catalog in a library	field independence	8	11.84	8.86	15.28	8.60	-2.83*
Video player/recorder	field independence	15	8.22	6.46	11.72	7.27	-2.85*
ATM	spatial orientation	5	6.20	7.56	9.60	8.17	-3.47*

*Note: *p < 0.05.*

DISCUSSION

This study investigated technology usage changes of older adults over years, and relations of computer attitudes and cognitive abilities with these changes. Computer attitudes were found to have relations with dynamic changes in technology usage, as well as with usage status that has been reported in previous studies. The results confirmed attitudes as major influential factor on technology adoption of older people. Explicitly, the dimensions of gender equality, utility, control and interest were found to have relations with dynamic changes of technology adoption. These results underscore the diversity of attitude changes among different products. Jay and Wills[6] mentioned that self efficacy and comfort are two attitude dimensions targeted by the training program. In this research, dynamic changes were supposed to have occurred in their daily life environment and not necessarily with a help from interventions. This might be the reason that there were no changes observed on these dimensions.

Another important result was that significant changes in computer attitudes were observed only for the computerized technology products; when older people started or stopped to use non-computerized products, there were no significant attitude changes observed. One possible explanation is that the complexity of operation of these two groups of products and services are quite different. Even if some technologies are somehow implemented using computer-based technologies, if older adults don't have to use complicated commands and menu to control those products, they will not consider them related with computer. Then their computer attitudes might not appear to be significantly different even if they started or stopped to use non-computerized or "somehow computerized" technologies.

Cognitive abilities did not show clear relations with dynamic changes of technology usage, while they have been reported to have some relations with usage status in previous literature. One possible explanation for this could be that cognitive abilities are age-related multifaceted variables, and thus older adults' cognitive abilities might change regardless of their changes in usage of certain technology products and services. Another point we need to pay attention is that the numbers of valid sample of cognitive abilities were rather small due to the limited number of participants who agreed to participate in the measurement sessions. Thus it is still possible that we could not simply observe any statistically significant results, even if there existed some patterns. The results of this study thus should be interpreted with caution. In order to make this point clear, further investigations with larger sample and longer period should be pursued.

Finally, in this study, all examples of technology products and services were analyzed as a whole and not categorized into groups by nature. As seen in the discussion on non-computerized and computerized products and services in the previous section, some nature of the products could be important in order to better understand the adoption and discontinuance of usage of older adults. Further analysis with this viewpoint should also be pursued in future work.

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