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Curriculum Design and Program to Train Older Adults to Use Personal Digital Assistants

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Abstract

Purpose—The aim of this study was to demonstrate that many older adults can share in the potential benefits of using a personal digital assistant (PDA), including using the device as a memory aid for addresses and appointments, to improve medication adherence, and as a useful organizational tool and communication device.

Design and Methods—A curriculum, designed specifically for older adults, was developed that provided the necessary information and practice to use the technology. The degree to which the curriculum improved user skills was measured by testing participants on basic and advanced features of each of the standard PDA programs.

Results—Participants were successful in using the technology and indicated satisfaction with the medication-reminder program specifically designed to accommodate the needs of older adults.

Implications—The PDA, supported with well-designed software and well-executed training, can provide unique benefits to older adults.

Keywords

Computers; Memory aid; Personal digital assistant; Technology and older adults; Training

In this research, I focused on understanding and overcoming the barriers that would otherwise prevent older adults from gaining the benefits of using a personal digital assistant (PDA). Through careful analysis and planning, these barriers can be overcome through a training program for older adults to learn to use a PDA. This training program incorporated the best practices recommended by researchers in the field of older adult learning and computer training.

Medication adherence is a particularly challenging problem for older adults; when it fails, it results in great personal and financial harm (Alliance on Aging, 2000). As a demonstration and for comparison by study participants, my fellow researchers and I created two programs, a medication-reminder program and a survey program to gather information about the daily activities of study participants. We designed these applications to minimize hardware barriers with an improved interface that better meets the needs of older adults (see Figure 1). These changes meet the criteria established by Czaja and Lee (2001) to maximize usability of software for adults and older adults.

My goal in this article is to present an overview of the methodology for developing a successful PDA training curriculum and software usable for both adults and older adults. The research

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team evaluated the curriculum and software by recruiting, training, and testing a group of older adults who were willing to explore this new technology.

PDAs are small computers with limited capabilities that can be carried in one's hand. They currently provide all the functionality of an address book, calendar, appointment reminder, and calculator. The latest cell phone and wireless models also allow telephony, picture exchange, e-mail messaging, and web browsing. PDAs also are capable of being expanded by running new programs that add additional functionality. The PDA has the potential to greatly benefit older adults in particular, as it can act as a memory aid, organizer, and virtual assistant that can track exercise and remind the individual about appointments and medications. It also can provide a portable means of communication and, eventually, a means of convenient environmental control.

PDA Barriers

A user interacts with the operating system of a PDA by using a stylus (a pen-shaped pointer) on its screen. The user enters information by writing it on the screen. It is also possible for a user to enter information on a computer and then transfer the information, though this method was not used in my study.

There are a number of barriers that make the device particularly challenging to older adults. First, a special symbol language, Graffiti, is required; the language is similar in concept to shorthand symbols. Most of the symbols are common English letters, but some are not. This makes the initial use of a PDA challenging because some learning is required to enter new information into the device. In addition, using the stylus to enter the information takes practice to ensure that the letters and numbers are entered correctly the first time.

Screens have typically been low contrast, high glare, and difficult to read outdoors. Because of the small screen size, most programs use small lettering to put more information on the screen. These conditions are the exact opposite of what is required for universal ease in reading.

Understanding how the PDA interprets inputs and takes corrective actions is challenging for many adults. Less obvious challenges to people who are not familiar with computers include negotiating complex menu structures, becoming comfortable with technological syntax such as web and e-mail addresses, and using methods to delete or correct mistakes by using the "undo" function.

The PDA environment, though much simpler than a computer, has many of the initial challenges and pitfalls of using a computer for the first time. Although more and more older adults are being exposed to computers, those 65 years of age or older are still the group that has the least experience with computers and PDAs (Taylor, 2003).

Technology and Older Adult Learning

There are several age-related changes that affect an older adult's ability to learn in general and may create additional challenges in learning the PDA specifically. These include sensory changes, slowed information processing, demands on working memory, reductions in the effectiveness of inhibitory mechanisms, and limited attentional resources (Hasher & Zacks, 1988; Salthouse, 1991). If these changes are addressed, training can be designed to compensate for them. One approach is to address the environment, such as by reducing background noise, providing good lighting to reduce glare, and increasing font size (Charness & Bosman, 1992). Another approach is to modify the task, such as by making the task self-paced, breaking the task into its component parts, providing assistance, and allowing time for practice (Sterns, 1986).

Several research studies have designed tasks based on these principles and have found that older adults were able to learn new skills. Training has been improved for both complex lab tasks, such as learning an algorithm to square numbers, and real-world tasks, such as learning a word-processing program (Czaja, Hammond, Blascovich, & Swede, 1989; Rodgers & Fisk, 2000).

Not only is it important for older adults to learn the skills needed for computers and other related digital devices, it is also important that they be able to retain those skills and be able to use the skills in new and different situations. If older adults do not use a computer for a couple of weeks, they need to be able to remember the necessary skills they learned in training. Research shows that distributed practice, the spacing of training, and frequency of feedback can be modified to improve retention (Schmidt & Bjork, 1992).

Medication Adherence

Reduced efficiency in memory and cognition associated with aging produces a variety of negative consequences for older individuals. These changes impact a wide variety of areas such as medication adherence; recollection of appointments, addresses, and telephone numbers; driving ability; and trainability (Sterns & Camp, 1998). The PDA can provide support for higher cognitive loads or as an aid as memory abilities decrease.

Nonadherence to a medication regimen can take several forms. The individual may not follow some or all instructions, or may misunderstand or just make errors. With medication, a person may take extra doses, take doses at the wrong times in the wrong combinations, or without following special instructions for administration of the medication.

To make medication reminding easier, the developed application had to bring all required information together in one place and to make it effortless. To that end, the application presents the name of the medication, medication warnings, and dosages all together. (The current version of the software includes a picture of the pill as well.) My fellow researchers and I created a customized pillbox that attaches to the PDA to hold a day’s supply of pills. The alarm program runs in the background and sounds an alarm and turns on the screen when it’s time to take a pill. Users have the option of indicating they have taken the pill or putting the alarm to sleep for 5 or 30 min. In a 3-month use test, 93% of older adults used the medication-reminder software successfully. The effectiveness of the PDA as a medication-reminder device is beyond the scope of this article and will be the focus of a later publication. Similarly, work on activities and social networks utilizing information collected by using the survey application will also be reported elsewhere.

Method

Designing the Curriculum

The research started with the premise that older adults can achieve adequate use of the PDA’s many features. A thorough cognitive task analysis identified the skills required to achieve successful usage of the PDA. I applied known principles that aid older adults in learning to organize the training curriculum. I selected the Samsung i300 for the experiment (a) because it is a combination cell phone and PDA; (b) for its large, bright, full-color screen; (c) for its wireless Internet connectivity; and (d) for its cost (see Figure 2).

I carefully examined the Palm Operating System (PalmOS) and applications to see how they were implemented on the PDA. For cognitive task analysis (Sterns & Doverspike, 1989), I prepared a list of skills required to use the various programs and the concepts required to understand how to interact with the device. The skills were then ordered and connected to those utilizing the PDA's applications providing examples that gave immediate reinforcement and had clear utility to the participants. My fellow researchers and I took detailed notes as we explored every action and function on the PDA—turning it on, tapping icons, entering letters, using menus, scrolling, and so on. We identified skills that could be taught outside the device and skills that required using the device. We categorized skills that encompassed all programs and those that were program specific, and we used the hierarchy to build the order in which skills would be taught. We created practice activities that combined existing skills with new skills in applied and immediately useful tasks.

Procedure

We oriented the curriculum around the three training sessions; each consisted of 3 hr of training and practice. On the first day, trainers introduced participants to the device; they spent most of the day learning Grafitti, the handwriting-recognition program that requires some specialized characters. Participants used simple drill sheets to practice the letters, and then they entered them into the PDAs by using the on-board tutoring program. At the end of the first day, trainers introduced the two custom applications designed for the study: the medication-reminder program, RxReminder, and a survey application called SurveyAp (see Figure 1). These programs were designed to be universally easy to use by adults and older adults alike (Czaja & Lee, 2001).

The second day was spent on first reviewing Grafitti to provide additional practice and to ensure the necessary skills were in place to perform the next tasks. Throughout the training, we provided summary sheets to give participants an easy review of presented information. Trainers showed participants how to use the address program and the Memo Pad and To-Do List applications, and the participants explored features contained on the detail pages. In our training we concentrated on emphasizing the similarities between the interfaces and helped establish an understanding of the uniformity of features between the programs.

On the third day, trainers covered the Date Book, its many screens and detailed features, and the e-mail application SprintWeb. The training concluded with an application use test.

Throughout the curriculum, we made efforts to ensure appropriate pacing and that there was constant opportunity for questions. The trainers encouraged the older adults to help each other. The trainers also were constantly moving about the room to quickly catch and correct procedural errors and demonstrate the general gestalt of how the device worked. The trainers used a video projector and laptop to demonstrate the software using the Palm Emulator, and they provided time for extensive practice.

Participants

There were 50 training slots available over a 2-week period. Of 49 individuals, 46 (94%) participated in training; 3 canceled as a result of illness. Of the training participants, 44 (96%) older adults completed the training. All of the older adults were community dwelling and were driving or were the spouse of someone driving and participating in the study.

We asked participants only about availability (morning or afternoon, Week 1 or Week 2) and placed them in one of four 5-person (n = 17) classes or one of three 10-person classes (n =27). We assigned spouses to the same class. Most participants were female (65%), and most were Caucasian (93%). Participants varied in age from 56 to 89 years (M = 72, SD = 7.08). Participants took an average of 3.8 (SD = 2.65) prescription medications and 3.5 (SD = 2.14) over-the-counter supplements.

The group had higher exposure to technology than the average population. Most of the individuals had used computers for e-mail or to surf the Internet (76%), and about half had used cell phones (53%). Approximately 25% had no exposure to either computers or cell phones. All participants indicated an interest in learning to use a PDA.

Results

Number and Letter Entry

To test the success of the curriculum, my fellow researchers and I established a number of relevant criteria to measure success. First we hypothesized that older adults could successfully learn to enter letters, numbers, and punctuation into a PDA with a stylus. To test the hypothesis, we used a PalmOS-based game, Giraffe, to measure performance. We used scores on the letter game as a test of mastery of the Grafitti letter-and number-entry skills. We recorded the score of the first game the participants played, except in one class in which the Giraffe scores were not collected. A total of 38 Giraffe scores were reported from all of the remaining classes. The range of scores was from 14 to 508. The average score was 108 ($SD = 134$) and the median score was 53. A score over 40 indicates that individuals reached the third round of the game, in which two letters or numbers are falling at the same time. This demonstrates that the older adults, not familiar with playing the game, demonstrated in some cases dramatic successes in quickly entering data by using the stylus. A one-sample *t* test indicated that the participants' scores were significantly greater than zero ($t = 6.14$, $p < .001$).

Application Icon Recognition

We next hypothesized that participants would learn to use the PalmOS interface and by doing so would come to recognize the icons associated with key modules or programs. At the start and end of training, trainers gave participants a list of 10 icons and asked them to match those icons to the names of the applications with which they were associated. The four core applications, the home icon, HotSync, and several others were included. We predicted that, following training, participants would have a significantly higher level of icon recognition than they had at baseline.

The application icon-matching quiz is a test of familiarity with the PalmOS interface and its programs. Several individuals skipped the quiz, either at baseline or after training. A total of 34 individuals had data at both baseline and the completion of training. At baseline, participating older adults were able to correctly discern fewer than four icons ($M = 3.82$, $SD = 2.29$). A one-sample *t* *t*est ($t = 10.41$, $p < .001$) indicated that this was significantly greater than zero. On average, three or four icons were recognizable even without familiarity with the functions of the PDA. Following training, participants matched nearly seven icons correctly matched with the name of the application or module ($M =6.75$, *SD* 2.63). A paired-samples *t* test ($t =4.99$, $p < .001$) indicated that participants correctly matched significantly more icons after training than they did at baseline.

Palm Standard Application Usage

My fellow researchers and I designed the curriculum to provide the skills necessary to use the PDA regardless of age. We designed a set of tasks to test the ability to use basic and advanced skills in each of the basic PDA programs. We hypothesized that age would not predict success on the skills test. However, because intellectual ability does play a key roll in learning, we predicted that neurocognitive ability (Solomon & Pendlebury, 1998) and fluid intelligence (Cattell & Cattell, 1963) would predict the amount of knowledge acquired in training and therefore the score on the skills test. The neurocognitive subtests included time and place orientation, a short-term memory of pictures test, a draw-a-clock visuospatial test, and a name-animals timed verbal test. Fluid ability subtests included completing series, classifying (exclusion), solving picture analogies, and evaluating conditions involving spatial rotation. Finally, because students are likely to receive more attention when they are in small groups

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than when they are in large ones, we predicted that the smaller classes (5 persons) would perform significantly better on the skills tests than would the larger classes (10 persons).

Overall, 89% of participants who took the application usage test (*N* = 39 of 44) completed all four tasks with some help in the time allotted. Over one fourth (26%) completed the four tasks without a single request for help. Average requests for help were 1.33, 1.42, .88, and 1.63 for the Address Book, To Do List, Memo Pad, and Date Book test, respectively (see Table 1).

To better understand the level of mastery, we categorized participants into three groups. For each task, we identified those individuals who completed the task without help and considered them to have mastered the application required to complete the task; we labeled this group's performance *mastery*. We considered a single request for help to indicated adequate performance on the task, and we identified those individuals as *highly successful performers*. We labeled those individuals with two or more requests for help *partially successful performers*. Highly successful performance was achieved by a majority of participants for each of the four standard applications. Mastery varied from 31% for the Date Book application to 63% on the Memo Pad Application (see Table 2).

The relative contribution of the demographic, neurocognitive, and fluid measures and class size were of interest to the research team. We had an insufficient sample size to conduct a soundly generalizable regression, but we did conduct an exploratory analysis to guide future research. This analysis began with a hierarchical approach with demographics predicted to have the least effect, as we designed the curriculum to provide the skills necessary to use the PDA regardless of age. Because intellectual ability does play a key roll in learning, we predicted that components of the neurocognitive screen, fluid intelligence, and class size would relate to performance on the application usage test in ascending order. The distribution of total application usage test scores was skewed (skew = 1.41, *SD* =0.36). To achieve a more normal distribution of scores, we used the square root of the total score as the dependent variable (skew = 0.127, *SD* = 0.36).

To reduce the number of variables, we examined the bivariate correlations with the square root of the skills test score, and we selected those with a significance of .10 or smaller. Selected variables are listed in Table 3.

Demographic variables, most neurocognitive subtests, and fluid ability subtests did not contribute significantly to the prediction and weakened with each block of variables added. We found class size ($\beta = .42$, $p < .05$) and the verbal component of the 7-Minute Screen ($\beta = -.36$, $p < .05$) to be significant predictors of performance on the applications use test. The verbalization task consisted of naming as many animals as one can think of in 30 s. Because the lower the skills test score, the better the performance, care must be used in interpreting the direction of the relationships. Smaller class sizes resulted in better performance by the participants. Fewer verbalizations predicted higher numbers of help requests (lower performance) on the application usage test (see Table 3).

The research team made an attempt to analyze the types of problems encountered that lead to a request for help. No consistent pattern emerged. All participants were successful at navigating to and from the programs and the main data-entry screens, and all were successful in entering the correct data. We found few typographical errors. In general, the participants worked steadily, independently, and successfully through the challenging set of tasks. Importantly, age was not correlated with most application usage test scores or the overall test score.

Rating the Applications–User Interface

To ensure that hardware influences were minimized, the research team chose the best PDA screen and an environment that provided ideal indirect lighting. Trainers asked the older adults trained to use PDAs to rate the ease of use of each of the four standard PalmOS applications, a commercial PDA e-mail application, and the two custom applications. We predicted that the programs with enhanced interfaces would be rated easier to use than the standard applications.

Trainers asked participants to rank the applications they used on a 5-point scale (5 = very easy to use; 1 = very difficult to use). RxReminder received the highest rating, with an average score of 4.4. SurveyAp and the Date Book application received a score of 4.2. The Address Book received a score of 4.0. The e-mail client SprintWeb received the lowest score, with an average of 3.5. RxReminder was significantly easier to use than the SprintWeb program. This seems to demonstrate that modifying the interface (increasing the font size, simplifying the interface, etc.) does indeed result in software that is perceived to be easy to use (see Table 4).

Discussion

Our research demonstrated that older adults can be trained to overcome the barriers of learning to use a PDA. A majority of the participants not only were successful in completing the training but also embraced the technology and mastered the skills necessary to take advantage of the PDA's tools to improve medication adherence, as a memory aid, and as an organizer. Forty-two of the 44 individuals who completed training went on to participate in a 3-month use test. Details of those results will be reported later; however, 62% of the participants continued to use at least one of the standard programs in the PDA on their own. Only medication reminder and survey program usage were requested of the participants with 93% and 88% usage demonstrated, respectively. The use of the standard programs demonstrates that, for a majority of the participants, the skills taught in training were sustained.

The main barriers we identified that make the PDA difficult to use were generally overcome. These included learning the symbol language, reading the screen, interpreting inputs, and taking corrective actions. This was demonstrated by the success of the participants throughout the training.

Success in the use of the symbol language was demonstrated through successful performance on the Giraffe letter and number game. Entering data by writing was reported by the participants as being a more natural process than was using a keyboard, but those who did type reported some impatience with inputting data by using the stylus. However, capabilities such as beaming (transfer between two devices using infrared [IR], the same method utilized by TV remote controls) were well received, and the participants understood how quickly a large list of addresses could be acquired.

Careful choice of the hardware in combination with improvements to software designed with older adults in mind yielded the highest ease-of-use and readability ratings. Once exposed to the device, there were several individuals who found the device to be awkward and small, and the lettering difficult to use. Nevertheless, a vast majority of individuals were excited by the device and fascinated by its ability to perform so many functions.

It must be recognized that the group of older adults who participated in the study expressed and demonstrated a strong interest in utilizing technology, either because they had an interest in computers or staying current, or because they wanted to improve their medication adherence. This kind of technology will be much less novel in just a few years, and much more essential. As time advances, older adults are likely to be more like those in this study than less like them.

In the initial reviews of proposals for this study, our National Institute of Health committee reviewers stated that older adults could not use a PDA. Although only 25% of the participants were able to demonstrate complete mastery of the device, more than half of the participants were able to demonstrate successful usage on even the most difficult of the standard programs. In addition, 100% of the participants were able to use the basic features of each of the standard programs and were able to use the applications designed for medication reminding and gathering survey data. Clearly, the ability that older adults showed in this study to adapt and learn lends confidence to initiatives of the future.

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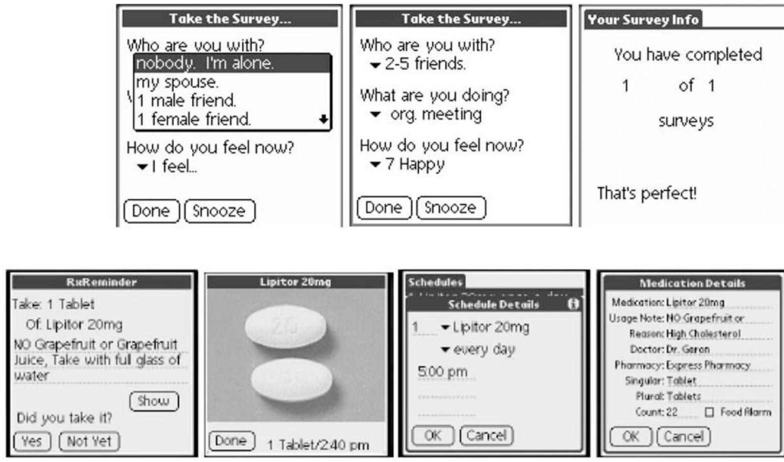

Figure 1.
In the top row are the main screens of the SurveyAp application, designed to make the PDA more usable than the typical PDA by adults and older adults. The screen illustrates the large font for easy reading and the menu of answers for easy data entry. In the bottom row are key RxReminder application screens showing a reminder with warnings and instructions, a picture with dosage and time, and a medication details page.

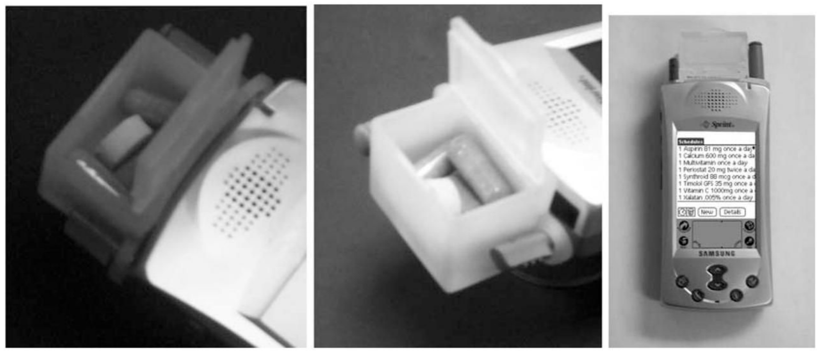

Figure 2.
The PDA Pillbox Prototype on the Samsung i300. The PDA pillbox improved access to the stylus, allowed wireless infrared transfer of information between devices, and could hold a day’s worth of pills.

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Table 1

Descriptive Statistics on Study Measures

Variable	*N*	%	Minimum	Maximum	*M*	*SD*
Technology comfort index	43	98	1.93	26	10.22	5.34
Giraffe score	38	86	14	508	109	134
Mastery test score	43	98	0	25	5.23	5.66
Address book	43	98	0	8	1.33	1.67
Date book	43	98	0	5	1.42	1.48
Memo pad	43	98	0	10	.88	1.83
Date book	43	98	0	10	1.63	2.23
Fluid IQ[a]	39	89	18	34	26.90	4.31
Completing series	39	89	0	5	4.59	.91
Classify (exclusion)	39	89	5	12	8.31	1.75
Solving matrices	39	89	4	11	8.44	2.15
Evaluating conditions	39	89	2	8	5.54	1.62
Solomon 7 minute[b]						
Orientation	43	98	0	8	.33	1.43
Memory	43	98	6	16	15.4	1.68
Visuospatial	43	98	3	7	6.4	0.88
Verbal	43	98	8	28	18.2	4.73
Icon quiz baseline	39	89	0	10	3.82	2.29
Icon quiz posttraining	38	86	1	10	6.75	2.63

Note: Mastery test score is the count of number of help requests. A perfect score is zero.

[a] Cattell & Cattell (1963).

[b] Solomon & Pendlebury (1998).

Table 2

Performance on the Application Usage Test

Performance	Mastery Performance		Successful Performance		Partially Successful Performance	
	N	%	*N*	%	*N*	%
Address book test	18	41.9	10	23.3	15	34.9
To do list test	18	41.9	6	14.0	19	44.2
Memo pad test	27	62.8	8	18.6	8	18.6
Date book test	15	30.6	12	24.5	16	32.7
Total test score	11	25.6	2	4.7	30	69.8

Notes: Mastery performance was defined as no help requests, adequate performance as a single request for help on the test, and two or more requests for help was defined as not adequate performance.

Table 3

Summary of the Three-Step, Forced Entry Multiple Regression Analysis for Variables Predicting the Square Root of Total Application Usage Scores

Variable	***B***	***SE B***	***Β***	***t***
Step 1				
Constant	−3.91	1.98		−1.98
Race	1.628	.83	.327	1.96
Age (years)	.06	.03	.29	1.75
Step 2				
Constant	−.25	2.49		−.10
Race	.92	.87	.184	1.05
Age (years)	.06	.03	.28	1.73
7MS–Verbal	−.08	.04	−.29	−2.04*
CFT–Comp series	−.26	.24	−.17	−1.09
Step 3				
Constant	−.02	2.18		−.01
Race	1.18	.77	.24	1.53
Age (years)	.02	.03	.12	.80
7MS–Verbal	−.10	.03	−.36	−2.87**
CFT–Comp series	−.21	.21	−.14	−1.01
Class size	1.13	.34	.42	3.33**

Notes: 7MS = 7-minute screen; CFT = culture fair test. Class size ranged from 5 to 10 persons. $R^2 = .56$, $F(5, 37) = 8.21$***.

* $p < .05$;

** $p < .01$;

*** $p < .001$

Table 4

Ratings of Participants Comfort and Ease-of-use for Selected PDA Applications

Question	*N*	Minimum	Maximum	*M*	*SD*
Do you use the medication reminder program?	42	0	1	.93	.261
Do you use the PDA pill box?	42	0	2	.19	.455
How comfortable are you using the medication reminder program?	41	3	5	4.39	.771
How comfortable are you using the survey program?	38	2	5	4.21	.935
How comfortable are you using the address book program?	33	1	5	4.09	1.011
How comfortable are you using the date book program?	32	1	5	4.34	.902
How comfortable are you using the sprint Web program?	37	1	5	3.32	1.156
How comfortable is holding the PDA?	42	1	5	3.64	1.032
How easy are the icons on the PDA to see?	42	1	5	3.52	1.348
How easy is the text on the screen to see in the address book program?	40	1	5	3.70	1.181
How easy is the text on the screen to see in the date book program?	40	1	5	3.70	1.203
How easy is the text on the screen to see in the medication reminder program?	41	1	5	4.02	1.193
How easy is the text on the screen to see in the survey program?	39	1	5	3.85	1.204