THE EFFECTS OF COMPUTER TRAINING AND INTERNET USAGE ON THE USE OF EVERYDAY TECHNOLOGY BY OLDER ADULTS: A RANDOMIZED CONTROLLED STUDY

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According to the skill transfer concept, people may use general technological skills to solve new problems. To test this concept, a technological transfer test was included in a randomized controlled-intervention study aimed at the causal relationship between computer use and autonomy of older adults. Older adults with and without exposure to computer training and Internet use and participants without interest in computers were administered this test. On two occasions, participants performed four daily tasks with everyday technological devices. Exposure to a novel technological challenge did not affect the efficiency of, and involvement in, other technological activities.

Being able to use modern everyday technology has become increasingly important in regard to older adults remaining autonomous. For instance, in many places public transportation tickets can only be purchased at vending machines, and money from a bank account can only be withdrawn at a cash machine. Besides this necessity to use technological applications, technological devices may also provide opportunities to increase the autonomy of older adults (McCreadie & Tinker, 2005; Zimmer & Chappell, 1999). Devices such as microwave...
ovens and microcomputers providing medication reminders can assist older adults in their everyday lives and allow them to live independently, even when they are in need of assistance.

Older adults often experience problems when using these modern technologies. It has been shown in several studies that, for instance, older adults need more time to learn to use a computer system, make more errors, and require more help (e.g., Kelley & Charness, 1995). Another example of a technological task which has been shown to be more difficult for older persons is the use of automatic teller machines (Rogers, Gilbert, & Fraser Cabrera, 1997).

Several attempts have been made to train older adults in the use of specific technological applications such as the Internet (Cody, Dunn, Hoppin, & Wendt, 1999), the use of a word processor (Charness, Bosman, Kelley, & Mottram, 1996), or an automatic teller machine (Rogers, Fisk, Mead, Walker, & Cabrera, 1996). In order to improve technological skills on a more general level, ideally, the training of a specific technological skill should generalize to skills needed under different technological demands. This use of previous experience to devise a solution for a new problem or task has been described as “problem-solving transfer” (Mayer & Wittrock, 1996). Several views on transfer have been described by Mayer and Wittrock (1996). According to these authors, in order to yield the transfer of general skills learned in one situation to a novel situation, the aim should either be the specific transfer of general skills or the metacognitive control of general and specific skills.

According to several authors (Jelsma, van Merrienboer, & Bijlstra, 1990; Sweller, 1989), the two most important cognitive processes in the successful transfer of problem-solving skills are schema acquisition and rule automation. A schema is a mental framework in which related concepts are organized in a meaningful way based on previous experience (Sternberg, 1996). Each time a problem within the domain of this schema is solved, the schema is expanded with newly acquired skills and rules. When faced with a novel problem, individuals can use existing schemata that provide analogies based on previous experience with similar problems. They do this by mapping processes to solve unfamiliar parts of the new task (Paas & van Merrienboer, 1994). In the context of older adults learning to use a new technology, this might imply that individuals acquire and expand some kind of “technology” schema, which enables them to recognize analogies between familiar and unfamiliar technological applications. As a result of this, solving a new technological problem may be facilitated. In this respect, individuals with computer experience will acquire a “computer schema” with knowledge about several concepts that
are central to the functionality of a computer system. They know, for example, that not all of the necessary options are available at once, but that specific options become available at specific levels of the menu structure. This concept is also embedded in a computer-based device such as an ATM, in which a button can be used at one level to choose the appropriate amount of money, while at the next level the same button is used to confirm the option.

The second cognitive process essential to transfer of problem-solving skills, the automation of rules, is in fact a task specific procedure. This process can provide identical elements that are helpful in new tasks (Paas & van Merrienboer, 1994). Thus, when a novel technological task consists of elements that were processed by automated rules in earlier tasks, these automated rules also facilitate solving a new technological problem. For instance, applications that are operated by using a touch screen usually have in common that the touch screen has to be touched before the main menu options become visible. Therefore, the rule “touch the touch screen to activate it” can be applied to many different applications.

Not only may newly acquired technological skills be transferred to the use of other technological devices, individuals who master some technological skills may also feel more confident in using technology in general. As a result, they start using other technological applications as well and might experience fewer problems. In research into computer anxiety for instance, where it has been suggested that computer anxiety prevents individuals from using computers (Harrington, McElroy, & Morrow, 1990; Rosen & Weil, 1995), it has been shown that positive experiences with computers may lead to decreases in anxiety (Chu & Spires, 1991). Thus, acquiring general technological skills should result in lower levels of perceived difficulties with and in a higher frequency of the use of everyday technological devices. Therefore, teaching older adults general technological skills may be an effective strategy in improving their autonomy.

Problem-solving transfer is a very promising concept in the present context of teaching older adults technological skills they could use to solve unfamiliar technological problems they encounter in everyday tasks. However, transfer seems to be a rare phenomenon in laboratory studies (Mayer & Wittrock, 1996), which is often considered one of the main problems in instructional methods (van Gog, Paas, & van Merrienboer, 2004). Also, research focusing on skill transfer in older adults is particularly scarce and most often aims at the transfer of very specific cognitive abilities or at the transfer of cognitive training to everyday problem solving. For instance, Fernandez-Ballesteros and Calero (1995) showed that training in inductive
reasoning skills and spatial orientation skills resulted in improvements in both the domain and a transfer test. Transfer of similar specific cognitive skills to measures of everyday functioning, such as everyday problem solving, were not found in an intervention study by Ball et al. (2002). Because technological performance has become an increasingly large part of everyday functioning, intervention programs aimed at increasing the autonomy of older adults should include a degree of technological performance in order to measure the impact of the intervention.

Before developing specific strategies that focus on the transfer of technological skills to novel technological problems that older adults are faced with in everyday activities, it is important to study whether this transfer can actually be achieved. Otherwise, research should focus on different approaches of reducing older adults’ problems with technology: such as, perhaps, more specific training methods or design solutions. The aim of the current research, therefore, was to study whether or not newly acquired general technological skills help older users to perform technological tasks in other areas of daily life. That is, are older adults able to apply newly acquired technological skills to new situations in which they are confronted with other technological task demands? And, do older adults report higher frequencies of using everyday technologies and fewer difficulties with this use as a result of newly acquired technological skills?

We addressed these questions in an intervention study into the impact of computer training and Internet use on the functional status of older adults. Due to the randomized design of this intervention study, we were able to study these hypotheses using a strictly controlled approach. To our knowledge, this has not been done before, as previous research on the transfer of problem-solving and other cognitive skills has mainly focused on the specificity of transfer and on educational strategies to increase the level of transfer in younger adults (Paas & van Merrienboer, 1994; Phye, 2001; Spaulding & Phipps, 1997; Speelman & Krisner, 1997; van Merrienboer, de Croock, & Jelsma, 1997).

The present intervention program provides a first opportunity to experimentally study whether older adults are able to transfer newly acquired computer skills to the execution of everyday technological tasks in a large group of participants. This study consists of three control groups in addition to the intervention group. As a result, we could separately investigate the effects of using a computer and the Internet for 12 months, the effects of computer training, and the effects of a participant’s interest in learning to use computers. The distinction between the 12-month computer use and the training
is important. This is because when skill transfer occurs, it provides information about the amount of computer experience that is required for transfer to occur. Whether participants are interested in computers and the Internet or not may also be connected to technological skills. Perhaps individuals who are enthusiastic about learning to use computers are less reluctant about everyday technology before they have actually used computers in the first place.

In accordance with the theory of problem-solving transfer, it was hypothesized that technological skill transfer would occur, and that older adults who acquire computer skills in a one-year period would show higher efficiency in several everyday technological tasks (that is, they would act faster and make fewer mistakes). With respect to the frequency of and difficulty with performing everyday technological tasks, it was hypothesized that mastering computer skills in older adults will result in an increase in the frequency of using everyday technological devices and a decrease in the difficulty older adults experience in using these devices. The frequency and perceived difficulty with these everyday technological tasks were measured by means of a structured questionnaire.

The technological tasks included in the present study were tasks that older adults are likely to be required to perform in daily life. For instance, in many Western European countries, paying for a parking ticket is in many places only possible by using a smartcard. And many companies can only be reached by telephone by means of a computerized voice menu system. In our study we wanted to know whether technological computer skills are only transferred to computer-based tasks or also to other types of technological tasks, which would mean a more general transfer. To study this process, both computer-based tasks and tasks with devices that are not strictly computer-based were included (see Table 1 for an overview of the used devices and tasks).

Many computer-related skills may be required for performance of both computer-based and other types of technological tasks. For instance, when charging a smartcard (one of the tasks used in the present study), the user receives feedback on every action. The user then has to make an appropriate response based on this feedback (e.g., when the feedback on the display tells the user to input the amount to charge it is of no use to input the PIN code or to press the OK button). The same applies to devices that are not computer-based. For example, to set the correct time on an alarm clock, the user has to keep track of information on the display to make sure of which button to press and how many times to press this button. Therefore, it was expected that teaching older adults general
computer skills will affect both computer-based devices and devices that are not directly computer-based.

The research topics that are central to this paper are relevant to the question of whether transfer of technological skills in older adults is likely to occur. If it is likely, training in technological skills may provide a solution to the problems older adults’ experience with technological applications. Transfer of technological skills would result in older adults experiencing fewer problems in using technology and being able and willing to use new assistive products. Fewer problems with technological applications would contribute to older adults maintaining an independent lifestyle in later life. If transfer is not observed, other solutions will have to be found.

**METHODS**

**Participants and Procedure**

The participants were community dwelling older individuals aged between 64 and 75. They were randomly recruited by sending invitational flyers using address information from the Maastricht city register. Individuals with no prior computer experience, both with

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Assignment</th>
</tr>
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<tbody>
<tr>
<td>CD player</td>
<td>Play song number four from this CD.</td>
</tr>
<tr>
<td>Telephone</td>
<td>Program this phone number in the memory of this phone.</td>
</tr>
<tr>
<td>Automatic teller machine</td>
<td>Withdraw the maximum amount of money from this bank account.</td>
</tr>
<tr>
<td>Train ticket vending machine</td>
<td>Buy a return ticket to the city of Eindhoven.</td>
</tr>
<tr>
<td>Microwave oven</td>
<td>Heat up this glass of water for 60 seconds.</td>
</tr>
<tr>
<td>Alarm clock</td>
<td>Set the alarm clock for 7:15 am. tomorrow.</td>
</tr>
<tr>
<td>Smartcard charger</td>
<td>Charge this smartcard with 150 Euros.</td>
</tr>
<tr>
<td>Telephone voice menu</td>
<td>Arrange travel insurance for a holiday in Spain.</td>
</tr>
</tbody>
</table>
and without interest in learning to master computer skills for personal use, were invited to respond. Participants were included in the study if they were aged between 64 and 75, considered themselves to be healthy, and were sufficiently mobile to travel independently to the research center. Exclusion criteria were prior experience with the neuropsychological tests used in this study and general mental functioning in a range suspect of a cognitive disorder (score below 24 on the Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975). Also, participants were to have no prior active computer experience and be willing to sign a form stating that they would refrain from any self-initiated computer use during the study period (i.e., 12 months). Each participant signed an informed consent form. The local medical ethics committee approved the study.

Eligible for the study were 240 individuals. These were scheduled for double baseline administration of a test battery including several cognitive tests as well as a test of technological efficiency, which will be discussed below (the outcome of the cognitive assessment is not discussed in this paper). Screened but excluded from the study because they did not meet all inclusion criteria were 126 people. The test battery was administered again to all participants after 4 and 12 months using parallel test versions. For the purpose of this paper, baseline and 12-month follow-up data were used. In addition, a questionnaire to measure both the frequency and the difficulty of performing several everyday technological tasks was administered on both test occasions.

After the baseline test procedures, participants with interest in computer usage were randomly assigned to three groups in a two-phased randomization procedure (for a schematic overview of the recruitment and randomization procedure, see Figure 1).

First, two-thirds of these participants were selected for a three-session training course in general computer and Internet skills. The remaining participants with interest were assigned to the No training/No Intervention Group. During the training, participants were instructed in three 4-hour sessions on how to use the computer and common software applications such as an Internet browser, e-mail, and a word processor. After the training, these participants were randomly assigned to the Intervention Group and the Training/No Intervention Group. To account for a possible effect of computer interest, participants without interest in mastering computer skills were assigned to the Control Group.

Participants in the Intervention Group were equipped with an up-to-date personal computer (Apple iMac) with high-speed Internet access (cable) for a 12-month period. Regular home assignments were
Figure 1. Flowchart of the recruitment procedure.
given through e-mail to promote continuous use of the computer facilities and to track down participants who made insufficient progress with respect to their computer skills. A help desk with remote support facilities was available for all questions related to computer and Internet use during the project.

All No Intervention groups were to refrain from computer use during the intervention interval of 12 months. Compliance to this agreement was again confirmed by signing a statement at the end of the study. Participants in the No Intervention groups could win one of six personal computers in a raffle at the end of the study period.

After the baseline tests, 32 participants dropped out of the program for various reasons (e.g., health problems, time constraints, private reasons). Complete follow-up data were eventually available for 204 participants. Post-hoc power analyses of the available number of participants with complete follow-up data using a medium critical effect size of 0.15 and an alpha level of 0.05 resulted in a power of 0.99 for this study (Buchner, Faul, & Erdfelder, 1992).

Measures

Technological Efficiency
To measure the efficiency of using everyday technology, the Technological Transfer Test (TTT) (Slegers, van Boxtel, & Jolles, 2005) was administered twice during the intervention study, once at baseline and once after 12 months. On both occasions, participants were instructed to successfully operate four technological devices that are commonly used in daily life (see Table 1).

On each test occasion, two of the devices that were used for testing were real life consumer devices. The other two were common, public technological devices. These were simulated on a computer that could be operated with a touch screen interface. The simulated devices were developed so that the procedures and interfaces exactly matched the original interface.

Participants received written instructions for each device. For the real life devices, the instruction sheet also contained brief directions for use (derived from the original instructions supplied with the devices). Participants were instructed that they could refer to these instructions, if needed. Participants were asked to complete the assignments as fast and as accurately as possible. The experimenter was not allowed to intervene during the task or assist the participants in any way.

The performance time (for all types of devices) of each task and the number of errors participants made before completing the task (for
the simulated devices only, because a log file of the participant’s actions was available for these devices) were used to measure the efficiency of completing the aforementioned assignments. Finally, for both administrations, an overall performance time score of the four tasks was computed on each test occasion. As the tasks were quite different with respect to the time it took to perform the assignments, z-scores were used for individual scores, which were added up to the overall scores.

Use of Everyday Technology
To measure the use of everyday technology, participants were asked to indicate the frequency with which they performed 17 specific technological tasks (e.g., sending a fax, programming a video recorder, or buying a parking ticket) and the difficulty they experienced when performing these tasks. Frequency was measured using a 5-point scale ranging from “never” to “at least once a week.” Difficulty was also rated on a 5-point scale, ranging from “very easy” to “very difficult.” Data collected at the baseline and 12-month follow-up questionnaires were used.

Two general measures of technology use were calculated. First, as a general measure of the frequency of using everyday technology, the mean frequency of performing the tasks participants stated they perform regularly was used. Second, the mean difficulty participants experience with performing these tasks was calculated. In the analyses, these measures were corrected for the number of tasks participants stated they perform.

STATISTICAL ANALYSES
Statistical analyses were performed with the SPSS v11.0 program series for Apple Macintosh. The alpha level was set at .05. To study demographical differences between the four groups at baseline, ANOVAs were conducted on the dependent variables age and level of education. Differences with respect to sex were analyzed using a chi-square test.

Effects of Intervention
Differences in performance time for each of the TTT tasks were studied using univariate ANOVAs with age, level of education, sex and the frequency of performing the particular tasks in everyday life as covariates. As the outcome of the train ticket vending machine task was not normally distributed, a log-transformation was done first.
The number of errors made on each of the simulated tasks was analyzed with the Kruskal-Wallis test, as these variables were skewed to the right.

To measure the effect of the intervention on the overall scores and both use of technology scores (frequency and difficulty), a General Linear Model (GLM) with repeated measures analysis of variance was used. Analyses were conducted with group as between-subject variable (four levels) and time as within-subject variable (two levels). Contrasts were defined to compare changes in performance over time (between baseline and follow-up) of the four groups. Age, level of education, and sex were used as covariates. And in the analyses of the frequency and difficulty scores, the number of technological tasks participants stated they perform regularly was added to the set of covariates. We specifically tested the interactions of time and group, as these interactions show whether the groups differed from one another with respect to changes over time in the dependent variables.

All analyses were repeated with only the individuals in the Intervention Group to account for the extent of computer use. In these analyses the between-subject variable “extent of computer use” had two levels: light and heavy. This variable was calculated by using a median split method on the number of hours per week participants said they used their computers at the 12-month follow-up moment. In this case the median was 7.5 hours, so participants who reported using their computers 7 hours per week or less were labeled “light users” and participants who reported using their computers 8 hours per week or more were designated “heavy users.”

**RESULTS**

At baseline, the four groups did not differ with respect to age, sex, and level of education. Baseline comparisons of participants who dropped out of the study at some point (n = 36) with participants who completed all test administrations (n = 198) showed differences in level of education (F(1, 229) = 4.13, p = .04), in the mean difficulty of performing technological tasks (F(1, 221) = 8.99, p < .01), and in the number of technological tasks participants stated they perform regularly (F(1, 229) = 23.20, p < .01). Participants who dropped out had lower educational levels, a lower mean difficulty with performing technological tasks, and performed fewer technological tasks. As regards the measures of the use of everyday technology, one group difference was found at baseline (F(3,226) = 5.167, p < .01): participants in the Intervention Group showed higher scores on the general frequency score—corrected for
the number of tasks regularly performed—than participants in the Control Group \( (p < .01) \).

**Technological Efficiency**

The mean performance times and number of errors of the four groups for all the technological tasks are listed in Table 2. At baseline, no differences between the groups were found with respect to performance time and the number of errors participants made on the TTT tasks. Also, no group differences with respect to the overall score were found. At the 12-month follow-up, group differences were present in regard to the performance time on the alarm clock task \( (F(3,182) = 3.608, p = .01) \), the voice menu task \( (F(3,178) = 6.145, p < .01) \) and the number of errors participants made on the voice menu task \( (\chi^2(3, N = 200) = 9.435, p = .02) \). Posthoc pair wise comparisons (adjusted for multiple comparisons using Bonferroni correction) showed that participants in the Intervention Group needed less time than participants in the Training/No Intervention Group to complete the alarm clock task \( (p = .02) \) and the voice menu task \( (p = .02) \). On the latter task, it was also found that participants in the Control Group were faster than participants in the Training/No Intervention Group \( (p < .01) \) and participants in the No training/No Intervention Group \( (p = .04) \). Finally, pair wise comparisons of the mean number of errors participants made on the voice menu task showed that participants in the Control Group made fewer errors than participants in the Training/No Intervention Group \( (p < .01) \).

All analyses were repeated with extent of computer use as the between-subjects factor. This was done to study whether there were any differences between participants in the Intervention group who used their computers more often and participants who used their computers less often. No differences were found with respect to the separate TTT tasks between light and heavy computer users.

GLM repeated measures ANOVA was done to study whether the intervention caused changes in a general measure of technological efficiency. For this purpose, the overall measure of the four TTT tasks at both test administrations was used as the dependent variable. No differences were found between the groups in changes on this general technological efficiency score over time.

This repeated-measures analysis was also done on the extent of computer use in the Intervention Group as between-subjects factor. In the light use group, participants used their computer with an average of 3.73 hours per week \( (SD = 1.97) \). Average use in the heavy computer group was 12.93 hours per week \( (SD = 5.46) \). It was found
Table 2. Mean (SD) performance time (seconds) and Mean (SD) number of errors for the TTT tasks and mean overall performance time scores on baseline and 12-month follow-up for the four groups

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Training/no intervention</th>
<th>No training/no intervention</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>time telephone</td>
<td>62 136.66 82.36</td>
<td>60 164.85 110.25</td>
<td>68 150.56 96.95</td>
</tr>
<tr>
<td>time CD player</td>
<td>62 202.70 93.50</td>
<td>60 239.05 109.43</td>
<td>68 202.01 106.39</td>
</tr>
<tr>
<td>time ATM</td>
<td>62 123.92 79.93</td>
<td>60 135.42 92.42</td>
<td>67 123.06 75.08</td>
</tr>
<tr>
<td>errors ATM</td>
<td>62 4.69 4.38</td>
<td>60 4.58 5.66</td>
<td>67 5.03 4.75</td>
</tr>
<tr>
<td>time train ticket</td>
<td>62 58.77 35.95</td>
<td>59 68.22 39.86</td>
<td>67 65.24 34.95</td>
</tr>
<tr>
<td>errors train ticket</td>
<td>62 0.35 0.85</td>
<td>59 0.64 1.21</td>
<td>67 0.63 1.17</td>
</tr>
<tr>
<td>overall score</td>
<td>62 -0.37 2.85</td>
<td>59 0.67 2.96</td>
<td>67 -0.07 2.57</td>
</tr>
<tr>
<td>12-month follow-up</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>time microwave</td>
<td>58 39.34 18.21</td>
<td>49 49.86 36.07</td>
<td>55 48.16 27.91</td>
</tr>
<tr>
<td>time alarm clock</td>
<td>58 90.42 45.91</td>
<td>49 121.50 55.67</td>
<td>55 111.20 62.23</td>
</tr>
<tr>
<td>time smartcard</td>
<td>58 87.72 40.85</td>
<td>49 105.37 61.39</td>
<td>55 88.58 39.55</td>
</tr>
<tr>
<td>errors smartcard</td>
<td>58 1.76 1.86</td>
<td>49 1.98 2.46</td>
<td>55 1.47 1.65</td>
</tr>
<tr>
<td>time voice menu</td>
<td>58 181.41 35.22</td>
<td>48 202.65 48.06</td>
<td>55 192.15 37.90</td>
</tr>
<tr>
<td>errors voice menu</td>
<td>58 0.90 1.37</td>
<td>48 1.13 1.45</td>
<td>55 0.91 1.18</td>
</tr>
<tr>
<td>overall score</td>
<td>58 -0.83 2.27</td>
<td>48 0.96 3.46</td>
<td>55 0.13 2.38</td>
</tr>
</tbody>
</table>
that heavy computer users did not show different patterns of change with respect to general technological efficiency compared with light computer users.

**Use of Everyday Technology**

GLM repeated-measures ANOVA was done for the general frequency of everyday technological tasks and the general difficulty with everyday technological tasks. The mean frequency and difficulty for these tasks are shown in Table 3, as well as the mean number of devices that the participants in the four groups used during the study. It was found that there were no differences between the four groups with respect to changes over time in respect of both measures.

The same analyses were done with extent of computer use in the Intervention Group as the between-subjects factors. Again, the results showed no significant differences in changes over time with respect to frequency of and difficulty with everyday technological tasks between heavy and light computer users.

**DISCUSSION**

The first aim of the present study was to determine whether older adults who mastered personal computer skills showed evidence of skill transfer to other everyday technological tasks. The results did not support this hypothesis: no effect of the intervention was found in the efficiency of using everyday technological devices, both
computer-based and other types of devices. Hence, transfer of newly acquired computer skills did not occur.

Some group differences were found with respect to performance of the TTT tasks that were administered after the intervention. At baseline no differences were found. Actually, at baseline, the Intervention Group showed the fastest mean performance time on two out of four tasks (though not statistically significant), and at follow-up, this group showed the fastest performance time on three out of four tasks (statistically significant in two of the tasks: the alarm clock and the voice menu task). This might reflect a trend towards an effect of the intervention. However, for both the alarm clock task and the voice menu task it was found that the Intervention group outperformed the Training/No Intervention group, but not the other two groups. This difference can, therefore, not be considered a direct effect of computer use. In case of a robust effect of intervention, group differences between the Intervention Group and the No Training/No Intervention Group and the Control Group should also have been present. Visual inspection of the data showed that participants in the Training/No Intervention group almost consistently needed more time for all of the technological tasks compared with the other groups. Therefore, the group differences in performance time after the intervention are most likely considered to be chance findings.

One group difference was found with respect to the number of errors that was made on the separate TTT tasks. Participants in the Control Group needed the fewest steps to complete the voice menu task. Again, in case of a transfer of newly learned computer skills, it is not expected that participants in the Control Group outperformed participants in the Intervention Group or the Training/No Intervention Group.

In line with the aforementioned results, with respect to the second aim of this study, no effect of intervention was found on either the frequency of or the difficulty with performing everyday technological tasks. In other words, older adults who have mastered personal computer skills and gained computer experience for 12 months do not show higher frequencies or fewer difficulties in the use of everyday technological devices.

Summarizing, no evidence was found that transfer of technological skills to the efficiency in performing everyday technological tasks occurred as a result of the intervention. In terms of problem solving transfer, we have found that although older adults in this study most probably acquired and expanded a schema with respect to using a computer, they were not able to use this schema when confronted
with other, and in many respects quite similar, technologies. The same applies to the process of rule automation. After using a computer and the Internet for 12 months, which we were able to monitor by means of the response to our regular e-mail assignments sent out to the participants in the Intervention Group, it is highly likely that the participants automated at least some common computer-related rules. Apparently, the participants were not able to apply these rules to the use of everyday technologies. Finally, gaining general computer skills has also not encouraged our participants to use everyday technological devices more often, and they still experience equal amounts of difficulty with these devices.

Because the present study did not show any transfer of computer skills to the execution of everyday technological tasks, teaching basic technological skills is not an effective strategy for increasing the efficiency, frequency, and ease of use of everyday technological applications for older adults. Therefore, future research should aim at identifying and developing other types of strategies to improve older adults’ execution of everyday technological tasks. One such strategy may be a more specific training method instead of teaching general technological skills. Another strategy could be to design solutions that take older adults’ capacities into account. There could also be an approach with a focus on technology generations (Docampo Rama, 2001) since individuals in older generations gained most of their technological experience at a time when technology was typically represented by electromechanical devices. Nowadays, technology is more represented by display-based and menu-structured items. Finally, there may be a role for psychoeducation. For instance, it has been suggested that general anxiety and the way people relate the requirements of technology to their own capacities (or perceived behavioral control) prevent individuals from using computers (Hone, Graham, Maguire, Baber, & Johnson, 1998; Morris & Venkatesh, 2000). Therefore, education that aims at reducing these psychological obstacles older adults face when adopting new technologies may prove to be of value.

The major strength of the present study is the ecological validity of the Technological Transfer Test. As real life tasks and technological devices were used, we were able to study participants’ performance of tasks they are likely to encounter in their daily life in a large group of older adults. It was not possible to administer the exact same test twice to the same participants because of learning effects, which were expected to be quite large. We have tried to solve this by designing eight different technological tasks that were balanced over the two measurements with respect to expected experience and difficulty with
the particular devices, as no validated instruments were available from earlier research. In total, eight tasks were included, to represent a broad domain of everyday technological tasks and to provide parallel test administrations to enable us to administer pre and posttests to assess the effect of both 12-month computer use and computer training in a large group of older adults.

The fact that we have not found any transfer of newly acquired computer skills to performance of everyday technological tasks may imply, as was explained above, that the theory of skill transfer does not work with respect to technological skills. On the other hand, there may also be other reasons for the lack of transfer in the present study. A first explanation is that the basic computer skills that were acquired by participants in the present study are not sufficiently similar to the skills required by the technological tasks. However, this is not very likely because mastering computer skills would probably cause an expansion of the technology schema of the participants and, thereby, result in more available skills and rules to solve other problems. In addition, most of the technological applications today require actions that are almost identical to those required when using a personal computer (such as pushing a button on screen). A possibility in this context is that people did not recognize the analogies between using a computer or the Internet and other applications, a problem that is mainly observed in situations of transfer between different domains and superficially different analogs (Catrambone & Holyoak, 1989). As a result of this lack of noticing analogies, participants in this study may not have been able to use their computer schema and to apply automated rules gained when using their computers. However, it was not possible in this study to determine whether participants made any analogies between the TTT tasks and their computer-related skills. An aim for future research, therefore, may be to explore this question further and develop strategies to help individuals recognize similarities between elements of novel and familiar technological tasks.

Another explanation for the lack of transfer is the fact that the everyday technological tasks were identical to real life tasks and, therefore, not entirely new for all participants. That is, to solve the TTT tasks, participants who were already familiar with these tasks used their own existing strategies and were not inclined to transfer any new skills. On the other hand, gaining relevant technological experience, such as computer skills, should also help individuals who have some experience with the tasks at hand because these skills enable them to work more efficiently. This is supported by the fact that our analyses were controlled for the experience participants already had with the separate
TTT tasks and by repeating the analyses with only those participants who had never performed the tasks. These procedures did not change the pattern of observed effects (\(n = 133\) for the telephone task, \(n = 36\) for the CD-player task, \(n = 14\) for the ATM task, \(n = 146\) for the train-ticket-vending-machine task, \(n = 53\) for the microwave oven task, \(n = 73\) for the alarm clock task, \(n = 144\) for the smartcard task and \(n = 127\) for the voice-menu task).

In conclusion, the mere acquisition of computer and Internet skills is not a successful strategy for obtaining transfer of technological skills essential to everyday independent functioning in later life. Research in this area is very scarce, and because the present study in a large group of participants did not yield any evidence to suggest that transfer of technological skills actually occurs, we feel that more research should be done to develop efficient methods to improve technological efficiency. Also, it may be worthwhile to outline possible conditions under which transfer of technological skills in older adults does occur. For instance, future research may focus on more generic technological skills that underlie many technological tasks and on the psychological barriers that might lie beneath problems with technology. Also, the question of whether older individuals recognize analogous aspects of technological problems, which is essential to the transfer of skills and rules acquired in earlier problems, should be considered more specifically in such studies.

REFERENCES


