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SUPPORTING THE DESIGN OF ELECTRONIC DEVICES FOR SENIORS

C. Bruder, H. Wandke and L. Blessing

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1. Introduction

With an ever increasing aging population there is a necessity for considering senior users when designing devices. In general, multifunctional devices, such as mobile phones, have not been designed with seniors in mind and are usually difficult for them to use [Ziefle & Bay 2005].
Additionally, electronic devices with an increasing number of functions appear on the market. This poses new challenges on users, who often do neither recognize nor realize the existence of possible actions. The handling of the system becomes a problem.
Designing a usable electronic device, such as a mobile phone, for seniors may appear to be straightforward. Combining a large display with high resolution, a small subset of big buttons, and a small set of functions seems to be the solution. However, the design process involves much more than a mere adjustment of input and output features and selection of functions. The complete interaction between user and device has to be addressed. Human-technology interaction (HTI) is the study of interaction between users and technology. The interaction process between users and computers occurs at the user interface, which includes both hardware (i.e. input and output features) and software (i.e. determining which functions are implemented and how these are presented to the user on a screen).
This paper presents our research project investigating how the software of multifunctional devices, exemplified by mobile phones, can be designed to support their daily use by seniors. After an overview of age-related cognitive changes we draw conclusions for senior-technology interaction. We describe an exploratory interview study with senior mobile phone users and present the results. The aim was to obtain an impression of senior users' interaction behaviour. A discussion of design principles which can be applied to interface design for multifunctional devices follows. The paper finishes with an outlook on further research intended in this project.

2. Background

When designing human-technology interaction for seniors, knowledge about their behaviour while interacting with electronical devices is needed.
Generally, aging is associated with a decline in sensory and motor performance as well as cognitive basic capacities [Verhaeghen & Salthouse 1997]. For instance, Freudenthal [2001] found that seniors in comparison to younger adults performed slower in an information retrieval task which required searching in a hierarchical menu structure. In general, age related decline of performance regards specifically speed oriented and simple tasks [Salthouse 2000]. In comparison, complex cognitive tasks which are based on knowledge and experience are less associated with age related declines [Salthouse 2004].

Moreover, senior users differ from younger ones as to their experience with interactive systems [Poynton 2005]. For example, handling a hierarchical menu structure relies on knowledge about interaction techniques taken from desktop computers - such as multiple mapping - that are unfamiliar and confusing to less experienced users. Senior users differ from younger ones as to their computer-related self-confidence [Marquie, Jourdan-Boddaert &, Huet 2002].
An important matter is how seniors manage their daily lives in spite of declining abilities. Baltes [Baltes & Baltes 1990] provides an explanation for this antagonism between multiple declines and daily well-being: the SOC (selective optimization with compensation) approach (Figure 1). SOC is based on the premise that successful individual aging is a process involving three components: selection, optimization, and compensation.

Figure 1. SOC approach of Baltes [9]

The selection mechanism consists of limiting personal goals by focusing resources on specific life domains. Optimization is based on intensive exercising. Additionally, optimization results in handling which requires more time in order to assure good performance. Compensation focuses on the use of tricks and strategies to compensate for the loss of resources and capacities.

3. Research idea

Our research project attempts to apply the optimization and selection mechanisms to human-technology interaction, exemplified by mobile phones. We suggest that seniors use SOC mechanisms while interacting with multifunctional devices, such as mobile phones. Therefore, it is assumed that these mechanisms can be used to design multifunctional devices for senior users to make up for changes in mental abilities and to enhance computer experience. In the long run multifunctional devices such as mobile phones should be designed to support SOC mechanisms and even to take over selection processes from users by interactive training and adaptive functionality.
When seniors optimize their performance by extensive practice, what is the best way to satisfy their need for training? Knowledge about seniors' learning strategies and their difficulties in handling mobile phones will help to design instructions and training. Therefore, one topic of the presented interview study was how the seniors become acquainted with their first, as well as their current mobile phone.
When seniors select a subset out of offered options and focus their mental resources on this subset, how can they be supported in this process? A starting version of the user interface could block off all the functions they do not needed for the basic tasks. Depending on the experience and demands of the user, the provided number of functions may increase step by step. Literature provides evidence that adaptive (technology-initiated adjustment) and adaptable (user-initiated adjustment) user interfaces are able to support inexperienced users in learning the interaction principles with an interactive system [McGrenere & Moore 2000]. Knowledge about the functions needed in a starting version is required. Therefore, the interview study provides an insight into functions used by seniors. Additionally, senior users were asked to appraise the opportunities and challenges of adaptive mobile phone user interfaces.

4. Interview study design

We conducted an exploratory study to receive an impression of senior users' interaction behaviour. This study consisted of semi structured interviews combined with tasks concerning the handling of their mobile phone. Aim was to obtain information about approach and performance senior mobile phone users.
Senior mobile phone users (n=20) aged between 58 and 80 were interviewed (Table 1). They were recruited from a test person database of the Technical University Berlin, with placards, or asked by

colleges. The interviewed seniors have owned mobile phones for a period varying from half a year to ten years. Eleven participants were experienced in handling computer programs, like a word processor or an internet browser. The participants had more experience with internet and computers than their peers average of German Seniors [TNS infratest 2005].

Table 1. Description of sample (n=20)

age (years):	58 – 80 (median 68)
sex (m = male, f = female):	m = 9, f = 11
use of computers (y=yes, n=no):	y = 11, n = 9
use of mobile phones (years):	0,5 – 10 (median 5)
use of different mobile phones (number):	1 – 7 (median 2)

At the beginning of the interview, the participants were asked where, when, and why they bought their mobile phones. They reported on their approach to becoming acquainted with their first, as well as their current mobile phone. They were also asked in which situations they usually use their mobile phones, which functions they exercise and which experiences they have had with it. Senior participants were also interviewed about their opinion about adaptive user interfaces.
To obtain an impression of the participants' performance in handling mobile phones, seventeen out of twenty participants had to perform some tasks with their mobile phone. Two participants were interviewed via telephone. One refused to do the tasks. The interviewed seniors were asked to solve four tasks with their own mobile phone. For example, they had to read a missed call from the record list and enter the interviewer's number in the phonebook of their mobile phone. A score was defined to quantify the performance of the participants. The score ranges from one (low performance) to five (high performance) and is calculated on the basis of performed steps and correctly performed tasks. Based on this score, interview data and user performance were correlated in order to obtain an impression of the participants' performance in handling mobile phones.

5. Results

The results give a first insight into the subjective reasons for buying a mobile phone, approaches to become acquainted with handling mobile phones and exercised functions.

5.1 Reasons for buying a mobile phone

Asked in the interview why they bought their current mobile phone, participants (n=20) answered that they had wanted to communicate with the family (9), to feel safe in every situation (7), to be connected with their friends (11), and be reachable by phone (8).

5.2 Approaches to become acquainted with mobile phones

All participants were asked to report about their first steps after opening the packaging of their mobile phone. The main strategy was to read the manual (9). This is done to become familiar with the handling the mobile phone and the functions. Alternatively, some participants tried to use it without any help (5), some were briefed by friends (4) or got help from the shop assistant (2). Almost every interviewee practises the handling of the mobile phone (19). As presented in Table 2, results show that the interviewees use different strategies; which strategy is preferred depends on the experience with multifunctional devices, and correlates with performance in handling them.

Table 2. Strategies in becoming familiar with new phones depends on users' experience and performance (n = 20)

strategies	used strategy (n)	computer use (n)	performance (score, n=17)
read manual and practice	9	5	5,00 (max. score)
first try without help, then manual	5	4	4,75
briefed by friend	4	2	3,75
shop assistant explained	2	0	3,00 (medium score)

Less experienced senior users (mainly those not familiar with computers and with low performance) neither read the manual nor tried without help, rather they asked friends or a shop assistant for help. Asked why, they state that unknown technical terms, incomprehensible explanations, too many technical details and insufficient orientation to users' perspective complicated the understanding and frustrated them.
Many participants (n=14) mentioned the need for good manuals, which would be characterized by:

- complete and step-by-step description on what to do for every basic function (12)
- short introduction for novice users (6)
- pictures and diagrams (4)
- explanation of every action with corresponding changes in display (4)
- explanation of basic and special functions separately (4)
- use of the same starting point for all explanations (3)
- explanations of displayed symbols (2)

5.3 Exercised functions

A set of questions were posed on the functions of mobile phones that are used as well as those desired by senior users. For all main functions offered by mobile phones, the participants were asked:

- Does your mobile phone offer function X?
- Have you ever tried function X?
- How often do you use function X?
- Do you want to have function X on your mobile phone?

Table 3 presents an overview of the results, illustrating how important the different functions are for senior users. Table 3 shows that the telephone directory, the calling lists and short messages are the most frequently used functions. Nearly all participants reported that a telephone directory, calling lists, short messages, a mailbox, a clock, games, and a calculator are implemented on their current mobile phone.

Table 3. Frequencies of self-reported offered, tried, used and desired functions (n = 20)

function	is offered	was tried (n)	is used (n)	is desired (n)
telephone directory	20	18	15	18
calling lists	20	12	11	14
text messages	20	17	11	16
mailbox	18	13	9	11
clock	17	8	5	9
organizer	13	5	3	4
camera	4	3	2	4
voice recorder	4	4	1	7
calculator	16	6	1	1
games	16	1	0	0
Internet	7	3	0	4

The percentage rate of use is calculated by comparing frequencies of offered and used functions together. The majority of participants use functions which are linked to communication tasks: 75% of participants reported to use the telephone directory, 55% the calling lists and text messages, 50% use the mailbox. Less participants use supplementary functions such as clock (29%), organizer (23%), voice recorder (25%) and calculator (6%). Nobody uses games or internet.
Participants also reported to practice some tasks daily: telephone book (60%), keyboard lock (40%), calling lists (35%) and text messages (25%).
The subset of functions which, according to the participants, should be offered by an ideal personal mobile phone is shown in Table 3. Telephone directory, text messages, calling lists, mailbox, clock,

and voice recorder are the most desired functions. Compared with used and desired functions, nearly all participants state that they need neither a calculator nor games.
Finally, the participants were asked for an appraisal of adaptive functionality. For this purpose they were given different descriptions of plausible futures (scenarios). Scenarios provide an insight into potential technological solutions. Two different kinds of adaptive user interfaces were described:

- Obtain context sensitive support by pushing a help button and
- Possibility of deactivating and activating functions.

Fourteen participants prefer a mobile phone with context-sensitive help over a device without support. Eleven participants reported that they sometimes forget how to handle a function they do not need very often. These participants expect help in such situations from a context-sensitive support. Seventeen participants look upon adaptive functionality favourable. By blocking functions, participants demand that:

- the menu structure becomes easier,
- the efficiency of handling increases,
- the risk for selecting false menus is reduced and
- the load on users' memory is decreased.

Some participants express the idea that the mobile phone initiates an installation process, which guides the user to block or activate functions. This seems to result into a mixture of adaptive and adaptable techniques.
Limitations have to be taken into account when conclusions are drawn from statements obtained by an interview study,. On the one side, interview studies allow questioning to be guided as needed and allow clarification of points that are unclear. On the other side, interview data are influenced by possible feelings of embarrassment, lack of knowledge on the topic, memory loss or confusion. The sample size chosen is adequate for the interview study, but, referring to the diversity of senior users, it is possible that the selection is not representative

6. Conclusions

Several suggestions can be derived from the results of this study. Senior users should be integrated into the design process. In case of manuals, seniors could help to define basic functions and make the explanations more understandable. For example, the approach of the research project SENTHA (Everyday Technology for Senior Households) was to work not just for, but in cooperation with seniors [Elsner & Blessing 2002]. Seniors participated in various steps of the development process. Not only devices but also instruction manuals were tested together with the Senior Advisory Board.
The results of he presented exploratory study allow suggestions for improving the process of familiarization with new multifunctional devices. Moreover, the statements of the participants give ideas for designing the starting version of an adaptive mobile phone user interface.

6.1 Supporting optimization of senior users

As mentioned before, seniors optimize their performance by extensive practise [Baltes et al 1990]. The results give clues in support of senior users' need for training. Summarizing the seniors' critics and statements about manuals, a complete step-by-step explanation of required actions is needed. While reading manuals, many senior users practise every function extensively. In doing so, they prefer task-oriented descriptions augmented by feedback from the display. They expect help from pictures, which should illustrate buttons that have to be pushed and are associated with changes in the display.
Ogozalek [Ogozalek 1994] suggests that written instruction manuals are not the best way to support users while practising. Providing video-based training is a better way to help senior users. It offers environmental support for the learner by explicitly demonstrating the task sequence and visualizing actions [Fisk & Rogers 2000]. Using e-learning as interactive training is another way to support seniors to learning to handle multifunctional devices. Through interactive training, feedback is given to guide the attention to important aspects, and to support the understanding of the link between actions, changes in display, and aimed functions. Literature shows that senior users will perform with electronic devices comparable to younger who have undergone an appropriate training [Baldi 1997].

6.2 Applying selection mechanism to user interface design

As noted above, seniors reduce mental load by selecting a subset of goals and focussing their resources on it. The statements reported in the interviews help to select functions to design an adaptive training application for inexperienced seniors. Senior users like the idea of adaptive functionality. From an adaptive functionality, participants expect that the menus will be less complex than that of the current user interface. This is in line with the interfaces used by Carroll and Carrithers [Carroll & Carrithers 1984] and McGrenere [McGrenere et al 2000]. They used interfaces which blocked off all the functionality that is not needed for simple tasks. This was done to support novice users in accomplishing tasks. They performed faster and with fewer errors than novice users using the full version.

Concluding from which functions are offered, which are used and which are desired, a starting version has to be designed, which provides the most frequently used functions. The starting version offers the main functions of telephone directory as well as allows to receive calls. Calling lists, text messages and mailbox are also important for senior users and will be offered step-by-step in adjusted versions of the user interface. Games and calculator are not needed. Hints for designing the adaptation process can also be inferred from the interviews. A combination of interactive training and function blocking seems promising. Another option is that users initiate an application which helps them to block unneeded functions. Moreover, most participants like the idea of context-sensitive help.

7. Further research

The aim of further research is to develop and evaluate design principles for an interactive training applicaton. Research is intended to give users an interactive e-learning application which users can use hand-in-hand with manuals to enhance their understanding of the device. A prototype of an interactive e-learning application integrated in a mobile phone is developed. This will be done to support senior users to acquire and consolidate basic knowledge on how to handle mobile phones. Moreover, written manuals will be improved by implementing the statements of the interviewed seniors about manuals.

Further research is intended to compare different kinds of interactive training applications with the improved written manual. A Wizard-of-Oz experiment is planned to research these versions of training interfaces. In a Wizard-of-Oz experiment, the subject interacts through an interface with a human "wizard" simulating the behaviour of a system [Bernsen, Dybkjær, & Dybkjær 1998]. The Wizard-of-Oz methodology is commonly used to investigate human-computer interaction in systems under development. With the planned experiment it will be investigated whether and how an adaptive training interface supports user groups of different ages in learning the handling of electronic devices.

The article emphasized that designing training interfaces for seniors is not an easy task, but poses a sophisticated challenge. Two approaches are presented to improve seniors' performance in handling multifunctional devices. Training supports knowledge acquisition and a gain in experience. Complexity is reduced by adaptive training interfaces which are tailored to the characteristics of seniors. It is obvious that these design principles are also qualified to support all users regardless of age.

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Carmen Bruder, Dipl.-Psych.
Graduate PhD Student, prometei training research group
Technical University of Berlin, Center of Human-Machine Systems
Jebensstraße 1, D-10623 Berlin
Tel.: 004930 314 29636
Fax.: 0049 30 314 72581
Email carmen.bruder@zmms.tu-berlin.de