

# 3 x 7 Usability Testing Guidelines for Older Adults

Paula Alexandra Silva  
 Fraunhofer AICOS  
 Rua do Campo Alegre 1021  
 4169-007 Porto, Portugal  
 paula.silva@fraunhofer.pt

Francisco Nunes  
 Fraunhofer AICOS  
 Rua do Campo Alegre 1021  
 4169-007 Porto, Portugal  
 francisco.nunes@fraunhofer.pt

## ABSTRACT

There is a large amount of literature on usability tests and guidelines, giving advice on how to plan, conduct, and analyse usability tests in various contexts. However, when it comes to usability for elderly people, little is known on how to prepare and set up such tests. Older adults are a growing user group for technology, and usability for them is of particular importance since they often feel handicapped when interacting with technology developed by young people for young people. Elder people are a special user group who have specific requirements on technology and the interaction with it.

The research presented in this paper is based on work performed in the frame of the European project eCAALYX – Enhanced Complete Ambient Assisted Living Experiment. This paper focuses on how the authors conducted usability tests with older adults. From the experience gathered running these tests, the authors derived a set of guidelines on how to run usability tests with and for older adults. These guidelines are the main contribution of this paper and are presented in three groups of seven guidelines each. The first group includes guidelines to enhance user drive and control; the second refers to the test settings and preparation and the third presents considerations on care, communication and listening.

## Categories and Subject Descriptors

H.1.2 [User/Machine Systems]: Human factors; Human information processing; H.5.2 [User Interfaces]: User-centered design; H.5.m [Miscellaneous]: HCI

## General Terms

Experimentation, Design

## Keywords

Human-Computer Interaction, Usability Testing, Older Adults

## 1. INTRODUCTION

Human-Computer Interaction (HCI) is the discipline that studies the quality of the interaction between humans and technology [11]. In that context, the main goal of HCI professionals is to create products that are useful, usable and used [11].

Regardless of the specific domain of application, there is a number of common HCI methodologies, such as User-Centered Design (UCD) [30] and Participatory Design (PD) [20] which aim is to support and guide the development of user interfaces. The main difference between these two methodologies has to do with the involvement of the end-users in the process. While PD implies the active involvement of the end-user since the beginning as equal partners of the design team, UCD pays attention to the users, however may never require their active involvement [36]. The basic principles of UCD are [8]: i) analyse the users and task; ii) design and implement the system iteratively through prototypes of increasing complexity; and iii) evaluate design choices and prototypes with users.

UCD is well documented when it comes to mainstream users, however the same cannot be said for children or older adults [10][17]. In fact, research involving older adults tends to focus on age related changes and their potential impact on user interfaces [5][7][9][14][15][35] with others studies covering the relation between technology and the older adult [7][14][16][26][29][18].

There is also some research on how to drive requirements elicitation with and for older adults [38] [28] and work from Newell et al. on how to use theatre to evaluate very early prototypes for older adults [28]. Focusing specifically on usability evaluation with older adults, there is the work of Dickinson et al. [10], which presents methodological and organisational advice on how to recruit and run usability tests with older adult users. Nevertheless, studies on how to design and perform usability evaluation with and for older adults are scarce and therefore are the focus of this paper.

The work presented in this paper was developed in the scope of the eCAALYX project (Section 3) and find their backdrop in the work of Dickinson et al. [10]. The main outcome of this paper, which concern usability testing guidelines on how to design and perform usability tests with and for older adults were derived from the experience with the eCCALYX project only. These guidelines are not only aimed at experi-

enced practitioners. They consist of a tool to aid professionals that either are less knowledgeable of this particular type of audience or are inexperienced with usability testing: for these, the guidelines presented in this paper consist of quick start list of recommendations on how to run usability tests with and for older adults.

The organisation of this paper is as follows: Section 2 briefly describes the importance of prototyping and usability testing; Section 3 presents the eCAALYX project; Section 4 details our test settings; Section 5 introduces the guidelines on how to design and perform usability evaluation with and for older adults – our main contribution; Section 6 reflects on the effects of usability tests in the participants; Section 7 presents the discussion and future work; and Section 8 the conclusions for this work.

## 2. PROTOTYPING AND EVALUATING USER-INTERFACES

Usability testing aims at ensuring that a product is easy to use by its intended audience [23]. It can be performed: i) later in the product development cycle, to test the validity of the built system, and/or ii) iteratively, guiding the addition of features to a system informed by the tests.

Typically, while performing usability tests, users are presented with a prototype of the system and asked to complete a set of tasks that the system will perform. Monitoring this process enables the practitioners to collect rich information and feedback about the user interfaces and the quality of interaction these provide to the user. The knowledge gathered during this process is then fed into the product.

Prototypes can be, for example, software or paper-based [13]. Paper is a medium that makes it particularly easy to explore the design space and introduce changes in the designs at will [25]. As a result, it reduces the design team's commitment with designs and the time spent implementing early decisions. Paper prototypes also enable design teams to start usability testing very early in the design process therefore solving problems before the design is implemented [1][8].

The focus of this paper is not so much on the usability testing technique itself, but on some differences that were detected when applying this technique with older adults. For more information on usability testing refer to [8][11][13][23][39].

## 3. ECAALYX PROJECT

The eCAALYX project is part of an effort of the European Commission's AAL Joint Program to create a complete solution that improves the quality of life of older adults with chronic conditions by monitoring their health and by improving the communication with their caretakers. In this context, the authors of this paper are responsible for designing the user interface of the TV system that will be used by the older adult. This TV system, placed at older adults' home, should enable a patient inexperienced with computers to: i) communicate with caretakers, ii) check health condition and iii) receive reminders for medical appointments and to take medication. The user interface dialogues developed for each of these functionalities were the ones that

were evaluated during the usability testing, as described in Section 4.2.

The goal of eCAALYX is not only to detect and monitor risk situations, but also to educate the patient in order to avoid risk situations. Specifically, eCAALYX's addresses problems caused by six chronic conditions that can impact the older patient's health severely. These are: i) cardiovascular disease (heart-failure), ii) chronic obstructive pulmonary disease (COPD), iii) diabetes mellitus type 2, iv) arthritis, v) dementia and vi) chronic wounds.

The eCAALYX project is currently on its first of three years and this paper derives from the knowledge gathered during the first year. Previous work [31] reports on how the authors employed User Research and Personas to elicit the TV system's requisites. This paper focuses on how the authors conducted usability tests with the target users. From the experience running these tests the authors derived a set of guidelines on how to run usability tests with and for older adults.

## 4. RECRUITING USERS AND PERFORMING USABILITY TESTS

UCD (see Section 1) recommends the evaluation of design choices and prototypes with end-users. This section describes how the authors recruited the participants of this study and how usability tests were designed and carried out.

### 4.1 Recruiting Users

Recruiting participants is sometimes challenging, especially if the target audience is very specific [24]. In such cases, the system should be tested with users who have similar age, education, social background and interests to the target users [12].

The eCAALYX's project intends to support a number of specific diseases. On the one hand, this variety posed the authors with a difficult issue, since it is hard to find a large group of test users with all the above-mentioned diseases. On the other hand, concepts such as the ones related to arterial tension and diabetes, are almost common sense and can be understood by individuals without chronic conditions. For this reason, the authors opted to work with a diverse group of older adults.

There was a number of available options concerning where to recruit user from: i) a health institution (e.g. a hospital); ii) a senior's association (e.g. senior's university); iii) a nursing home or iv) a day care centre. A hospital would probably raise ethical and confidentiality issues and the recruiting would probably be done on a one by one basis. The senior university would give access to older adults that usually have a higher academic level, a fact that might bias the study. The nursing home would be a good option, however their users do not manage their health autonomously as the project requires. Day care centres are places that welcome seniors during the day. These seniors are independent, maintain their active life and live at their own homes. In this particular setting, the confidential issues are less noticeable and the academic level is diverse.

From the options available for recruiting test users, the authors chose the one of the day care centre, since this option was the one that best fitted the project requirements. The day care centre selected for this particular project was located in Oporto and had 31 daily attendees. The approach to the centre was enabled by the cooperation of a group of social education interns from the Paula Frassinetti's School of Education (ESEPF). These students were responsible for planning the activities<sup>1</sup> for the older adults; usability testing was included as one of these activities and therefore ESEPF interns acted as intermediaries between the older adults and the authors.

From a group of 31 individuals, fifteen (only one male) agreed to volunteer for the usability testing. Ages varied from 54<sup>2</sup> and 92 with the participant's average age being 79. Older adults originated from a variety of backgrounds and past professions (e.g.: craftsman, farmer, housemaid, moderator of psychometric tests, nurse, nurse assistant, office worker, professor, seller, seamstress and sewer of books). From these participants only two had ever used a computer: one in his professional life and another during introductory courses taken at another day care centre.

## 4.2 Performing Usability Tests

The authors evaluated the complete set of user interfaces dialogues that composed the eCAALYX TV system, from the ones that enabled the user to check their health condition (see example in Figure 1) to the ones that showed medicine reminders and established a videoconference with the medical doctor. There was a total of eight tests performed on a weekly basis. All tests were performed with at least six participants, except for two situations. On these two occasions either a large number of adults was absent or the tests took much longer than expected. This number of test participants follows Nielsen's advice to divide the test pool into small groups in order to do iterative testing. This way, it is possible to solve issues from session to session [29]. It is worth noting that older adults may be slower than younger adults [10] and that their pace should always be respected, as explained later in Section 5.2.

Figure 2 introduces a brief description of the phases and procedures a test would generally go through. The authors were responsible for designing the usability tests, however they would have a meeting with the social educators before and after the tests preparation. The initial meeting was particularly important for cases when the authors needed more and specific information about older adults (for example, the number and medical function of pills to take at lunch). The meeting after preparing the test was done to inform the social educators of the prepared test and, if necessary, perform

<sup>1</sup>In this day care centre, older adults chat to each other, play card games and participate in a variety of activities such as singing, dancing, exercise and learning new things. These activities aim for example to amuse them, train their cognitive functions and improve their lifestyle habits.

<sup>2</sup>There was one test participant who was 54 years old. Although this participant's age does not belong to the chronological definition of older adult (> 60 years), this person's mental and cognitive impairments made her illegible for the day care center and for participating in the usability testing as well.

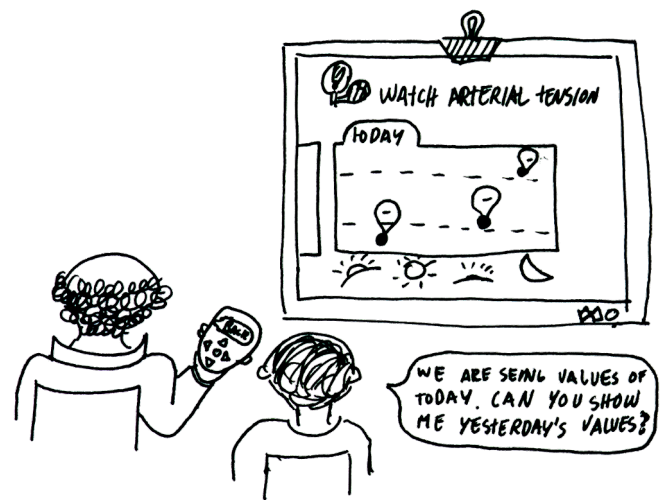


Figure 1: Usability test in which the participants were asked to switch to yesterday's graph of arterial tension.

some minor final changes

**Usability Test**

- 1 - Presentation of the facilitator
- 2 - Presentation of the project and objectives of the tests
- 3 - Evaluation of happiness and fatigue
- 4 - Core usability testing tasks
- 5 - Re-evaluation of happiness and fatigue
- 6 - Questionnaire administration
- 7 - Explanation of some details of the test
- 8 - Thank you

Figure 2: Stages of a typical usability test.

Moreover, these meetings allowed for the social educators to share their experience with the authors ultimately enable them to improved their knowledge and understanding of this particular audience. This might not have had an immediate impact but turned out valuable for the preparation of the subsequent tests. A particular example of a test that required the help and experience of the social educators was the test concerning the medication reminder dialogue. The authors asked the social educators how did older adults referred to a certain medication, if by its name or by its function. Getting this information was necessary so that the low-fidelity prototypes were adapted to the way they remembered the medication.

The method chosen to run the usability tests for this project, that is number 4 in Figure 2, is found somewhere in between the wizard-of-oz [19] and the talk-aloud protocol techniques [22]. In short, one or two facilitators, depending on the complexity of the tasks being evaluated, asked questions about the system and simulated the system's behaviour, functions and features; users were invited to answer questions and to simulate the execution tasks in the system as well as to verbalise any thoughts or doubts that have occurred to them.

After each test was finished, a reflection was done on the results and findings. This usually implied coming back to theory and discussing the features with the medical partners of the project. Conclusions were then incorporated in the designs and/or notes in order to guide the design of forthcoming user interface dialogues.

## 5. 3 X 7 USABILITY TESTING GUIDELINES FOR OLDER ADULTS

This section presents a set of guidelines on how to run usability tests with and for older adults. These guidelines were derived from the experience the authors gathered during the design and evaluation of the eCAALYX's TV system. Also, whenever possible, the authors looked for evidence for the proposed guidelines in previous studies. A number of guidelines are also valid for younger audiences and can be found in more general usability testing best practices. However, it is noteworthy that the guidelines that may have a broader application scope gain a much greater importance when working with this particular audience and thus consisting of specific recommendations that should be carefully considered when working with older adults. For instance, practitioners should not ask test participants to move while in a test situation, however if for a young adult this may cause a simple inconvenience, for the older adult it may cause a strong discomfort.

The guidelines here presented are divided in three sub-sections:

i) User Drive and Control, ii) Test Settings and Preparation, and iii) Care, Communication and Listening. User Drive and Control guidelines include guidelines that aim to help participants during the test by enhancing their sense of control of the situation and by keeping them motivated to participate in the tests. Test Settings and Preparation guidelines concern biophysical aspects of the older adult that should be kept in mind when preparing the test and its settings. Care, Communication and Listening guidelines include directions on how to improve communication and develop an empathic relationship with the older adults during the test.

### 5.1 User Drive and Control (UDC)

Usability testing is likely a new situation for the older adult because of the lack of formal education [10]. The usability test situation can be confusing for older adults if they do not know what is going to happen. To avoid such situations of uncertainty in the test users, it is important to put them in control, hence strengthening their sense of confidence, during the usability test. They should be able to: i) know the purpose of the work; ii) know what the plan is; iii) choose to participate; and iv) know at least some details of the test when it is finished.

**UDC 1: Create social situations that let participants clarify doubts.** Older adults may get tired of the tests and may not understand their purpose, therefore, it is important to give them the opportunity to express their feelings and clear their doubts. With this in mind, the authors participated in a number of the day care centre activities to give older adults the opportunity to know the authors and question them about their work.

**UDC 2: Do not standardise your approach to the el-**

**ders.** Some older adults are likely to suffer of some sort of mental illness others are not and have no cognitive limitation at all. For this reason each older adult should be treated according to her/his mental abilities. Reinforcing this, Active Aging<sup>3</sup> argues for the older adult to maintain autonomy as long as possible [40]. Also, if the older adult does not want to participate his will must be respected. During this project, one test participant once said wanted to stop collaborating in the tests. Although he did not explain his reasons, his will was respected and therefore he did not participate in the following tests.

**UDC 3: Inform the older adult of the goal of the project beforehand.** Before starting the test, the facilitator should introduce the project and why he needs the participant's help. Older adults may only consent to participate if they understand the 'valid' purpose of the project. The test participant might even understand one's attitude as disrespectful. Also, older adults easily forget this information, therefore it is crucial to remind them of the goals of the project to maintain their help.

**UDC 4: Explain some of the test details after the test is finished.** Sharing details on the test older adults had just participated on will not only help gaining older adults' trust but also improve their understanding of the project. This explanation is likely to maintain their will to help in the project.

**UDC 5: Don't forget to say thanks.** At the end of each test show older adults a big honest smile and explain them that their hard work helped you seeing what needs to be fixed. The value of the information gathered with usability testing cannot be measured, therefore the act of showing gratitude should not be forgotten.

**UDC 6: Don't say the word computer on the first approach.** When arriving at the day care centre for the first time, the authors were asked what their academic background was. When informatics was mentioned the answer was quick: "I cannot help, I don't know how to use a computer" or "I don't like computers". The fear of an 'unknown' artefact was clear. After this episode, the authors started telling they worked in interaction.

**UDC 7: Let them know the plan beforehand.** Retirement forces the older adult to re-organize his day [33]. Older adults usually like to plan their day and routine and will try to give 'a purpose' to the time they were used to spend working during their active lives by filling it with activities. Older adults also tend to prefer to follow established routines and will have problems changing their schedules [32]. For these reasons, they should be informed and reminded of the usability tests, so they can include it in their planning.

### 5.2 Test Settings and Preparation (TSP)

When preparing usability tests for older adults, it is important to keep in mind physical and cognitive age related issues. Limitations can impact, for example, the time older adults take to complete tasks and their ability to move from

<sup>3</sup>Active aging is the process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age.

one place to another. This section presents some advice related to the settings of the test and details that should not be forgotten when preparing them.

**TSP 1: Do not ask them to move.** Older adults are likely to suffer from motor impairments that may influence their ability to move. Therefore, they should not be forced to walk, specially long distances. Our first usability tests were conducted in a room that was two minutes away from the common lounge where the older adults usually stay. Many older adults were not very comfortable with: i) walking this distance; ii) going down three steps; and iii) being for around 20 minutes in a slightly cooler room. When the authors changed to a room that was next to the common lounge, older adults were suddenly more willing to participate.

**TSP 2: Some usability tests can be performed while in a group.** The older adults were usually in the common lounge participating in activities or talking with each other. To participate in a test, they had to move not to influence the answers of others. Creating group usability tests allowed for quicker tests and reduced the number of interruptions. However, this situation was only found valid for tests in which there was only one question and a limited number of answers.

**TSP 3: Isolate what you want to test.** The interaction of the older adult with a system can be affected by physical, cognitive and fine motor issues simultaneously [14]. By isolating test variables, it is possible to identify the origin of problems and therefore enabling their correction. For example, to evaluate a user interface that uses a remote control, it is important to be sure that the user can operate the remote before testing the user interface. Otherwise, fine motor control problems can be confused with difficulties understanding the user interface.

**TSP 4: Talk to privileged informers.** Privileged informers are individuals that due to their profession, role or current situation have developed a deep understanding of a certain audience. Social educators and doctors have a deep understanding of older adults, therefore talking with them can enlighten some of your doubts and suggest different points of view. Suggestions and advice from these privileged individuals are often useful to design tests better.

**TSP 5: Relate the tests to the participants' world.** One of the user interfaces' prototypes consisted of a reminder to specifically take stomach medication. Participants with no stomach problems uttered: "No, that is not me" and "No, I don't take that". The difficulty in separating the participant's own reality from the reality that is being represented in the test often resulted in a change of topic and in the main objective of the task being forgotten. Therefore, it is important to plan tests for their reality.

**TSP 6: Role-play helps participants performing tests that do not relate to their reality.** Although usability tests should relate to the participants' world (TSP 5), it is not possible to do so in all situations. Sometimes test participants are not available (see Section 4.1). When the user interface could not be related to the participants' world, role-play was used to pretend they were someone else with

someone else's chronic condition. Older adults interpreted role-play as a fun game and enabled them to use interfaces created for people with different diseases.

**TSP 7: Keep the test short and make use of breaks.** Older adults get more easily tired than younger adults. To reduce fatigue, it is important to keep tests short and to take breaks in between activities. These pauses, can help the participant relaxing and re-gaining concentration. From our experience, each test takes about 20 minutes with 7 to 10 minutes of core test activities.

### 5.3 Care, Communication and Listening (CCL)

Communication is very important during usability testing. If the older adult cannot understand the facilitator or vice-versa, a number of important information may be lost. This section presents clues on how to improve the communication with older adults and on how to develop an empathic relationship with them.

**CCL 1: Make it clear that they are not being tested.** Older adults were always concerned about their performance in the usability tests and would often ask how they have performed. Therefore, it is important to clearly state and remind them that the goal of the test is not to test them, but to pinpoint what is right or wrong with the designs being tested, thus there are no correct or incorrect answers.

**CCL 2: Respect the opinions of the test participants.** Older adults are very keen on expressing their opinions and feel that they do have the right to so. For this reason they may say something the facilitator disagrees with during the tests. If this happens, the facilitator should not argue, instead the facilitator should respect the opinion of the participant, with no further judgment or discrimination, as advised by the American Psychological Association code of ethics [3].

**CCL 3: Listen to the patient's historical narratives.** Health practitioners have demonstrated that listening to the patient creates an environment of trust and security that enables the expression of feelings [2]. In the usability tests, hearing stories unrelated to the test was common. Although these moments did not contribute to the test itself, they contributed to the well-being of that person and revealed important details about them that were useful to the project later. For example, the agenda designed for eCAALYX was inspired by the way one of the participants organized his medical appointments into a stack of papers.

**CCL 4: Use simple language.** Although the older adults group is very diverse in terms of academic education level, the percentage of users with a little or no formal education is high [10]. In addition, perception and cognition may also pose problems to speech comprehension. For this reason, the language used to communicate with older adults should be as simple as possible.

**CCL 5: Adjust your volume appropriately and repeat and paraphrase if necessary.** Communicating with older adults may involve sensory limitations [2]. However, not all participants will have hearing problems. Therefore, the facilitator should adapt the voice volume to the listener

not being too soft nor too loud [34]. Hearing impairments may hinder the older adult's ability to understand speech [37]. Therefore, the facilitator should repeat or rephrase his sentences if he feels that the participant did not understand him [37][41]. Also, when talking, it is important to give attention to the face of the participant, because the elder may be uncomfortable saying they did not understand [4].

**CCL 6: Give test participants' time to think.** Older adults will probably need more time than younger adults to complete tasks [10]. Plan tests with this premise in mind and don't interrupt their line of thought. This can also be improved by reducing background noise.

**CCL 7: Do not use elderspeak.** Do not use elderspeak. Elderspeak is similar to the way adults talk to very young children [37]. It is usually characterized by: i) exaggerating the pronunciation of words; ii) reducing complexity of sentences; iii) speaking very slowly; iv) using limited vocabulary; v) using terms like 'dear' and 'sweetie'; and vi) repeating or rephrasing what the other said. Although it is meant to help, elderspeak transmits the idea that the elder is no longer considered an equal hence his wills and opinions are not relevant [6][21]. In order to avoid this, elderspeak should not be used.

## 6. THE IMPACT OF USABILITY TESTING ON OLDER ADULTS' HAPPINESS AND FATIGUE

To understand the effects of usability tests on older adults, the authors performed a very simple test to assess older adults' self-sense of happiness and of fatigue before and after each usability test. The test consisted of presenting two scales of images (Figure 3) to the older adult in the beginning and at the end of the test. From these images participants were asked to choose the image that resembled their feelings the best. Results shown that, at the end of the test, participants were on average happier (Table 1) and less tired (Table 2).

While the fatigue average image chosen in the beginning was the second from left, at the end it was the third. Happiness was initially situated at the third smile, at the end of the test it would be at the second face.

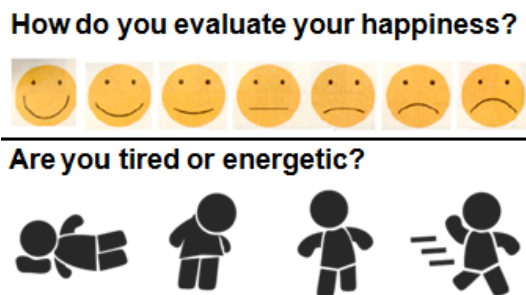


Figure 3: Image scales used to evaluate happiness [27] and fatigue.

The results gathered with these tests lack scientific validity and are insufficient but they still triggered the authors'

Table 1: Average Results per Test on Happiness Evaluation.

Test 1		Test 2		Test 3		Test 4		Test 5	
S	E	S	E	S	E	S	E	S	E
2.7	-	3	2	3	1.5	2.8	3	3.6	3
S=Start; E=End									

Table 2: Average Results per Test on Fatigue Evaluation.

Test 1		Test 2		Test 3		Test 4		Test 5	
S	E	S	E	S	E	S	E	S	E
2.5	-	2.3	3	2.7	3.1	1.7	1.8	2	2.8
S=Start; E=End									

interest into their determinants and consequences. Emotion-related aspects seem to be important in usability tests with older adults. This subject should be covered in another paper from the authors.

## 7. DISCUSSION AND FUTURE WORK

This paper presents a set of guidelines on how to design and perform usability tests with and for older adults. These guidelines build upon the authors' experience while conducting usability testing for the eCAALYX TV system and are the result of a critical reflection on that process. The usability testing guidelines for older adults were organised in three groups: User Drive and Control, Test Settings and Preparation and Care, Communication and Listening.

If on the one hand one may question the robustness of the guidelines this paper presents since they are based on the experience with one project only, on the other hand, the authors believe they consist of a valid starting point that was developed over a period of 13 weeks of careful observation. Also, the positive effect of the tests in older adults' happiness and fatigue also encourages the authors towards the belief that following the guidelines presented in this paper is the right path to follow. However in the future, in order to validate this belief, the authors would like to run sound experiments in which the effect of the applications of these guidelines could be carefully studied.

The authors are also aware of the fact that some of these guidelines significantly depend on the facilitator that is running the usability tests. The skills of a good facilitator are not easy to define and therefore are hard to teach, however a good direction would be to try to create an emphatic relationship with the test participants and to avoid stereotyping them.

## 8. FINDINGS AND CONCLUSIONS

In general, the same 'good practices' valid for usability testing with mainstream users also apply to usability testing with older adults, the difference lies in the fact that those guidelines gain a greater relevance when it comes to the older adults, as explained in Section 5. Adapting the testing situation for older adults essentially means to tailor the environment to their characteristics, objectives and experience with computers.

The guidelines identified during this particular project will guide the authors in future projects for older adults. These guidelines are likely to be iterated and subsequently improved as the authors approach and get involved in different projects. From the authors' experience in this project, a clear impression emerges: that usability testing can benefit a more emotional and humane approach.

## 9. ACKNOWLEDGMENTS

We would like to thank the social educators from Escola Superior de Educação Paula Frassinetti for their help during the tests and for sharing their experience with older adults. The authors are also grateful to the European Commission under the AAL Joint Programme for funding the project eCAALYX, the context in which we developed the work presented in this paper.

## 10. REFERENCES

- [1] C. Abras, D. Maloney-Krichmar, and J. Preece. *Draft of User-Centered Design*. 2004.
- [2] D. Antai-Otong. *Nurse-client communication*. Jones & Bartlett Learning, 2007.
- [3] A. P. A. APA. *Ethical Principles of Psychologists and Code Of Conduct 2002*. American Psychological Association, 2002.
- [4] M. M. Burke and J. A. Laramie. *Primary care of the older adult: a multidisciplinary approach*. Elsevier Health Sciences, 2, illustrated edition, 2004.
- [5] A. Carmichael. Style guide for the design of interactive television services for elderly viewers. Technical report, Independent Television Commission, December 1999.
- [6] L. L. Carstensen and C. R. Hartel. *When I'm 64*. The National Academies Press, 2006.
- [7] N. Charness and K. W. Schaie. *Impact of technology on successful aging*. Springer Publishing Company, illustrated edition, 2003.
- [8] M. F. Costabile. *Usability In The Software Life Cycle*. World Scientific Publishing Company, 2002.
- [9] S. J. Czaja. *Handbook of human-computer interaction*, chapter Computer Technology and the Older Adult, pages 797–812. Elsevier, 1997.
- [10] A. Dickinson, J. Arnotta, and S. Prior. Methods for human-computer interaction research with older people. *Behaviour & Information Technology*, 26(4):343–352, July 2007.
- [11] A. Dix, J. Finlay, and G. D. Abowd. *Human-computer interaction*. Pearson Education, 3rd edition, 2004.
- [12] G. Doherty, D. Coyle, and M. Matthews. Design and evaluation guidelines for mental health technologies. *Interacting with Computers*, 22(4):243 – 252, 2010. Supportive Interaction: Computer Interventions for Mental Health.
- [13] J. S. Dumas and J. C. Redish. *A Practical Guide to Usability Testing*. Intellect Books, Exeter, UK, 1999.
- [14] A. D. Fisk. *Designing for older adults*. CRC Press, 2nd edition, 2009.
- [15] J. Gill and S. Perera. Accessible universal design of interactive digital television. In *Proceedings of Interactive Television Conference*, pages 83–89, Brighton, March 2003.
- [16] S. Greengard. Facing an age-old problem. *Commun. ACM*, 52(9):20–22, 2009.
- [17] L. Hanna, K. Ridsen, and K. Alexander. Guidelines for usability testing with children. *interactions*, 4(5):9–14, 1997.
- [18] T. v. D. Helene Gelderblom and J. van Biljon. Mobile phone adoption: Do existing models adequately capture the actual usage of older adults? In *SAICSIT 2010*.
- [19] J. F. Kelley. An iterative design methodology for user-friendly natural language office information applications. *ACM Trans. Inf. Syst.*, 2(1):26–41, 1984.
- [20] M. Kyng. Designing for cooperation: cooperating in design. *Commun. ACM*, 34(12):65–73, 1991.
- [21] J. Leland. In 'sweetie' and 'dear', a hurt for the elderly, October 2010.
- [22] C. Lewis and R. Mack. Learning to use a text processing system: Evidence from "thinking aloud" protocols. In *CHI '82: Proceedings of the 1982 conference on Human factors in computing systems*, pages 387–392, New York, USA, 1982. ACM.
- [23] C. Mills, K. F. Bury, T. Roberts, B. Tognazzini, A. Wichansky, and P. Reed. Usability testing in the real world. *SIGCHI Bull.*, 17(4):212–215, 1986.
- [24] K. Moffatt, J. McGrenere, B. Purves, and M. Klawe. The participatory design of a sound and image enhanced daily planner for people with aphasia. In *CHI '04: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 407–414, New York, NY, USA, 2004. ACM.
- [25] B. Moggridge. *Designing Interactions*. The MIT Press, 2006.
- [26] R. W. Morrell. *Older Adults, Health Information, and the World Wide Web*. L. Erlbaum Associates Inc., Hillsdale, NJ, USA, 2001.
- [27] D. G. Myers and E. Diener. The pursuit of happiness. *Scientific American*.
- [28] A. F. Newell, A. Carmichael, M. Morgan, and A. Dickinson. The use of theatre in requirements gathering and usability studies. *Interact. Comput.*, 18(5):996–1011, 2006.
- [29] J. Nielsen. Why you only need to test with 5 users, March 2000.
- [30] D. A. Norman and S. W. Draper. *User Centered System Design; New Perspectives on Human-Computer Interaction*. L. Erlbaum Associates Inc., Hillsdale, NJ, USA, 1986.
- [31] F. Nunes, P. A. Silva, and F. Abrantes. Human-computer interaction and the older adult: An example using user research and personas. In *ABRA workshop Petra 2010*, 2010.
- [32] J. Pikunas. *Desenvolvimento humano : uma ciência emergente*. 1979.
- [33] N. Y. Rossell, R. R. Herrera, and M. A. Rico. *Introducción a la Psicogerontología*. Ediciones Pirámide, 2004.
- [34] G. M. V. Servellen. *Communication skills for the health care professional: concepts and techniques An Aspen Publication*. Jones & Bartlett Learning, 1997.
- [35] K. A. Siek, Y. Rogers, and K. H. Connelly. Fat finger worries: How older and younger users physically interact with pdas. *Human-Computer Interaction* -

*INTERACT 2005*, 3585/2005:267–280, 2005.

- [36] P. Silva. *Designing User Interfaces with the BadIdeas Method: Towards Creativity and Innovation*. PhD thesis, Lancaster University, 2009.
- [37] J. Simpson. *Elderspeak – Is it helpful or just baby talk?* The University of Kansas Merrill Advanced Studies Center, 2002.
- [38] H. Sustar, U. Pfeil, and P. Zaphiris. Requirements elicitation with and for older adults. *IEEE Software*, 25:16–17, 2008.
- [39] T. Tullis and B. Albert. *Measuring the User Experience*. Morgan Kaufmann, 2008.
- [40] W. H. O. WHO. Active ageing: A policy framework. Technical report, Madrid, April 2002. A contribution of the World Health Organization to the Second United Nations World Assembly on Ageing.
- [41] wikihow. How to communicate with older adults, may 2010.