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Healthcare TV Based User Interfaces for Older Adults

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Abstract

Designing for older adults is different from designing for younger adults. Older adults are usually less enamored with technology than they are about getting things done and usually experience a range of perception and cognition issues.

This study documents the analysis, design and evaluation of a TV system for the European project eCAALYX – Enhanced Complete Ambient Assisted Living Experiment – targeted at older adults suffering from a selection of chronic conditions. User-Centered Design methodology was used to concentrate on older adults' specificities and therefore create an adequate product that is easy to use by them. In this context, we applied user research, personas, low-fidelity prototyping and user based evaluation. User Research was used to understand the target audience of the project. Personas were created to concentrate on the goals of the different types of users of the system. Finally, a low-fidelity prototype of the Health Channel was created and iterated a number of times with feedback from user based evaluation.

Based on the knowledge derived from the process described before, guidelines were created to drive the design of user interfaces for the TV targeted at older adults. These guidelines include aspects related to the design of the user interface but also to the preparation of usability tests.

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Finaly, I would like to acknowledge my friends and family for their love, and support every day of my life.

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Abbreviations

eCAALYX	*Enhanced Complete Ambient Assisted Living Experiment*
HCI	*Human-Computer Interaction*
PD	*Participatory Design*
TV	*Television*
UCD	*User-Centered Design*
UI	*User Interface*

Publications

This dissertation is the result of my own work, under the supervision of Maria Teresa Galvão Dias and Paula Alexandra Gomes da Silva and has not been submitted in support of an application for another degree at this or any other university. It is the result of my own work, research and judgment, and includes nothing which is the outcome of work done in collaboration, except where specifically indicated; therefore, I acknowledge full responsibility for the work presented. Excerpts of this dissertation have been published in conferences, most notably:

- Francisco Nunes, Paula Alexandra Silva and Filipe Abrantes, Human-Computer Interaction and the Older Adult: An Example Using User Research and Personas, ABRA workshop, Petra 2010 (Appendix C).
- Francisco Nunes, Paula Alexandra Silva, 3 x 7 Usability Testing Guidelines for Older Adults, MEXIHC 2010 (waiting for approval) (Appendix D).

PUBLICATIONS

Chapter 1

Introduction

Population is getting older. The United Nations predict that in 2050 the number of older adults in Europe will be 38% of the population (United Nations, 2001). At first glance, one may think there is no problem with that change. However, in the future, there will be fewer young people supporting a growing older population. In this scenario, our healthcare systems will have to treat more patients with more chronic conditions using the same professionals and resources.

The greater number of older adults will also drive the creation of new services and the adaptation of the existing ones to this growing audience. However, in order to design products for the older individual, it is important to understand and respect their characteristics. The older adult is usually less accustomed with technology and will likely develop age-related conditions, namely on perception and cognition. Ignoring the older adult's characteristics will likely result in a product with low acceptance level.

Currently, governments and private healthcare companies are looking for sustainable paradigms for healthcare. In this settings, the European Commission funded eCAALYX – Enhanced Complete Ambient Assisted Living Experiment (June 2009 - May 2012). eCAALYX aims to create a complete healthcare solution for older adults with chronic conditions; a sustainable approach to healthcare that offers more quality of life to the older patient.

Fraunhofer AICOS – Assistive Information and Communication Solutions – is one of the partners in the consortium of this project and responsible for developing a personal home health system – the Health Channel. This system aims to assist the elderly by providing videoconference with caretakers, medication and appointment reminders and updated health information. The Health Channel will work on a TV with a set-top box and will be operated using the remote control.

This dissertation has a larger goal that consists of the **analysis, design and evaluation of a TV based user interface for the eCAALYX project** and based on the experience and knowledge built during this process, to **derive a set of guidelines to guide the design of user interfaces for the TV targeted at older adults**. The first goal will include the study of the older adults and their specificities as well as the iterative development of the user interfaces for the TV channel. The second materializes in a collection of advices either on how to design user interfaces for this particular audience or on how to create and perform usability tests with them.

User-Centered Design is a design methodology that suggests an intensive communication with the target audience (see Chapter 3). Communication is even more important when the designer cannot put himself easily on the place of the user. In order to gain a better understanding on the target user, the author performed a thorough User Research which is detailed in Chapter 4. This chapter includes information on age related changes and on the chronic conditions addressed by the eCAALYX project (see Chapter 2). User Research helps gaining knowledge on the target audience, however when a system has very different users, the definition of the user may be blurred. Having a clear definition of the target user helps escaping the temptation of designing for every possible feature (see Section 3.1.2). This was very important for the work underlying this dissertation, since the system addresses very diverse users. Building upon the User Research, Personas were generated with the intention to concentrate on the goals of very different users. The generated personas include the three main types of users of the system: patients, caretakers and caregivers (see Section 5.1). Based on the requisites of the eCAALYX project and the knowledge gathered from the application of the two above-mentioned techniques, the author developed a low-fidelity prototype of the Health Channel described in the Section 5.2. This prototype was iterated with users under the usability testing umbrella. Section 3.1.4 presents the specific evaluation techniques used in this process as well as the detailed description of the prototype and its development process. The experience gathered throughout the analysis, design and evaluation of the Health Channel and especially with the execution of tests with the target audience, enabled the author to derive a number of guidelines. These are introduced in Chapter 6.

This dissertation is structured in eight chapters.

Chapter two (2) describes the eCAALYX project in which this project is build upon. This chapter also presents alternative approaches to the treatment of chronic diseases used by other telehealth and telemedicine systems.

The third chapter (3) introduces Human-Computer Interaction and calls attention to the User-Centered Design methodology, User Research, Personas, Low-fidelity Proto-

types and user based evaluation techniques. These concepts are introduced in this chapter because they ground the work of our project.

Chapter four (4) is dedicated to the study of the older adult. First we review the causes and consequences of the demographic change; then, we present some of the most important age-related changes. Finally, the chapter makes a short description of chronic diseases and limitations caused by them.

On the fifth chapter (5) we present the results of the analysis, design and evaluation of the Health Channel. First, we present the Personas that were created for this project along with some comments. Then, we describe the prototype of the Health Channel and the process that lead to its creation. At the end of the chapter, we described details on the evaluation of the prototype.

The sixth chapter (6) presents guidelines for designing TV-based User Interfaces targeted at older adults. These guidelines were derived from the analysis, design and evaluation of the Health Channel, and include advice on creating user interfaces and usability tests for older adults.

The seventh chapter (7) presents our analysis of the findings detailed in the previous chapter.

Finally, chapter eight (8) provides a summary of our main conclusions, the open issues that suggest directions for further research and a reflection on the contribution of our findings.

Chapter 2

The eCAALYX Project

eCAALYX – "Enhanced Complete Ambient Assisted Living Experiment" – is the project in which this dissertation is built upon. Due to its complexity, we start this chapter by describing further its context. But first, we should revise some of the ideas we have seen before.

Older adults are more likely (than younger age groups) to suffer from chronic conditions that require constant attention and care (eCAALYX, 2009b; Boulos et al., 2009). Although these diseases are not a consequence of aging, because of the accumulated exposure to risk factors, the probability to develop a disabling chronic condition increases with age (Ben-Shlomo and Kuh, 2002). In addition to the consequences of the disease, chronic conditions threat two of the most important human needs: independence and safety.

Independence is difficult to maintain in the presence of chronic conditions, due to the need of constant health monitoring. Routine home visits by caretakers have proved to be effective in reducing mortality and nursing admissions in chronic diseases (Elkan and Kendrick, 2004). However, the distance between the house of the patient and the caretaker, may be an issue (Boulos et al., 2009).

Safety is even more important. This necessity appears after basic needs like food in the Maslow's hierarchy of needs (see appendix A). Chronic diseases menace this need not only by the health complications that they induce but also by the constant fear of getting worse.

The European Union has undertaken a series of research initiatives to address problems – like independence and safety – that affect the quality of life of older adults. These initiatives also aim to create new models of treatment that can make the healthcare system sustainable despite the demographic change (Boulos et al., 2009).

eCAALYX is part of this effort to create systems that assist the elderly. The project has started in June 2009 and ends in May 2012 (ecaalyx initial report). The goal is to

produce a complete solution that improves the life of the older adult by monitoring his health condition and acting accordingly. The objectives of eCAALYX can be summarized in the following:

- Monitor the health of the older adult with chronic conditions, at home and on the move;
- Improve the quality of life of the older adult by increasing his independence and safety;
- Prevent deterioration of the patient's condition by providing continuous support guidance and relevant health education;
- Create a solution that provides the above objectives and is commercially viable, reliable, long-term, scalable, and virtually maintenance-free

Since this is a European project, partners from several countries are involved. The partners, in alphabetical order are: CETEMMSA Technological Centre, Spain; Charité – Universitätsmedizin. Germany; Corscience GmbH & Co KG, Germany; Fraunhofer Portugal; Fundació Hospital Comarcal Sant Antoni Abat, Spain; INESC Porto – Instituto de Engenharia de Sistemas e Computadores do Porto, Portugal; Telefónica Investigación y Desarrollo, Spain; TeleMedic Systems, United Kingdom; University of Plymouth, United Kingdom; and University of Limerick, Ireland.

The project is composed by three iterations. In each of the iterations, requirements are reviewed. After a common vision has been formed, a prototype is developed and evaluated. This iterative scheme allows the project to change over time and enables the partners to work in the same direction.

eCAALYX is composed by 3 main subsystems (Boulos, 2009):

- The Caretaker Site – is a platform for analyzing data from the sensors of the older adult. Using data-mining techniques, it will be able to access levels of risk and trigger preventive actions. By aggregating data from the patient, this platform will allow the collaboration between caretakers;
- The Mobile Subsystem – that involves the "smart garment" and the mobile phone. Those devices will be responsible for gathering health data from the patient on-the-go[1];
- The Home subsystem – which contains a set-top box that will enable the older adult to connect with his caretakers. This part of the system will also contain the necessary structure to gather and send the patient's health data to the Caretaker Site.

[1] Set-top box is the name of the device that produces output on a conventional television set. The name is due to the fact that this device normally sits on top of the television.

Fraunhofer Portugal is mainly responsible for developing the Home subsystem (eCAALYX, 2009a). The author's task is to design the user interface of the TV system that will be used by the older adult. This Health Channel, as we will call it from now on, will provide communication, possibly using videoconference. Other functionalities include remembering the patient to take his medicine and also medical appointments.

2.1 Related Projects and Previous Remote Health Care Systems

As it has been previously introduced, the Europen Union has invested in several projects with the objective of improving older adults' life conditions. Although objectives across projects are not exactly the same, some projects present similar goals to the ones of eCAALYX. Examples of projects similar to eCAALYX are DREAMING[2] and Persona[3].

Not many projects have the broad range of eCAALYX, however this project is still a remote healthcare solution. Therefore, it is important to study previous approaches to remote healthcare in order to know the reason of their choices and learn from their mistakes. One can mention the works from from Poon et al. (2005), Cullum et al. (2006) and Shore and Manson (2004) that approach cognitive and mental diseases, Valerie J and Fisher (1998), Kim et al. (2003), Braun et al. (2005), Baer et al. (2004) and Myra Kim et al. (2004) tackle some aspects of wound care and Jong and Kraishi (2004) and Jones (2007) document their experience with arthritis. Because it is not our objective, we will not dive deep into the details of studies from different diseases but we will describe remote healthcare solutions related with the treatment of diabetes, a disease that is largely covered in such solutions. Besides giving a good example of remote healthcare systems, it also grounds some of the concepts described in John's Persona in Section 5.1.1.

An experiment was conducted in Hong Kong to evaluate the feasibility of a diabetes group care program using telemedicine in elderly community centers (Chan et al., 2005). The study involved 22 older adults with type 2 diabetes divided into three groups. Each of the groups received education regarding diet, glucose monitoring and management, foot care, as well as exercise prescription. The participants concluded that after the program they had a better understanding of their disease, felt better, happier and were more active. Results showed significant changes in the management of the disease.

Barnett et al. (2006) studied the effectiveness of a different approach to remote health management. Instead of being focused in education, as the previous example, it was aimed to improve the communication between the doctor and the patient. For a period of 24 months, 800 older individuals were divided into two groups: one to test the new treatment and other as control group. The elements of the treatment group received a messaging

[2] http://www.dreaming-project.org
[3] http://www.aal-persona.org

device to communicate with their caretakers. This device enabled them to communicate with a nurse that would help them manage their health and medication, schedule medical appointments and assist with technology difficulties. The results of this research showed a significant decrease in the number of hospitalizations of the treatment group. This supports the thesis that a closer contact to caretakers can improve the management of the disease. On the other hand, the number of home visits also increased, which leads us to think that the worst problems were solved with home visits instead of hospitalizations.

Brown et al. (2007) analyzed some studies that used the Internet as a communication channel between patients and caretakers and noticed changes in the patient's health and life habits. Web sites are the most used technology to aid the management of the diabetic health. These systems pay attention to different dimensions of the treatment like the management of weight, blood pressure or physical activity as well as the monitoring of blood glucose and cardiovascular disease risk. Since these systems hold updated information on its user, it is possible to create a personalized treatment for the patient. Web sites can also stimulate group discussions which enable its users to gain confidence and increase engagement by exchanging their stories.

Videoconference also creates an effective alternative to direct contact between the patient and the caretaker. Studies have shown that the use of such systems resulted in a lesser need for face-to-face encounters and an increased patient satisfaction (Brown et al., 2007).

Interactive voice response systems send automatic messages to its users. The patients then respond using their voice or pressing phone buttons. By increasing the caretaker's information on the patient's status, these systems are capable of reducing hospitalizations and office visits (Brown et al., 2007). One important point referred by the same author is that the number of home visits increased, which can be justified by the prevention of expensive hospitalizations and emergency room visits. These systems are capable of quickly providing a personalized treatment. By doing so, they allow the older adult to learn more about his condition, which is crucial at the beginning when his knowledge is scarce.

The analysis of treatment approaches reported in this section enabled us to notice some relevant aspects. From these, we point out the following that although in different ways were addressed by every study mentioned: communication, education and feedback.

Chapter 3

Methodology

Currently, healthcare mainly focuses on the technological and scientific aspects of diseases (Hunser, 2009). For simple problems, this model is satisfying, but the same does not apply to diseases that require difficult lifestyle changes from the patient. For instance, if a patient is diagnosed with diabetes, and this condition is related to overweight causes, this patient is requested to change his lifestyle as part of the treatment. However, if the treatment is not planned from the patient's perspective, important aspects of his life will not be noticed and the treatment could be compromised or enjoy weak acceptance. On the other hand, older adults face important barriers when trying to use computers and technology (Greengard, 2009; Fisk, 2009). Although this audience is receptive, very often, technology is avoided because its benefits are not understood or because the way technology is designed is impossible to be used by them. In order to overcome such drawbacks, we suggest to adress this challenge with a multi-disciplinary approach centered on the older patient, aiming at answering his needs and finding the best fitting possible to his usual life.

Human-Computer Interaction (HCI) is the discipline that studies the quality of the interaction between the human and technology (Dix et al., 2004). The main goal of HCI professionals is to create products that are useful, usable and used. Since the beginning of HCI, technology, people and society have been rapidly changing (Harper et al., 2008). Today, it is not enough that people "can use the system, they must want to use it" (Dix et al., 2004, p. 156). The human body senses and interprets stimuli as a certain emotion. This biological response, according to the Dix et al. (2004), changes the way one reacts to different situations and impacts on one's interaction with computers to a point that if the user interface provides a good usage experience, it is likely to be more successful.

At the beginning of our work, it was clear that we should use an HCI design methodology in order to create a product that was adequate to the characteristics of our target

audience. This chapter describes User-Centered Design, the methodology that we chose, and the techniques that we used in this context.

3.1 User-Centered Design

There are number of HCI methodologies focused on creating better interactive systems, but among them, two are particularly interesting. These methodologies are Participatory Design (PD) and User-Centered Design (UCD).

PD – also known as Cooperative Design – was developed in Scandinavia in the eighties when the first computers were being introduced in factories (Kyng, 1991). As soon as the machines entered the location, all the workers had to adapt to their process. This forced adaptation lead to decreased motivation and increased absenteeism. Soon designers understood they had to include workers in the process. The share of knowledge between designers and workers was crucial in these settings because much information was "tacit knowledge" that was only available for the workers. The solution found was to include workers in the process as co-designers (Abras et al., 2004).

More or less at the same time, User-Centered Design was introduced through the book by Norman and Draper (1986). UCD was also a "philosophy based on the needs and interests of the user, with an emphasis on making products usable and understandable" (Norman, 2002, p. 188). Although in this methodology the design is also produced with the user in mind, he does not integrate the design team. Costabile (2002) presents UCD in the following three basic principles: 1) analyze users and task; 2) design and implement the system iteratively through prototypes of increasing complexity; 3) evaluate design choices and prototypes with users.

The ISO (International Organization for Standardization) has standardized the Human-Centered Design Process for Interactive systems in 1998 (see Figure 3.1). The description captures the essence of UCD; however the methods to apply in each phase of the life-cycle are not described (UPA, 2010). Users can be involved in the beginning of the process by using, for example, User Research.

UCD was the chosen design methodology for this project. In this context, we used User Research to understand the target audience of the project. Based on the results of the User Research, Personas were created to concentrate on goals of the different types of users. Then, based on the projects' requisites and on the above mentioned techniques, the author developed a low-fidelity prototype of the Health Channel. This prototype was iterated a number of times with feedback from user based evaluation.

The next sections will concentrate on describing some of the techniques that were used during this work. It is not our objective to list all the User-Centered Design techniques as

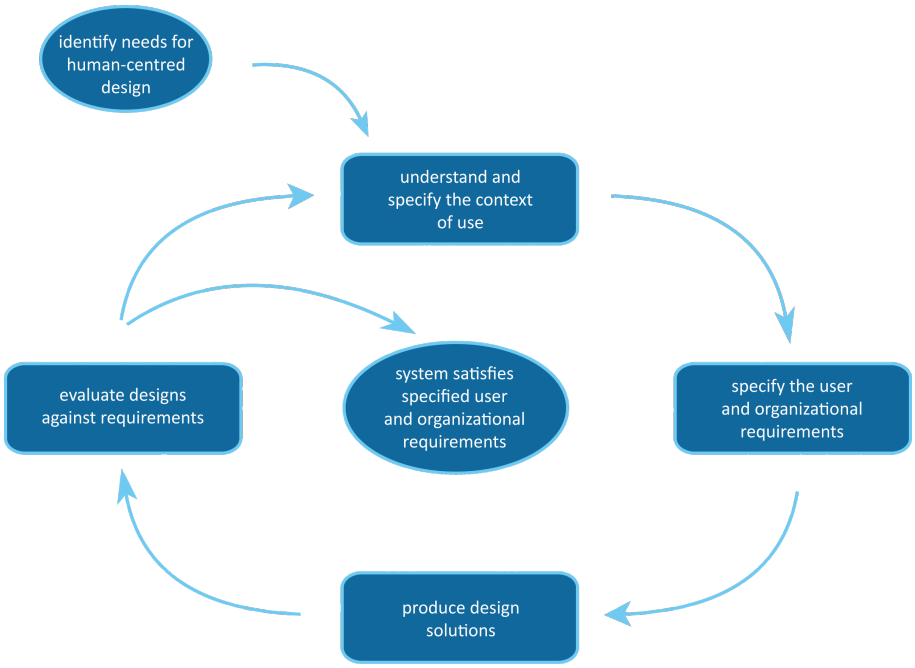


Figure 3.1: The Human-Centered Design process (ISO 13407) (Silva, 2009)

there is a large spectrum of resources available from other authors (for examples refer to (Sharp et al., 2007; Tullis and Albert, 2008; Dix et al., 2004)).

3.1.1 User Research

User Research is the process of understanding the impact of a product on the target audience (Kuniavsky, 2003). There are several user research methods, including literature research, ethnographic research and surveys (O'Grady and O'Grady, 2006; Baty, 2010). User Research will allow the design team to have a clear definition of the user profile, i.e.: characteristics, roles, needs, stories, etc. Once the design team has a clear understanding of whom it will be developing to, it can also define the design objectives, constraints, use cases, etc.

For the work reported in this dissertation, user research was mainly based on the review of the literature, testimognials of diabetic patients in blogs and informal interviews with the medical partners of the project. The outcomes of this technique form the Chapter 4 and fed into the creation of the personas described in Section 5.1.

3.1.2 Personas

Personas are made up archetypes that express motivations, expectations and goals of a particular user group when using an artifact (O'Grady and O'Grady, 2006; Blomkvist, 2002). Personas have two main advantages: 1) they help designers escaping from the temptation

of designing for themselves by moving the focus to the user (Pruitt and Grudin, 2003); and 2) they are an important vehicle to convey information across the team. In general, people have different ideas on who the final user is. With this technique, those ideas can be discussed to create a common vision.

Cooper (2004) coined the term personas when trying to describe a process of creating and evaluating software (Klee, 2001). In that process, Cooper would question who was using a certain product and what did that particular user wanted to achieve.

Having a blurred concept of the end user is half-way to design for every possible feature and to create products that are difficult to use. When using personas, the intention is really to incorporate the persona character and try to reason on the persona's objectives, characteristics and difficulties. The information that fills the persona profile is usually based on user research and therefore represents the real users and not the (designer's) self (O'Grady and O'Grady, 2006).

Besides a name and a picture, a persona profile also includes motivations, expectations and goals. The picture and the name of the persona are of crucial importance as these have the power to turn a user profile into a persona (Redish, 2007). Personas usually assume the graphical form of posters; more original forms like collages with pieces of life from the group of users are also possible. Another possibility consists of creating an e-mail address that sends e-mails for the team (Pruitt and Grudin, 2003).

In this project, eight personas were created representing primary users – older adults – as well as secondary users – caretakers and caregivers. The generated personas were based on the results of User Research and are described in Section 5.1.

3.1.3 Low-Fidelity Prototypes

A prototype is a tangible representation of an interactive system made before the final solution exists (Beaudouin-Lafon and Mackay, 2008; Moggridge, 2006). Prototypes are not abstract descriptions, but concrete artifacts that can be discussed between designers, developers, customers and end-users.

Prototypes can be categorized in two main types: low-fidelity and high-fidelity prototypes. Low-fidelity prototypes are cheap, fast and more limited in terms of functionality and resemblance to the final product (Rudd et al., 1996). High-fidelity prototypes in the limit can mimic all the final product features and be indistinguishable from it. However, they are much more expensive and difficult to change. Intermediate levels of fidelity are

also available with characteristics of both low and high fidelity prototypes.

Paper prototypes are one example of low-fidelity prototypes. These early, sketch based representations allow designers to simulate the interaction with a product (Moggridge, 2006). Paper is quick to draw, erase, correct and glue different pieces. Because it is so quick to change it becomes easier to experiment but also to throw away bad design decisions.

Often, designers turn too quickly to work on the final medium of a project (Moggridge, 2006). Instead of being worried with experimenting different user interface concepts, they get into the details of "pixel pushing". Unlike other design mediums, paper prototypes have no color, typography or alignment, which makes them ideal for experimentation.

Designers work often for a long time in an idea and become attached to it (Wong, 1992). Because of that, they are more reluctant to change their designs. If paper prototypes are used in the beginning, when a designer starts working in a prototype with higher fidelity, the design may have been already validated by the rest of the team or by users.

User-Centered Design methodology proposes the use of prototypes as part of its iterative cycle (Norman and Draper, 1986). Nevertheless, it is correct to ask when should prototyping end. Moggridge (2006) suggests that the design is good when "you have tried it out with the people who will use it and found that they are pleased, excited, motivated, and satisfied with the result" (Moggridge, 2006).

Paper prototyping was used in this project from the beginning to bring ideas to life and generate discussion among the design team and to test the system with users. The created prototype is described in Section 5.2. After the low-fidelity prototype was finished, it was delivered to a colleague from Fraunhofer AICOS that started working on a higher fidelity version of the prototype. Some of the decisions of the medium fidelity prototype were also evaluated with users in the eighth usability test (Appendix B.8).

3.1.4 User Interface Evaluation

The evaluation of the user interface was designed under the usability testing umbrella. In this context, the authors ran customized versions of a number of user-based evaluation techniques. Namely: empirical studies, wizard of Oz, think aloud protocol and card sorting.

An empirical study is, as the name refers, a technique that basis its conclusions on direct observation and experimentation. In this context a hypothesis is formulated and based on the observed results, conclusions are inferred and therefore new knowledge is built (Dix et al., 2004). In this project, a very simple version of this method was used. A script was defined and reproduced with users. Then a couple of indicators were measured and some qualitative information with the form of informal notes. In a previous phase, decisions were made based on the acquired results or in case of doubt based on the notes gathered.

In this project, a very simple version of empirical studies was used to define the usability tests. A script was defined and reproduced with users. Then a couple of indicators were measured and some qualitative information with the form of informal notes. In a previous phase, decisions were made based on the acquired results or in case of doubt based on the notes gathered.

The Wizard of Oz technique was coined by J. F. Kelley in the eighties (Kelley, 1984). At that time, Kelley was designing a natural language system. The Wizard of Oz enabled Kelley to test his system before it was finished. In order to make it work, there was one experimenter in the back answering the commands issued by the user and asking for the next input. The name "Wizard of Oz" comes from the famous story "The Wonderful Wizard of Oz". In that story, an ordinary man hides behind a curtain and pretends to be a powerful wizard (The Wizard of Oz) using sound effects (Kelley, June).

This technique evolved from natural language to graphical user interfaces. In its current form it requires, two evaluators (Höysniemi et al., 2004). While one controls the system under evaluation, the other evaluates the user actions. Using the Wizard of Oz, it becomes easy to test interactive systems that are not yet implemented. As reported by Maulsby et al. (1993), paper prototypes can represent the user interface while the experimenter simulates the behavior of the system.

In this project, Wizard of Oz was used to animate the paper prototypes of the Heath Channel during usability tests. This way, it was possible to evaluate the prototype without needing to implement it.

Think aloud protocol goes back at least to 1982. At that time, Lewis and Mack (1982) wanted to understand how inexperienced users learned to use a text-processing system by themselves. In order to do it, experimenters gave users a couple of days to try the system and asked them to "think aloud". This verbalization of thought allows experimenters to understand how the user approaches the system and what he keeps in mind. If the user expresses a very long sequence of steps, the user interface might be too complicated (Lindquist et al., 2008). Another output of using this technique is to gain access to the terminology used by the user.

In its current form, think aloud protocol can also be used to evaluate systems in early phases by making use of paper prototypes (Dix et al., 2004). The feedback that is received can be fed into the design process.

In this project, we used Think Aloud to know the ideas that the users had about some of the prototypes screens but also about some menu names and graphical representations.

Card Sorting is a technique with roots on grouping and sorting studies that date back to the fifties (for example see (Bousfield and Barclay, 1950)). Card Sorting comes to HCI around the eighties to categorize options in menus of operating systems (see (Tullis, 1985)). Today it is very used to define web site hierarchy (Chaparro et al., 2008).

The purpose of using Card Sorting is to explores how users conceptually organize information (Chaparro et al., 2008). In a card sort session, participants are given a stack of cards with information to sort into categories that make sense to them. The categories might be defined beforehand (close session) or be created during the test by the user (open session) (Hudson, 2005).

Card Sorting was used in this project, for example, to select names of menu options.

Chapter 4

The Older Adult

The target audience of this project is the older adult with chronic conditions. At the beginning of the process, it was clear that we needed to know more about our target audience. For this reason, User Research was conducted based on literature analysis, testimonials of diabetic patients in blogs and informal interviews with the medical partners of the project. Our findings are described across this chapter.

The start of the "golden years" is a subject that is far from reaching agreement, while some authors defend it starts at 60, others refer 65 (Fisk, 2009; O'Neill, 2002). We will not take a position in this discussion by considering studies in both definitions. Either way, it is not correct to "label" everyone over this age as "older adult" because it is common to find energetic and youthful people in the seventh decade and also very frail younger adults. As O'Neill (2002) concludes, "chronological age is just one indicator of how old a person is".

At the beginning of the chapter we will start by explaining the demographic change, then we introduce age-related changes and at the end we cover some aspects of chronic diseases.

4.1 The Demographic Change

Population is not only growing larger, it is also getting older (Fund, 2009). According to projections, by 2050, 37% of the European population will be 60 or older (United Nations, 2001, p. 11). Demographic changes are shaping a new society with fewer young people and an ever growing number of older adults (EC, 2005). The European commission explains that the demographic change is caused by three main factors (EC, 2005):

- increase in longevity caused by the progress in health care and quality of life;

- growth in the number of workers over 60, the generations of the baby boom[1];
- low birthrates due to difficulties finding job, housing and life choices.

The demographic change phenomenon was first described by Notestein (1954). In his words, the "problem of aging" is no problem at all. It is only the pessimistic way of looking at a great civilization triumph. We believe that Notenstein was right; the demographic change is not a problem in itself. The problem is that the current structures of our society are not prepared and therefore, will have to change radically (EC, 2005). A smaller working force and an increasing number of chronic diseases (associated with age) will introduce great challenges to health care organizations and governments (Hunser, 2009; Intel, 2006).

On the other hand, health care systems are not the only systems that will inevitably change. Designers will need to respect more older adults' specificities, otherwise they might be losing a growing market and audience that has the money to pay for their solutions. As Greengard (2009) refers, the reason why older adults don't use much technology is because they do not see a clear benefit in using them or because it is simply impossible to use. The next section will concentrate on some of the specificities of the older adult that will guide us through our design process.

4.2 Age-related Changes

The acceptance of a product or service depends, mostly, on its ability to solve a particular problem and on the facility of its integration into the user's life. Therefore, designing for the older adult requires the professionals to be knowledgeable into what concerns the older adult's characteristics. Along this section we will describe physical, cognitive, psychological and social changes. Our analysis is mainly focused on the characteristics that are more relevant to the implementation of a user interface for the TV (see Section 2); nevertheless many points are general and can be applied to different systems.

The human is not a "sum of physical parts". As Carstensen and Hartel (2006) refer, humans are the sum of all that they have experienced, a reflection of the social and cultural environments where they have lived. Therefore if one forgets the context of today's older adults, products will not achieve great acceptance. The elder did not grow up using computers or other devices, and what might seem like a very common technology to us might be very strange or even "rocket-science" to the older adult of today.

[1] The Great Depression and the World War II forced many couples to delay their plans of constituting a family and having children. After the war a period of stability and economic prosperity was accompanied by an exponential increase in the birth rate (Britannica Online, 2010a).

4.2.1 Physical Changes

The aging process introduces significant changes to the human perceptual system. To understand those changes, a distinction should be made between perception and sensation. Sensation is the apprehension of simple stimuli's properties through the senses; perception is the interpretation of those sensations. Seeing the red color is a sensation; recognizing an apple is a perception (Fisk, 2009). Many problems of the older adult however, are a mix of sensation and perception limitations; therefore our focus will be on problems rather than on their causes. The next section reports changes in vision and is followed by a section on hearing and another on motor changes.

4.2.1.1 Changes in Vision

Vision is one of the most relevant human sensory systems, since the human acquires information (mainly) using sight (Dix et al., 2004). Therefore it is fair to conclude that if the user cannot see the interface, most probably he will have problems using it. Fisk (2009) explains that "if we live long enough, nearly all of us will have vision problems". Vision can be affected in multiple ways and this section introduces the most important changes: visual acuity, presbyopia, peripheral vision and dark adaptation.

Charness and Schaie (2003) define visual acuity as "a measure of the visual system's ability to resolve fine spatial detail". According to Burke and Laramie (2004) a visually impaired individual has a 20/40 visual acuity or lower and can read an eye chart at 20 meters while fully sighted person can read at 40[2] (Burke and Laramie, 2004; Montgomery, 2009; Fisk, 2009). Recent studies revealed that a percentage of 92% of the individuals above 70 years wear glasses (Charness and Schaie, 2003). Although (near and far) acuity problems are so common, Fisk (2009) argues that the acuity of 20/40 – which most older adults have (> 80%) – is more than enough for most activities.

Presbyopia is characterized by a decrease in the competence of the eye to change its focal length (Gill and Perera, 2003; Fisk, 2009). In other words, it is the difficulty of changing focus between objects at different distances. Our eyes are designed to look at objects which are 6 meters away or farther; each time the eye focus closer objects, the crystalline lens in the eye have to bend into a more convex shape (Charness and Schaie, 2003). The problem, as the same authors conclude, is that as we grow older the crystalline lens become harder to bend. The normal eye experiences difficulties in focusing objects at a reading distance since 45 years of age (Tierney Jr et al., 2003). Although presbyopia can

[2] Visual acuity is a comparison coefficient. We could change the units of the example to feet and it would also be valid.

increase the difficulty of some tasks, it can be corrected by wearing glasses (Charness and Schaie, 2003). Based on this, and if a system requires the interaction with close objects, it is important to consider that the older adult may have extra difficulties due to the use of glasses. One example would be changing the TV channel, when the elder would have to put on the glasses in order to be able to read the channels number on the TV remote.

Age-related changes also bring the decrease in peripheral vision (Charness and Schaie, 2003; Fisk, 2009). As objects move away from central vision into the periphery, it becomes more difficult to resolve their details. Driving is one activity in which peripheral vision plays a critical role by allowing the driver to see cars coming from other directions. Similarly, user interfaces employ pop-ups often appearing on the corners of the screen. When dealing with older adults however, that information by itself might not be noticed, therefore other strategies for signaling events, such as sound signals should be used.

The adaptation from a very well illuminated environment to a very poorly one reduces the sensitivity of the vision (Charness and Schaie, 2003; Burke and Laramie, 2004). Recovering the visual sensitivity is known to be a slower process for the older observer. The older eye only recovers part of its sensitivity in poorly illuminated environments, which means that if the environment is not correctly illuminated, some details will be missed by these observers.

4.2.1.2 Changes in Hearing

The success of user interaction with a system or environment can be affected by the user's ability to hear (Fisk, 2009). Therefore if there is the need to include auditory information in a system, age related changes in audition have to be considered in the design process. About 10% of the middle-aged adults suffer from hearing losses to a point that they inhibit their social interaction. At the age of 65, half of the men and 30% of the women exhibit the same symptoms. This difference is usually attributed to the distinct noise exposure at the workplace; nevertheless, this difference should be attenuated as more and more women engage in work activities that are detrimental to hearing (Charness and Schaie, 2003).

As far as the volume is concerned, humans can hear sounds from 8 decibels (dB) (similar to a whisper) to 130dB. There are severe hearing damages when the individual's threshold is greater than 35dB. It is important to underline that this loss of sensitivity is especially pronounced for high-frequency sounds (Charness and Schaie, 2003; Fisk,

2009). Systems depending on sound should enable their users to easily adjust the volume.

The audible frequencies also decrease with age. A young adult can normally hear sound frequencies up to 15000 vibrations per second. However, for an older adult sound vibrations greater than 4000 vibrations per second may be inaudible (Fisk, 2009). Corso (1981) refers that complex tasks such as speech recognition and sound localization are affected by the inability to detect some frequencies (Charness and Schaie, 2003). Moreover, the hearing loss is worse for consonants than it is for vowels, which makes it very difficult to fully understand some words. The statement frequently used by the hearing impaired: "I can hear you, but I cannot understand what you are saying" is an example of this difficulty (Burke and Laramie, 2004). Similarly, the sentence "The thinner cat is red" may be heard as "The dinner hat is red", because of the listener's difficulty understanding consonants.

The intelligibility of speech is also conditioned by the background noise and architectural echo or reverberation (Charness and Schaie, 2003).

Accent is also an influential factor that can improve speech intelligibility by helping the listener to cope with background noise and hearing deficits; however, accent is only useful if the user is familiar with it (Fisk, 2009).

Finally it is imperative to understand that the hearing loss may be denied by the older adult because of the negative stereotype of people not hearing well (Burke and Laramie, 2004). This loss can create the feeling of social status loss or inability to compensate for his (hearing) problems, which would increase the problem even more.

4.2.1.3 Motor changes

The human motor system also experiences age effects. Modifications occur throughout the whole body. This section concentrates in the problems that may occur when manipulating a TV remote. In this context, Fisk (2009) reports the increased response times, lesser ability to maintain continuous movements and difficulties in coordination. Arthritis is also very common among older adults (Czaja, 1997); swelled fingers in pain will most likely reduce the speed and accuracy of the movement.

The changes expressed above can contribute to greater difficulties performing fine motor control actions. The following paragraph presents some of these difficulties as described in the literature.

Fisk (2009) discovered that older adults had difficulties double-clicking a mouse; however, when the time interval between clicks was increased, errors were eliminated. Given these results one can conclude that the problem was not the complexity of the task, but the speed of movement. Czaja (1997) explained that declines in the spatial abilities were known to create difficulties using devices like the mouse. This difficulty assumes greater importance as it can block the interaction with the user interface. When testing the usability of PDAs, older adults expressed their concerns about their 'fat fingers' preventing them from completing the task; the users 'feared' to push multiple buttons at the same time. Siek et al. (2005) concluded however that not many errors were registered in that task.

Physical changes are inevitable for the older adult. Since these changes can greatly impact the interaction of older adults with products, it is crucial not to forget them when designing a system. Cognitive changes also occur; these are introduced in the next section.

4.2.2 Cognitive Changes

Perceptual limitations are not the only ones that affect the older adult. Limitations in the cognitive ability might also create difficulties. Interacting with products usually requires the user to reason and choose over a set of options. Memory is crucial to this task; therefore its limitations should be explored in order to create an acceptable user experience. This section will start introducing memory considerations and then some reflections on attention.

4.2.2.1 Changes in Memory

There is a common belief that as we get older our memory gets worse. Memory is an ability that involves complex processes such as the storage and retrieval of information in the brain (O'Neill, 2002). Like with other parts of our body, changes occur in the brain that affect the way older adults learn and assimilate information. However, although changes occur, not all memory functions are affected (Satre et al., 2006; Fisk, 2009).

Working memory – or short-term memory – is "the capability to temporarily keep information active while we 'work on it' or until we use it" (Fisk, 2009, p. 20). This type of memory has an ephemeral character and a limited capacity (Satre et al., 2006; Dix et al., 2004). This capacity is usually limited by normal aging. Limitations in short-term memory can also influence the learning process and affect language comprehension.

O'Neill (2002) documents that older adults may recognize this changes and try to cope with them by taking notes that will, for example, help them in the first usages of a product.

If short-term memory is our working-memory, long-term memory is a permanent storage of information that contains everything one knows (Fisk, 2009; Dix et al., 2004). Long-term memory differs from working-memory in capacity (very big, if not unlimited), in retrieval time (much slower) and in occurrence of forget (very slow, if at all). This type of memory can be categorized according to different forms like semantic memory, prospective memory and procedural memory. As changes in memory occur differently in each form, they are described separately.

Semantic memory is responsible for storing factual information like the meaning of words, historical facts and general knowledge (Fisk, 2009). Its capacity declines minimally with aging. On the other hand, Salthouse (1996) refers that age causes a reduction in the processing speed (Satre et al., 2006). Even though reaction time can be decreased doing exercises, age differences are most of the times noticeable. The "tip-of-the-tongue" phenomenon is an example of this slower access of information, in which the older adult tries to remember the correct word.

Prospective memory is characterized by remembering to do something in the future (Fisk, 2009). This form of memory can be divided in two types: "time-based" – remembering to do something later, like for example to take medication in 4 hours – and "event-based" – remembering to perform some action after the occurrence of an event, like for example to take medication after breakfast. The decline in prospective memory is more accentuated in the "time-based" type than in the "event-based". Being so, it is important to optimize for the "event-based" memory making use of the appropriate reminders.

Procedural memory is the name of the form of long-term memory that represents the knowledge of how to execute a certain task (Fisk, 2009). Procedural memory includes not only the activities we do without thinking, like tying up shoes, but also less automatic ones like doing a multiplication. Older adults may experience difficulties developing new automatic processes in some domains and remembering activities not executed for long time. "Automatized" activities however, are not likely to be lost.

4.2.2.2 Changes in Attention

Attention is our capability of concentrating on one task instead of a number of competing thoughts and stimulus (Dix et al., 2004; Fisk, 2009; Charness and Schaie, 2003). Each second, the human body receives a massive amount of information through the senses,

and each second, through selective attention, the brain selects which stimuli to attend. This selection is our mechanism for switching tasks back and forth and it is based on our level of interest or need. Fisk (2009) states that "if we did not selectively attend to the stimuli coming into our senses, we would be overloaded". When required to execute more than one task at once – like for example driving and looking for street signs – older adults have shown more difficulty than younger persons. According to the same author, in general, older adults would need more time to change between tasks.

Older adults will have more difficulty distinguishing between target and non-target stimulus if the number of distracters increases (Rabbitt, 1965). On the same subject, Fisk (2009) refers that older adults are usually "more affected by salient events such as flashing, high-intensity lights as well as stimuli that appear to pose an immediate 'threat'".

To better design with the attention constraints in mind, it is important to require the minimum of search to perform a task, remove information that captures user attention as soon as it is not needed.

4.2.3 Psychological and Social Changes

There are many myths about the psychological and social effects of aging. Although inaccurate, stereotypes of the senile, mentally ill, depressed and isolated man are common (APA, 2003). This section presents a short summary of the most relevant changes. Covered themes include the characteristic problems of the older adult, personality and self-acceptance, social networks and treatment issues.

Although some problems only arrive at a late stage in life, many are similar to difficulties in other stages of life (APA, 2003). Dealing with losses and limitations is one of the most relevant issues. Inevitably, aging brings the need to adapt to physical limitations and functional impairments. The individual is forced to choose the most important goals, to refine the means to achieve them and to find new strategies to deal with losses (Baltes et al., 1999; APA, 2003). Losing loved ones is a problem that the older adult will encounter (Carstensen and Hartel, 2006). The older adult will have to deal not only with emotional ramifications but sometimes with the difficult task of building a meaningful social world. On the other hand, facing loss in the context of one's life often creates a unique possibility of achieving reconciliation, healing or deeper wisdom (APA, 2003, citing works on wisdom).

Wisdom takes us to our next subject: personality and acceptance of the self. The individual personality shapes according to the events and the decisions of one's life. However, age does not significantly change the core of the individual. When someone gets old, one is like what he was before, not an older person stereotype (Carstensen and Hartel, 2006).

Although personality does not change much, the acceptance of the self seems to increase. People are increasingly sure about who they are, their competencies and their weaknesses (Carstensen and Hartel, 2006). These changes lead them to a better self-acceptance.

Social networks are a subject where older and younger adults differ. Younger adults are likely to grow large social networks with the objective of finding a mate; later in life, the focus changes to maintaining emotional balance (Satre et al., 2006; Carstensen and Hartel, 2006). Confronted with limited opportunities, the older adult invests in the most satisfying and humanly rich relationships (Carstensen and Hartel, 2006; APA, 2003). This is also true for the relationship with their care takers, so it is important to consider and support this type of interaction when designing systems for this particular type of user.

Treatment is the last point we approach in this section. Although older adults may have more health problems – due to a longer exposure to risk factors – optimism has been related with lower distress, better coping with the disease and faster recovery periods (Carstensen and Hartel, 2006). It is also important to mention that the well-being of the older adult is strongly related with the quality of the relation with adult children (Ryff et al., 1994).

4.3 Chronic Conditions and the Older Adult

As it was mentioned before, current medical structures will have to change to correctly assist an increasing number of patients with more or less the same means. The first part of this section describes some of the chronic conditions that will be addressed by eCAALYX project. The second part however, unveils some details of the treatment of those chronic diseases.

4.3.1 Chronic Conditions

When developing products, many professionals don't consider users with disabilities. They excuse this behavior claiming that the market share of "special users" is very low. Although chronic conditions are not a consequence of aging, because of the accumulated

exposure to risk factors, the probability of developing a potentially chronic disabling condition is greater (Ben-Shlomo and Kuh, 2002). As we will see, the incidence of chronic diseases on older adults is far from little, therefore its effects should be considered. This aspect gains even more relevance due to the fact that our project is focused on the older individual with chronic conditions.

According to the National Center for Health Statistics of the United States, the most common older adults' chronic diseases are: hypertension (> 50%), arthritis (50%), chronic joint symptoms (> 40%), cardiovascular diseases (30%), cancer (20%), diabetes (< 20%) and sinusitis (> 10%) (Fisk, 2009). Different diseases imply distinct complications in the life of the patient. The focus of eCAALYX (the project in which this dissertation is built upon, see Chapter 2) is primarily on the ones with the heavier burden in terms of number of hospitalizations, level of disability and average mortality percentage. With these criteria in mind, the medical partners conducted an internal analysis and a literature review to find the diseases to address (eCAALYX, 2009b). This analysis resulted in the selection of the following diseases to address: cardiovascular disease (heart-failure), chronic obstructive pulmonary disease (COPD), diabetes mellitus type 2, arthritis, dementia and chronic wounds. A small description of the first three, the ones that will be addressed first by the project, is presented next.

Heart failure is an impairment that disables the heart from correctly pumping the blood to support circulation (Britannica Online, 2010d). The most common symptom is shortness of breath and the disease can be improved by eating less salt and doing regular exercise (Tierney Jr et al., 2003). Despite the improvements of the treatment of this kind of patients, the prognosis is poor, with a mortality rate ranging from 5% (in stable patients with mild symptoms), to 30-50% in patients with an advanced and progressive situation.

Chronic obstructive pulmonary disease (COPD) is characterized by the difficulty to bread, caused by an airflow obstruction (National Heart Lung and Blood Institute, 2009). Smoking is the most significant cause of the disease (Tierney Jr et al., 2003) that is under diagnosed very often because the patients finds the inability to bread, the difficulty to exercise and the "smoker's cough" characteristics of an older adult that smokes or used to smoke (Nolte and McKee, 2008). COPD is preventable and can be slowed if the patient stops smoking.

Diabetes Mellitus or simply Diabetes is characterized by the inability to produce (type 1) or respond to insulin (type 2); this inability prevents the body from keeping the right level of sugar in the blood (Britannica Online, 2010c; EC, 2008). Although diabetes is not a leading cause of death, it has a major impact on the global burden of disease. If not controlled, it can impact the heart, blood vessels, eyes, kidneys and nerves (Britannica Online, 2010c; EC, 2008). Insulin injections are part of type 1 diabetes treatment from start; type 2 on the other hand, can also be treated with lifestyle changes (EC, 2008).

Type 2 diabetes features a strong association with obesity and is the most common form, accounting with 90% of the cases (Tierney Jr et al., 2003; Britannica Online, 2010c).

Heart-failure, COPD and diabetes are examples of diseases that force the patient to change his life in order to improve (quitting smoke if you are a COPD patient, exercise if you are a cardiovascular disease patient, etc). These changes are not always easy to handle as we will see in next section.

4.3.2 Chronic Conditions Implications

The prognosis of chronic conditions is noticeably improved through strict control of risk factors (Boulos, 2009). Many times however, this control is neither easy nor pleasant to achieve from the perspective of both the patient and the physician.

Chronic conditions can be frustrating for the patient because they require too much time, money and travels (APA, 2003). Very often a chronic patient feels well and has to stay at the hospital to be monitored. When the patient is not hospitalized, transportation to health care facilities represents costs and can worsen his condition.

Handling medical appointments, remembering to take medications, monitoring health conditions and learning new treatment procedures are part of the daily routine of many older individuals (Fisk, 2009). Yet, changing lifestyle is the most difficult issue (Hunser, 2009).

It is very difficult for someone to change his lifestyle if one does not understand the disease. Therefore, information should be available early to avoid further complications (Chan et al., 2005). On the other hand, in order to improve his condition, the patient should know his body and the consequences of his actions. For this reason, feedback is very important in order to correctly adapt procedures.

Time and numbers of hospitalizations also disturb physicians. With the current situation, they cannot dedicate the time they feel they should to the patients and they cannot address the number of the patients they would if there was some kind of remote monitoring helping them.

Chapter 5

Analysis, Design and Evaluation of the Health Channel

Until this point, we have presented the context of this work (Chapter 2), the methodology followed (Chapter 3) and the outcomes of the User Research conducted to better understand our target audience (Chapter 4). This chapter presents the results of the analysis, design and evaluation of the Health Channel. First, we present the Personas created for this project along with some comments. Then, we detail the prototype of the Health Channel and the process that lead to its creation. At the end of the chapter, we describe how the prototype was evaluated.

5.1 Personas

As reported in Section 3.1.2, personas can be used to improve the understanding of the objectives, goals and needs of the final users. By creating a different persona for each type of user, it is possible to focus on the needs and goals of each of the different users at the same time. Within the eCAALYX project, eight Personas were developed representing primary users – older adults – as well as secondary users – caretakers and caregivers.

This section starts by introducing the process followed to create each persona by describing the example of John, the diabetic persona. At the end of the section, we list the remaining Personas pointing out their specific details.

5.1.1 John: The Diabetic Patient

John is the name of the persona that suffers from type 2 diabetes. This chronic condition has forced John to commit changes to his life in order to better control his disease. Because of this, the disease is an important part of his life. In order to understand John's

problems, one should understand his disease and how it impacts his life. This section reports some characteristics of the disease and then how these characteristics can generate a persona.

5.1.1.1 Diabetes disease

As was previously stated, diabetes is characterized by the inability to produce (type 1) or to respond to insulin[1] (type 2). This inability prevents the body from keeping the right level of sugar in the blood (Britannica Online, 2010c; netdoctor, 2010). When very high levels of glucose (sugar) are present for years in the blood, they can impact the blood vessels, heart, eyes, kidneys and nerves. The diabetic patient has to deal not only with the balance of glucose but with all the problems that can appear in his body, like for example on his feet .

The regulation of the sugar level in the blood can be done in three different ways: diet, exercise and insulin intake. The recommended diet suggests regular meals and a reduced intake of sugar, salt and fat. In addition, the patient will have to learn to measure food in terms of carbohydrates[2] in order to understand how it will affect his glucose levels (Renda, 2008). The exercise can lower the sugar level. Also in this case, it is important to know how to estimate the impact of the exercise in the glucose level. Insulin may be needed because the body stopped producing or responding to it (ADA, 2010; Renda, 2008). This hormone is responsible for transforming sugar into energy. While diabetes type 1 always needs insulin intake (because the body stopped producing it), type 2 may only require life style changes (netdoctor, 2010; Tierney Jr et al., 2003; Britannica Online, 2010c). However, it will not be easy to overcome long-lasting lifestyle habits as diabetes type 2 is strongly related to obesity.

The diabetic patient will have to balance the food ingested with the exercise taken to know, for example, how much insulin he will take. As one can predict, this balance is not always easy to handle. However, devices that measure the glucose in the blood can help patients manage this balance better by improving their knowledge of their body. Nevertheless, when one is learning to manage a new disease, it is normal to have doubts about the treatment and difficulties handling it. Changes will have to be made in one's life since adverse outcomes include limb amputations.

[1] Insulin is a hormone that is necessary to transform sugar and other food into energy. The purpose of insulin is to mimic the body's natural behavior (Renda, 2008).

[2] Carbohydrates are organic substances found in the food that produce immediate energy for the body (Britannica Online, 2010b)

Introducing changes to one's lifestyle is a difficult task (Hunser, 2009). If someone develops diabetes because is overweight, lifestyle should be changed as part of the treatment. In the same line of thought, the author believes that in order to commit lifestyle changes, the older adult should be very well informed of their ailment.

5.1.1.2 From a Disease to a Person(a)

After searching for the causes and characteristics of the disease, the team had understood a number of the problems to address. However, a persona is not a disease description. To be effective, it has to capture the cause of the problems. Many chronic conditions are caused by incorrect lifestyle habits. If one does not understand the origin of the problems, it will be very difficult to 'get under the skin' of the persona. With this premises in mind, the team searched for relatives that suffered from diabetes, read diabetic patients blogs[3] and scientific and medical literature concerning the problems of the diabetic (Edelman and Britton, 2007).

Dealing with diabetes can be very difficult in the beginning. The patient is probably overwhelmed with new precautions, medication and lifestyle changes (Edelman and Britton, 2007). Because this is an important detail of the disease, the persona should make a reference to it. Therefore, John's description refers that he is still discovering his disease (Figure 5.1). He wants to improve his condition but it has been difficult to handle so many things at the same time.

Having diabetes means experiencing a constant struggle (Edelman and Britton, 2007). The individual is not perfect but wants to live a long and healthy life. However, in order to do it, he has to accept his disease. Oncken (2010) published a blogpost in which she compares accepting diabetes to a problem in a marriage. She writes that there are people that ignore their disease like if it was going to eventually disappear. Similarly to a marriage, the only way to move on is to understand the disease, talking to it (as a partner) and having a lot of love for life. John's profile reflects this non-acceptance by referring that "he does not understand his disease and has been having problems handling it".

Medical testimonials pointed out that eating may be one of the pleasures that has not yet been taken from the older adult (problem of loss, see Section 4.2.3). For this reason, John is described as a "good fork". John likes very much to eat, however this cannot continue. John has to change his behavior in order to get better.

[3]Patient blogs share the experiences and frustrations of patients learning to deal with their disease. Both blogs are written in Portuguese: http://diabetico-mc.blogspot.com/ and http://diariodeumdiabetico.blogspot.com

Memory problems are common among older adults. Not taking the pills at the right time can be very problematic for the diabetic patient. For this reason, the persona description refers that John "has problems remembering his medication".

Independence is a very important issue/need to the older adult. However, because of the disease, the older adult may be deprived from his liberty. John has been hospitalized because of his difficulty in managing the disease. Since John does not want to lose his independence again, the goals of the persona profile refer he "wants to be better informed so that he can act effectively and avoid staying at the hospital".

Although memory changes can be attenuated, it is not possible to eliminate them. Therefore, the goals of John include having a system "that remembers him to take his medication and of his medical appointments".

In order to validate the generated Personas, these artifacts were presented and discussed with the medical partners of the project. During these discussions, the doctors confirmed the relevance of the aspects included in the created Personas, including John's. On the other hand, these conversations enabled us to gain confidence in the results and insight into the general doctors' experience treating older adults.

John

Background

John is a 70-year-old man that suffers from a dangerous type of diabetes. He is a very social person and a good fork.
John was diagnosed not long ago and is still discovering his new condition. However, he does not understand his disease and has been having problems handling it.
John also has problems remembering his medication and his medical appointments.

Goals and Motivation

John wants to be better informed so that he can act effectively and avoid staying at the hospital.John wants to have a system that remembers him to take his medication and of his medical appointments

Figure 5.1: John is a good fork and has diabetes.

Figure 5.1 shows John's persona, which includes a name, a picture and information on background, goals and motivation. The background, introduces the reader to key points

of the persona's personality and the goals and motivations, some of his wishes.

5.1.2 Created Personas

Patients are not the only users of the Health Channel. Therefore, the created Personas also include caretakers and caregivers. In this section, we will present the seven remaining Personas: Bill, David, Elizabeth, Jennifer, Lisa, Patricia and Robert.

Bill (Figure 5.2) is the name of a patient that just had a heart failure. These patients usually have to stay in the hospital for a period of time to learn how to deal with the disease. The problem is that, at some point, they are feeling ok and still in the hospital. Bill's persona tries to capture the will to be independent without losing the control on his heart condition.

Bill

Background

Bill is a 65-year-old very active man that lives alone in a small rural village. Some days ago, Bill had a heart failure and has been hospitalized since then.

Goals and Motivation

Bill is afraid of having more problems with his heart, but he is also tired of being at the hospital. Bill would like to be able to go home, but he does not want to loose contact with the doctor, as he fears getting worse.

Figure 5.2: Bill lives alone in a rural village and has had a heart failure.

David (Figure 5.3) is the son of Barbara and takes a good care of her. Barbara has been hospitalized and has developed a pressure ulcer that is healing slowly. David wants to take his mother home where he can take a better care of her however, like many other families, David and Barbara live far from the hospital. The Health Channel would enable Barbara to go home and still have a close monitoring from the doctor using for example videoconference. This persona also illustrates one case in which the Health Channel will be used not only by the older adult but also by his caregiver.

David

Background

David lives with his mother Barbara. Unfortunately, she has been hospitalized a month ago. However, she is feeling ok now, she has developed a pressure ulcer.

Goals and Motivation

David wants to take his mother home, where he can look after her. However, the doctor feels he needs to monitor her closely because the pressure ulcer might not heal well.
As David lives far from the hospital, a nurse will go to David's place to do the treatment, but David still thinks if the doctor had a look at the wound more regularly, it would be better.

Figure 5.3: David is the son of Barbara, a lady that has developed a pressure ulcer.

Elizabeth

Background

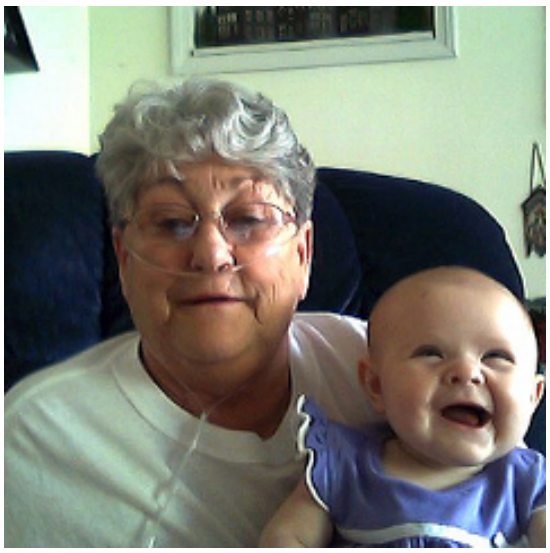
Elizabeth is a 75-year-old lady that lives alone in the center of the city. Elizabeth suffers from rheumatoid arthritis and has a lot of pain because of it.
When it rains Elizabeth has difficulties going to the street, as she gets really tired of holding the umbrella.

Goals and Motivation

Elizabeth has been hospitalized due to her disease. She wishes her problems could be discovered and solved early so that she can live her life independently, with dignity and away from the hospital.
Elizabeth feels the doctors do their best to give her back what the disease tries to take away, however she would like to have more monitoring of their health to avoid further complications.

Figure 5.4: Elizabeth is 75 years old and has rheumatoid arthritis.

Elizabeth (Figure 5.4) is 75 years old and has a very fragile body. She suffers from rheumatoid arthritis and has a lot of pain because of it. Elizabeth feels that she just needs to be aware of what is going on with her body to solve her problems early. But in order to do it, Elizabeth needs a close contact with the doctor.



Jennifer

Background

Jennifer is a 68-year-old lady that smoked for 40 years. In the last months she has been diagnosed with COPD. Jennifer has a lot of difficulty breathing as her lungs are not able to correctly absorb the oxygen.

Goals and Motivation

Every time Jennifer has a crisis, she fears for her life and she wishes she would have a quick way to contact the emergency services asking for help.
Jennifer knows her disease cannot be cured and that it was mainly caused by her smoking habits. She had some difficulties in quitting smoking. Today she wants to understand her disease and to be able to control it better.

Figure 5.5: Jennifer is a previous smoker that has developed COPD.

Jennifer (Figure 5.5) is sixty eight years old and has smoked for more than half of her life. Because of her addition, Jennifer has developed COPD, a disease which causes breathing difficulties. Each time Jennifer suffers a crisis, she fears for her life and wishes she had a better way of calling for help.

Lisa

Background

Lisa is Mary's daughter, a 67-year-old lady. Mary suffers from dementia and Lisa makes a great effort to improve her situation.

Goals and Motivation

Lisa wants to help her mother but she feels she does not have enough knowledge. Lisa sees her mother getting worse and would like her to have a closer monitor without having to take her through a confusing trip to the doctor.

Figure 5.6: Lisa is the daughter of Mary, a 67-year-old lady that suffers from Dementia.

Lisa (Figure 5.6) is Mary's daughter. Mary suffers from dementia and Lisa feels she is getting worse. However, Lisa feels she does not have the enough knowledge to help her. To learn more, Lisa has to take her mother to the doctor. The problem is that the trip can be very confusing for Mary. In cases of severe dementia, the Health Channel would only be used by the caregiver and would act as platform for information exchange between the caregiver and the doctor.

Patricia

Background

Patricia is a 40-year-old nurse specialist in wound care.

Goals and Motivation

Patricia is always occupied trying to see all the patients she can. However that's not possible because there is simply no time to do it. Currently Patricia visits only the patients which are in the most serious situations and regular nurses help treating the simpler cases.
Patricia cannot effectively monitor the evolution of simple cases to prevent complex situations. She would like to have a tool that would keep her on track of each patient's evolution.
Patricia would also like to exchange more information with the patient's family doctor, so both would make a more personalized and integrated treatment.

Figure 5.7: Patricia is a nurse specialized in wound care.

Patricia (Figure 5.7) is a nurse specialized in wound care. Patricia is always occupied and has to monitor a large number of patients. Currently she monitors the most dangerous situations however, she cannot track the evolution of simple problems as there is no time. Patricia would like to have a system that enabled her to monitor quickly the simpler without needing to do so many trips. This way, simple situations would not grow into worst problems.

Robert (Figure 5.8) is a family doctor with a vast experience with older adults' treatment. Robert would like to be acting preventively instead of only fixing things. But in order to do it, Robert needs a system that enables him to monitor closely the evolution of the health condition of his patients.

As we have seen, the created personas have different objectives with the Health Channel. The aim of the Personas technique is really to enable the design team to concentrate on the problems and goals of the different users of the system.

Robert

Background

Robert is a 50-year-old family doctor with has a vast experience in older adults treatment.

Goals and Motivation

Robert feels that it would be better for the patients if he could monitor their health closely. Instead of fixing things he would pay attention to changes and act preventively.

Robert has some older patients that move a number of times a year; this makes it difficult to keep track of them.

Robert would also like to exchange ideas with other specialties doctors when they examine his patients.

Figure 5.8: Robert is a family doctor of a number of older adults and tries keeping a good track on their health.

5.2 Health Channel Prototype

The Health Channel has three parts: the TV remote, the TV frame and the paper prototypes of the user interfaces. The (low-fidelity) prototype was created to enable the discussion of ideas within the design team and to evaluate its performance with users (see Section 3.1.3 and 3.1.4). The next section, presents some notes on the TV remote and on the TV frame. Then, the user interfaces of the system are presented along with some relevant comments.

5.2.1 Remote control and TV frame

The remote control is going to be used to interact with the Health Channel. However, these devices are usually populated with too many buttons which make them hard to use. To solve this issue, the author decided to craft a remote control out of soap that only had the required buttons. At this point it was important to decide which buttons to include. Some authors recommend using the channel numbers to select options (Gill and Perera, 2003). However, arrows appear to be a better option for two reasons: 1) arrows make it easier to automate behaviors because of their placement; and 2) they do not require the user to look at the remote so many times to choose a button, a process that requires the eye to adapt (see vision problems Section 4.2.1.1).

Although arrows were initially preferred, it was important to understand if older adults could use them effectively. In order to to find it, the author crafted a remote control with

(a) The first version of the remote control had numbers and arrows to allow the first usability test.

(b) The second version of the remote control had arrows to navigate a cursor on the screen and a button in the center to select options. The button "voltar" (go back) in the top allows the user to go back to the hierarchically superior screen.

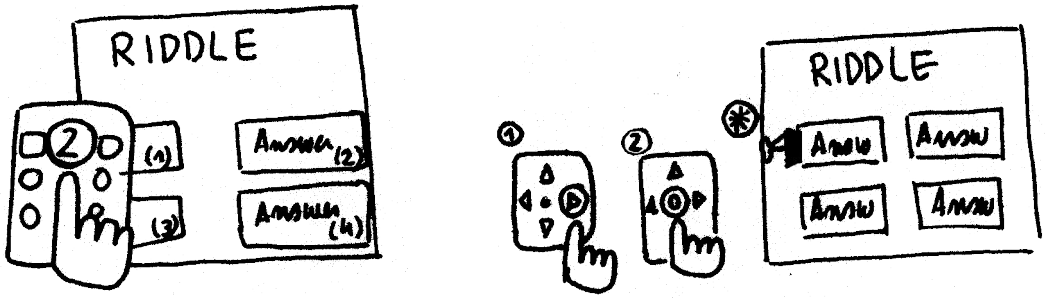
Figure 5.9: Different versions of the remote control.

both numbers and arrows (see Figure 5.9(a)) that was used in the first usability test (see Appendix B.1). The task involved selecting the answer to one riddle in a paper prototype user interface by pressing the number of the answer on the remote or moving a cursor to the right option with the arrows and selecting it with the middle button (see Figure 5.10(a) and Figure 5.10(b)).

Results showed that older adults were able to use both the numbers and the arrows. Since the numbers were printed under the options, when in doubt, the users tried the number of the option. When users completed the task using the numbers, the facilitator asked them to try again using the arrows; a task in which they succeeded after learning how to use the arrows of the remote. Forgetting how to use the arrows was a common problem in the first usability test. However, after the first usage, users did not experience more problems.

Our tests have shown that older adults did not have great difficulties using the arrows. Therefore, we chose arrows to control the system as they present fewer restrictions in terms of user interface elements. After this decision was made, the remote control in Figure 5.9(b) was used in the tests.

Just as the remote control enabled the user to select options, it was important to have a



(a) Selecting the answer to the riddle required to click on the button with the number of the answer.

(b) Selecting the answer to the riddle required to move the cursor (binder clip) to the answer and then to click the "middle button".

Figure 5.10: Different approaches to selecting options evaluated on the first usability test (Appendix B.1).

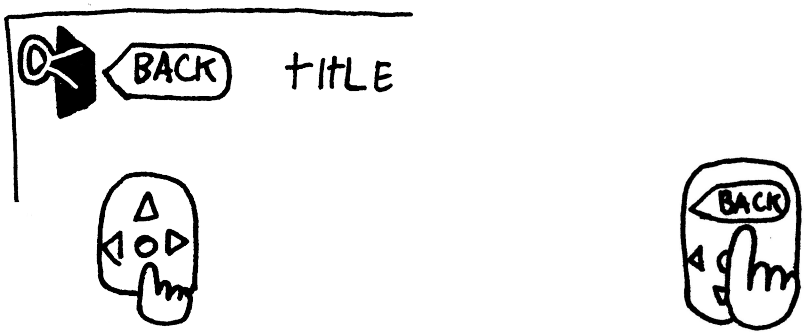
way to go back to the previous screen. For enabling this option, there were two different alternatives (see Figure 5.11(a) and Figure 5.11(b)). One could insert a button on the top of the screen or on the remote control itself. Again, the solution found was to test both the solution and see what was preferred by the users. This was evaluated on the fourth usability test (Appendix B.4). During that test, there were a number of activities to be performed that required the user to go back to the previous screen. In order to do it, the user was supplied with both the options: the button on the screen and on the remote. After a brief explanation on how to use both the options, the user started performing the tasks. The back button on the remote was used on all occasions. It seems that the users did not notice the back button on the screen. One possible explanation for this lack of notice would be because the screen button was too far from the center of the screen. This may have rendered it impossible to see due to the decrease in the peripheral vision.

Based on these previous results, we decided to put the back button in the remote control.

The TV frame was created to give more realism to the prototype. With the help of the TV frame, sketched paper sheets became TV screens. A binder clip held the current screen to the frame and allowed the sheets to be easily switched. Each time the user interface changed a different sheet came to the front.

The user interface screens were dimensioned according to the 4x3 ratio. This proportion is becoming deprecated with the rise of 16x9 televisions, however it is still very common in most older adult houses.

Another important issue was to decide the size of the screens. Reading on a television requires space and therefore a medium sized television was chosen. The first idea was to choose the dimensions based on the size of a common medium/large TV on the market. However, since 4x3 televisions are disappearing, it was not possible. The author then turned into paper sheet sizes. A2 appeared to be a large format that could be read at some



(a) (b)

Figure 5.11: There were two alternatives for going to the previous screen in the fourth usability test (Appendix B.4). The first required to insert a back button on top of every screen. Selection was done pressing the middle button in the remote. The second alternative (the chosen option) required to press the back button on the remote.

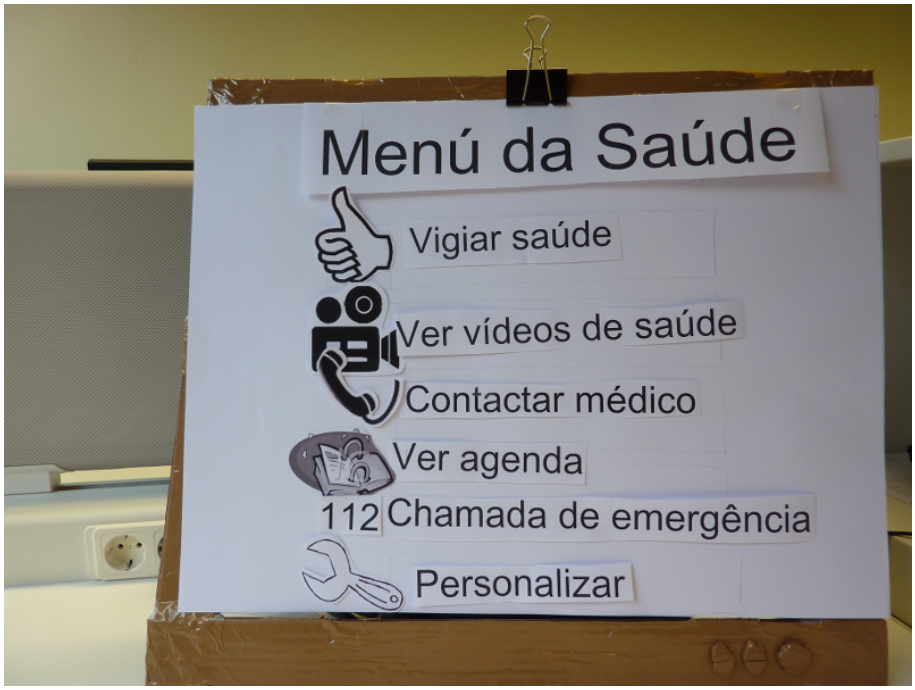


Figure 5.12: TV frame holding the user interface of the Health Menu after the 4th usability test changes.

meters of distance. The size of the screen is the closest to the A2 sheet format and features a diagonal of 69 cm.

To guarantee the legibility of text in the screens, the author decided to design the system to be used up to three meters of distance – the distance that people sited from the TV at the day center, our test setting (see Section 5.3).

The next section presents the user interfaces that were created for the Health Channel.

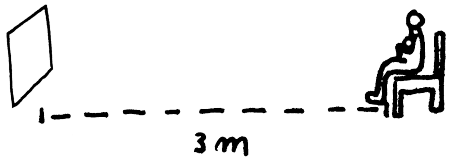


Figure 5.13: The system was designed to be operated at up to 3 meters away.

5.2.2 User Interfaces

In this section we present the user interfaces of the Health Channel (Figure 5.14 shows an overview of most user interfaces). This system presents the user with a number of functionalities for managing his health. These functionalities fall into four categories: learning, health condition monitoring, communication with the caretaker and utilitarian.

Learning about the (chronic) disease can help the patient to understand the points of his lifestyle that need to be changed. For this reason, the Health Channel enables the older adult to watch health videos (see Section 5.2.2.4) sent by the physician.

Monitoring the health status is also very important to introduce changes in the lifestyle. If a patient is able to see the effect of his actions in his health state, he has the opportunity to learn more about how his body works. Because of this, the Health Channel offers a feature that enables older adults to see a graphical representation of the evolution of a health condition like the arterial tension or the glucose level (see Section 5.2.2.3).

The communication with the caretaker is very important as it will allow the older adult to get advice whenever needed. In this context, the older adult will be able to videoconference with his caretakers (see Section 5.2.2.5) or with the emergency services (see Section 5.2.2.7). The older adult will also benefit from not having to make so many tiring trips for a medical appointment.

The utilities aim to solve problems that the user experiences in his daily life. This includes being remembered of medical appointments (see Section 5.2.2.8) and to take medication (see Section 5.2.2.9). Moreover, an agenda with medical and personal appointments is also included (see Section 5.2.2.6).

Before starting the description of the user interface, it is important to refer some general details that affected the design of some user interfaces.

5.2.2.1 General Considerations

This section presents general details that influence most interfaces. These include information about the size of text, the reasons why some screens have printed titles and why some images were printed.

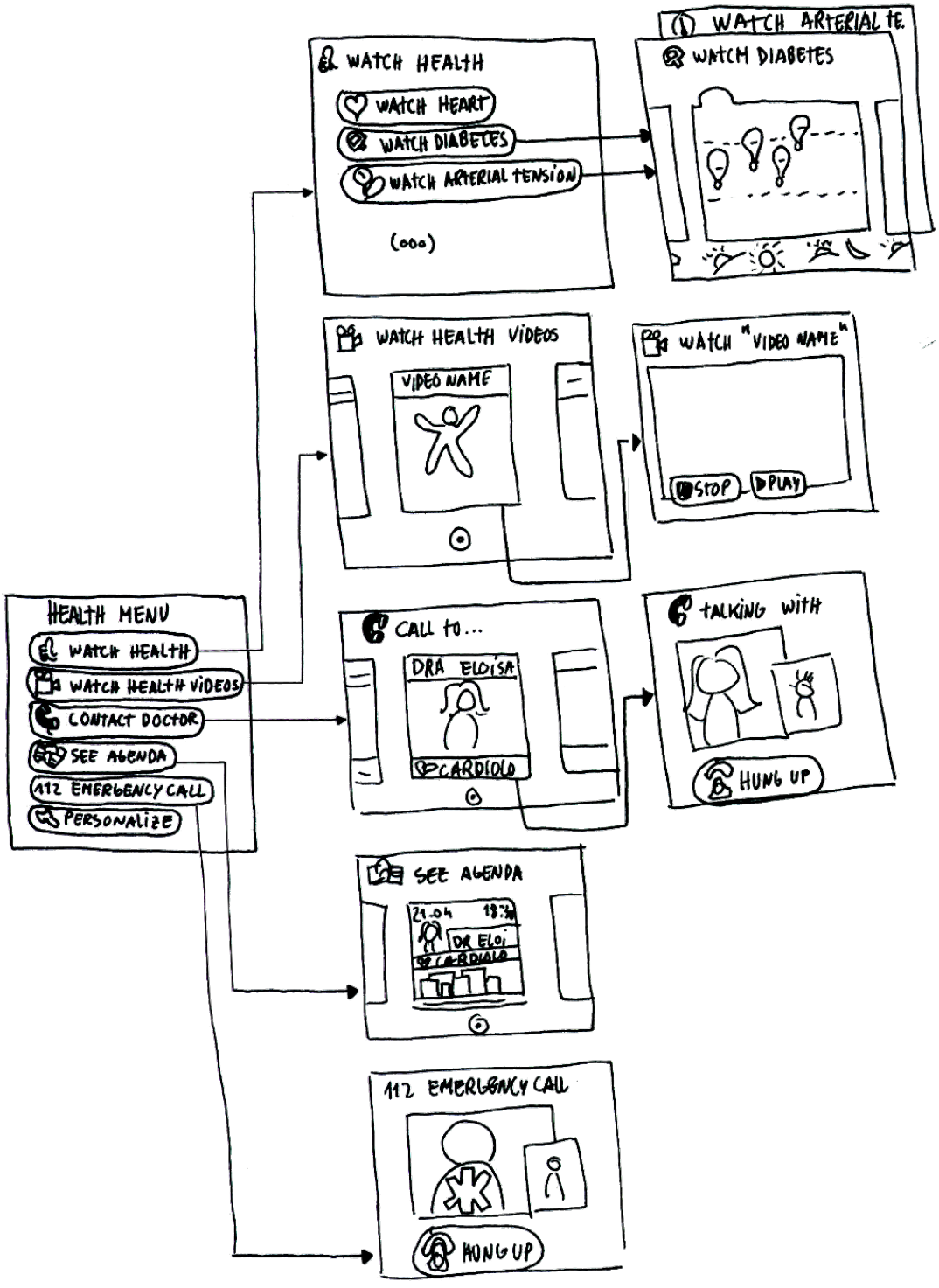


Figure 5.14: Map of all the user interfaces that can be launched from the Main Menu.

As it has been previously said, older adults suffer from vision problems (see Section 4.2.1.1). Because of that, text should be displayed in a large size. But what is the right text size for older adults? Not having found an answer in the literature, the author

decided to test different text sizes with users. Therefore, the first usability test included one task that presented a number of words in different sizes (see Appendix B.1). These words were shown to the user at a distance of three meters. Results have shown that all users were able to read at least part of the text in the larger size (50pt) that was presented. To prevent reading difficulties, the author decided to present text at least with 50pt.

After the fourth test (Appendix B.4), it became clear that text written with pencil was not easy to read when the user was sat three meters away. The solution found was to print the screen titles and paste them over the user interface. However, because the usability tests were mainly facilitated by one individual, it was easier to have the prototype close at 1 or 1.5 meters. This way it was simpler to change the user interface screen, monitor the interaction with the remote control, take notes and give instructions for the next task. One could argue that decreasing the distance to the prototype would cope with vision problems and therefore make usability tests much easier than the real setting. However, it is not relevant to test text legibility in all the tests. It was tested in the beginning, therefore, if the minimum size is respected and the interface has little noise, we believe that the distance does not influence significantly the result of the tests.

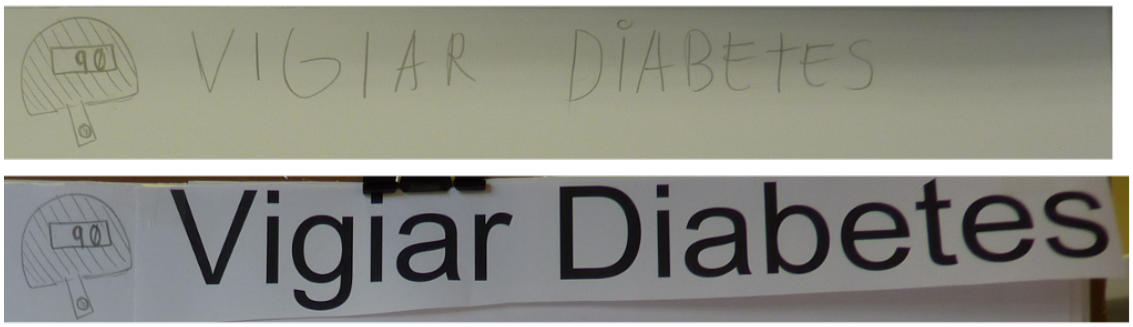


Figure 5.15: Screen Watch Diabetes with title written with pencil and printed. Some titles were printed to provide better readability and allow testing at a distance of three meters.

Visual cues like icons will enable illiterate users to use the system. However, this is not the only advantage of using this graphic representation. Users that can read will also benefit from them because, when together, icons are easier to distinguish than words (Norman, 1991, chap. 6). This will make it easy to automate, for example, choosing an option in a menu. Yet, the older adult will only benefit from the icon if the metaphor makes sense to him. Therefore it was important to test several metaphors with users to find the most suitable. With this in mind, the author found various alternatives and printed them. Because the goal was to think about the metaphor, the author searched for images with little detail and printed them on black and white. Different icon alternatives were

tested in the third, fourth and fifth test (see Appendix B.3, B.4 and B.5). Since the health menu has a large number of icons (see Figure 5.12), it is even more important for them to make sense. More specific icons like the one to represent watching the status of arterial tension were sketched and worked when creating the medium fidelity prototype[4].

5.2.2.2 Health Menu

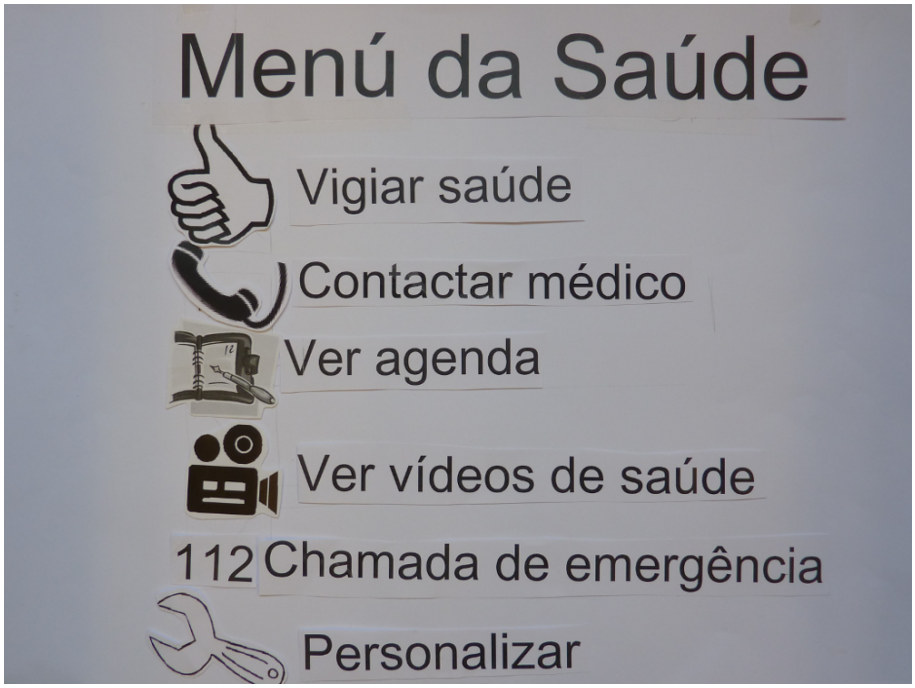


Figure 5.16: Health Menu is the main menu of the Health Channel. The options from top down are: "Watch Health Status", "Watch Health Videos", "Contact Doctor", "See Agenda", "Emergency Call" and "Personalize".

The Health Menu is the main menu of the system (Figure 5.16). When the user enters the Health Channel, this is the screen that appears. A superficial analysis could lead one to think that this screen is easy to design because it is just a menu. However, when designing, it is important to use the words of our audience. With older adults this is even more important because the designer and the audience are not likely to have a common background. For this reason, the Health Menu was iterated in three usability tests, the second, the third and the fourth (see Appendix B.2, Appendix B.3 and Appendix B.4). The issues studied in the usability tests include the names of the options, the icons to represent them

[4]The medium fidelity prototype was based on the low-fidelity prototype presented in this section. Although the prototype was not created by the author, he was involved, for example, in the evaluation of some of its design decisions with users in the eighth usability test (Appendix B.8).

an the order of the options in the menu.

The options of the menu were not difficult to choose. Since this is the main menu of the system, any option launched by the user, comes from this location. Now that the menu options were defined, it was important to find the names for the functionalities of the system that were more meaningful to the older adults. But which is the best way to ask for the appropriate name without influencing the decision of test participants? One should present several alternatives but also be open to their suggestions. With this in mind, the author created one task on the second usability (Appendix B.2) test to evaluate the initial names and gather suggestions (see Figure 5.17). The older adult was asked to imagine a system for the TV to help him manage his health. Then, the participants were shown a list of names for the functionalities and were asked what they could enable to do in the Health Channel. After hearing their ideas about the names, older adults were invited to suggest names given the functionality description. Results have shown that while some names were easy to understand, others were not. Participants referred that the name Make Call (Fazer Chamada) was too vague for a functionality that allowed calling the doctor. Therefore, two suggestions were made Contact Doctor (Contactar Médico) and Call Doctor (Telefonar a Médico). The functionality Watch Educational Videos (Ver Vídeos educativos), also brought up some difficulties. A number of participants thought this functionality was meant to teach them how to behave or to expand their general knowledge. Since the focus was on learning how to deal with their diseases, one test participant suggested the name: Watch Videos about Health (Ver Vídeos sobre Saúde), which can be simplified to Watch Health Videos (Ver Vídeos de Saúde). The functionality See Health Status (Ver Estado de Saúde) was understood by most of the participants. However, Watch Health (Vigiar Saúde) was suggested as a better designation for a functionality that enabled the older adult to check if his heart has been working well. The action named Personalize (Personalizar) was not understood by any of the test participants. This metaphor is widely used in informatics; however it appears to be strange to older adults. Configure (Configurar) was suggested as a better designation for a function that allows to personalize the system to its owner. The action See Personal Agenda (Ver Agenda Pessoal) was well understood, however after the test the author removed the Personal from the name since it does not add new information. The Emergency Call (Chamada de Emergência) was also well understood by the participants. Based on these results, the author decided to re-evaluate the names of the functionalities that received suggestions. At this point, the author decided not to iterate the option Personalize further because its purpose is not well defined.

In the usability test described above, the author gained knowledge of the definitions that the older adults had for the suggested functionality names. Besides this information,

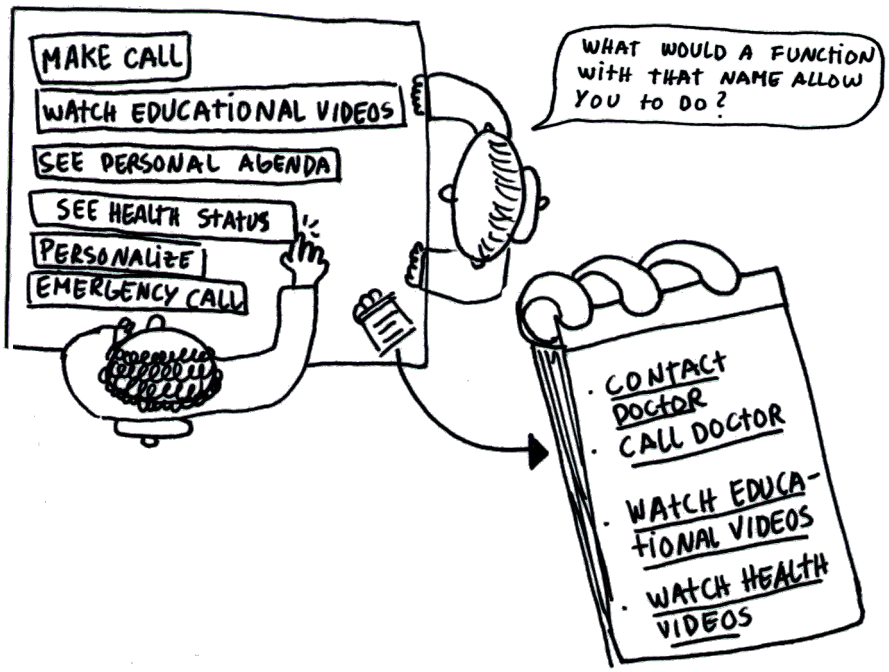


Figure 5.17: Testing Health Menu options names' on the second usability test (Appendix B.3). The second usability test asked the participants what could a functionality name enable them to do when inserted on a system that worked on the TV and enabled him to manage his health. After listening their ideas, the facilitator asked the participants to suggest names. The notebook shows the names that were suggested by older adults during the test.

we received several suggestions that should be tested against the initial names. Hence, a new task was created in the third usability test (Appendix B.3). In this task, the facilitator read a functionality description and asked the participant to choose the best name for it based on a list that was in front of him (see Figure 5.18). To avoid skewing the results, this test was performed with different individuals than the first one. Results have shown that older adults are much better at choosing names than the author since all their suggestions performed better than the initial ones. The functionality for calling the doctor had three alternative names: Make Call (Fazer Chamada), Contact Doctor (Contactar Médico) and Call Doctor (Telefonar a Médico). Contact Doctor was chosen by three of the six users. Although the two other options were also selected, Contact Doctor seems to be the most adequate name for the functionality. The choice of the name Watch Health (Vigiar Saúde) was unanimously chosen to describe a functionality that enabled the older adult to check if his heart is working well. When asked to choose the name of a functionality that enabled them to see health videos sent by the doctor, four participants selected Watch Health Videos (Ver Vídeos de Saúde) and two Watch Educational Videos (Ver Vídeos Educativos). Because of the confusion with the word education described in the previous paragraph, the author decided to keep the option that most users preferred. The

final names appear in Figure 5.16. Due to time constraints, these names did not continue to be iterated. However in an ideal situation, more names would be searched and tested with a larger number of participants to get more solid data.

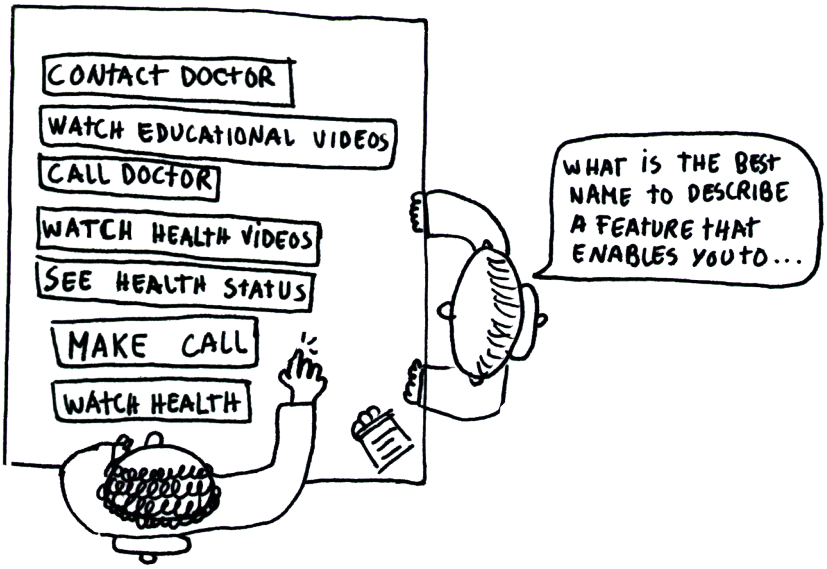
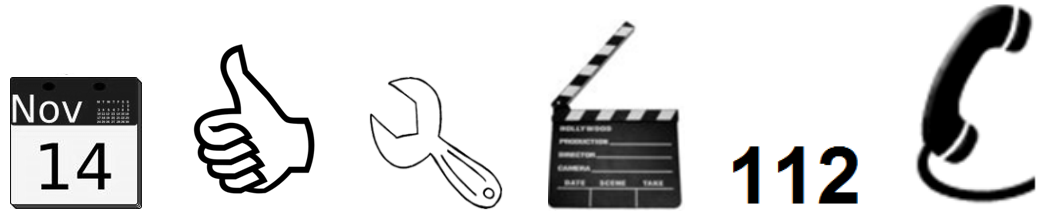


Figure 5.18: The participant chooses the best name for the functionality description read by the facilitator in the third usability test. This task included the initial names and the user suggestions from the previous test.

Figure 5.19: Participant chooses image for the menu options in the third usability test.

The names of the functionalities were not the only aspect of this screen to be evaluated. The icons that represent the menu options of the Health Menu were also tested. These icons were first evaluated in the third usability test and iterated in the fourth (see Appendix B.3 and B.4). Just like the menu options, the first test was created to get to know the opinion of users about the initial icon set and to receive suggestions. In the task,



(a) See Agenda (b) Watch Health (c) Personalize (d) Health Videos (e) Emergency Call (f) Make Call

Figure 5.20: First version of icons for the Health Menu options tested on the third usability test (Appendix B.3).

the facilitator had the names of the menu options on one side of the table and the icons on the other (see Figure 5.19). The participant was then asked to place the right icon over its name. Results have shown that the icons were difficult to understand as only two did not create doubts. The icon Watch Health Videos (a film claket in Figure 5.20(d)) and Personalize (a tool in Figure 5.20(c)) were understood by half of the participants. See agenda (a calendar image in Figure 5.20(a)) was understood by four of the participants. The icon for Watch Health Status (a thumb that indicates everything is ok in Figure 5.20(b)) was understood by five of the participants. Only the Emergency Call (112, the european emergency number in Figure 5.20(e)) and Contact Doctor (a phone in Figure 5.20(e)) were understood by all the participants. It is important to refer however, that in the case of the calendar and the film claket, the facilitator had to explain what the image was. Based on these results, the author decided to search for new images for the Watch Health Videos and See Agenda. Personalize was again excluded because when the functionality is better defined, it would be easier to choose its graphical representation.

In the usability test described above, the author concluded that the participants had difficulties understanding the icon of See Agenda and Watch Health Videos. In order to improve these icons, the author searched for alternatives with slightly different metaphors (see Figure 5.21). These alternatives were shown to the users in the fourth usability test (Appendix B.4). In this test, the user was presented with the Health Menu screen held to the TV frame. Each menu option had an icon to the left except for See Agenda and Watch Health Videos. Once read the description of each of the functionality, the user was asked to choose the icon for the missing placeholder from five available options. Results showed a tight between two images for both cases. For Watch Health Videos, two images were chosen: the video cassette (Figure B.9(a)) and the movie projector (Figure B.9(b)) each one with half of the six participants. For See Agenda, the metaphor of the pocket agenda (Figure B.8(b)) and the daily agenda (Figure B.8(a)) were chosen. At this point, the author decided to repeat the task in the following test but only with the images that were chosen in the fourth test. For this reason, the fifth usability test (Appendix B.5)

included a task that compared both the images chosen by users in the previous test. Only two participants answered however, the image for Watch Health Videos generated another tight. Although both the options were chosen, the cassette has a handicap because cassettes are disappearing. For that reason, the video projector was chosen. In the case of the agenda, both the users selected the pocket agenda (Figure B.8(b)), however since both metaphors are very similar, the graphically simpler solution was chosen (Figure B.8(a)).

(a) Daily Agenda (b) Daily Agenda (c) Daily Calendar (d) Pocket Agenda (e) Table Calendar

Figure 5.21: Different agenda metaphors evaluated on the fourth usability test (Appendix B.4).

(a) Film Strip (b) Claket (c) Film Reel (d) Cassette (e) Movie Projector

Figure 5.22: Different metaphors for videos evaluated on the fourth usability test (Appendix B.4).

The last aspect to be studied regarding the Health Menu was the options' order. Although it may sound superfluous, a good ordering can decrease the number of errors and improve the experience of the user, namely in terms of efficiency. It was important to have the most used functionality placed at first. To find the best order, the medical partners of the project were asked to sort the menu options according to two criteria: importance and frequency of use. The middle columns of the Table 5.1 show the ordering as identified by the doctors. Having these two numbers, the author then calculated the average position for each option. Table 5.2 shows the result of this ordering. However, a final arrangement was performed - the Emergency Call was moved to the end - not only because this functionality is the one least used, but also because selecting it by mistake would have a negative impact in the emergency services (see Table 5.3).

Name of the option	Importance	Frequency of use	Average
Contact Doctor	2	3	2.5
Emergency Call	1	5	3
Watch Health Status	3	1	2
Watch Health Videos	4	4	4
See Agenda	5	2	3.5

Table 5.1: Menu options as sorted by importance and frequency of use by the doctors.

Watch Health Status
Contact Doctor
Emergency Call
See Agenda
Watch Health Videos

Table 5.2: Order of menu options combining the criteria of importance and frequency.

Watch Health Status
Contact Doctor
See Agenda
Watch Health Videos
Emergency Call

Table 5.3: Final order of the Health Menu.

5.2.2.3 Watch Health

The Watch Health functionality allows the older adult to monitor his health. This functionality is formed by two screens: the menu to select the health condition and the user interface that shows the evolution of the health condition. These screens will be better described in the following sections.

Watch Health Menu

The Watch Health menu (see Figure 5.23) lists the health conditions that the system is monitoring. Therefore, the options are different from user to user. The current version of the prototype belongs to a patient that suffers from diabetes, hypertension and heart problems. Because the menu can have several of options, it is important that the user understands what each option does. In order to test the names of the menu options, a task was created in the fourth usability test (Appendix B.4). This task asked the participant to see the status of their arterial tension and their diabetes. In order to do it, the participant had to navigate to the Watch Health Menu and select the appropriate option. Results have

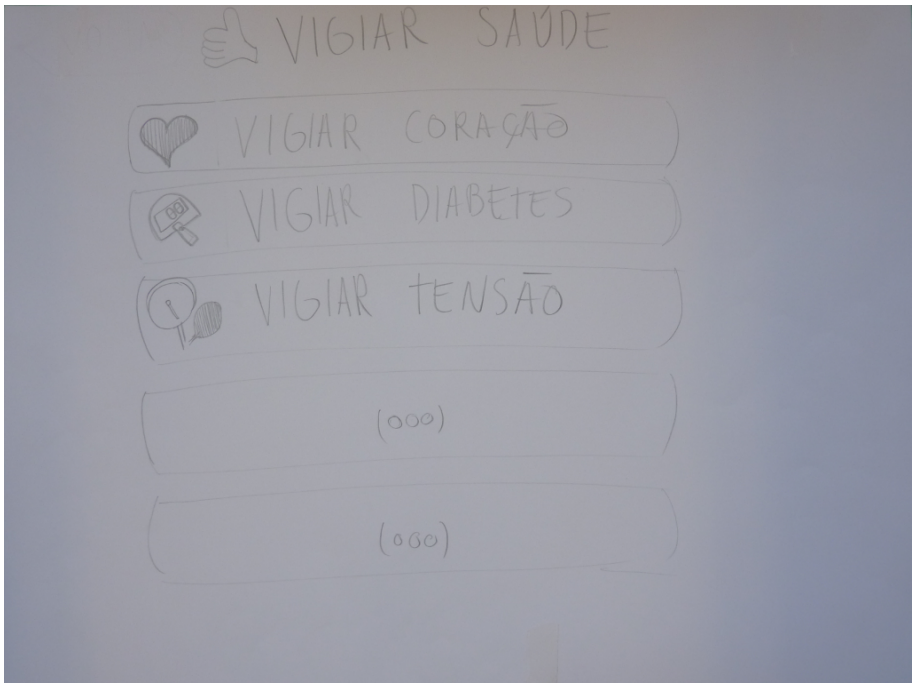


Figure 5.23: Watch Health menu screen. The options from top down are: "Watch Heart", "Watch Diabetes" and "Watch Arterial Tension", "See Agenda", "Emergency Call" and "Personalize".

shown that none of the six participants experienced difficulties choosing the right option. After the test, however, the author felt that the word "Watch" (Vigiar) could be removed from the options (see Figure 5.24). In order to evaluate this premise, the author repeated the same task in the following usability test with other users (Appendix B.5). Although none of the users had problems with the menu options, because the sample was too small (two users), the test had to be repeated with other users. However, when discussing this subject, another important premise aroused: older adults can forget the task they are trying to perform due to the decrease in short-term memory. Keeping the verbs in the name of the options can remember them what they were trying to accomplish. For that reason, the verbs were kept in the menu options.

Watch Health Condition

Selecting an option in Watch Health menu takes the user to a screen that shows the evolution of a certain health condition. Watch Arterial Tension (Watch Tension), for example, shows a graph with the values of glucose that were measured during the day (see Figure 5.25). This user interface presents a graph on the center and two pieces of graph on the sides (see Figure 5.26). The graph on the left is older or more general. And the one in the right is more recent. Pressing the left arrow of the remote control takes the user to see the evolution of the diabetes of yesterday. Pressing the left arrow again, takes the user

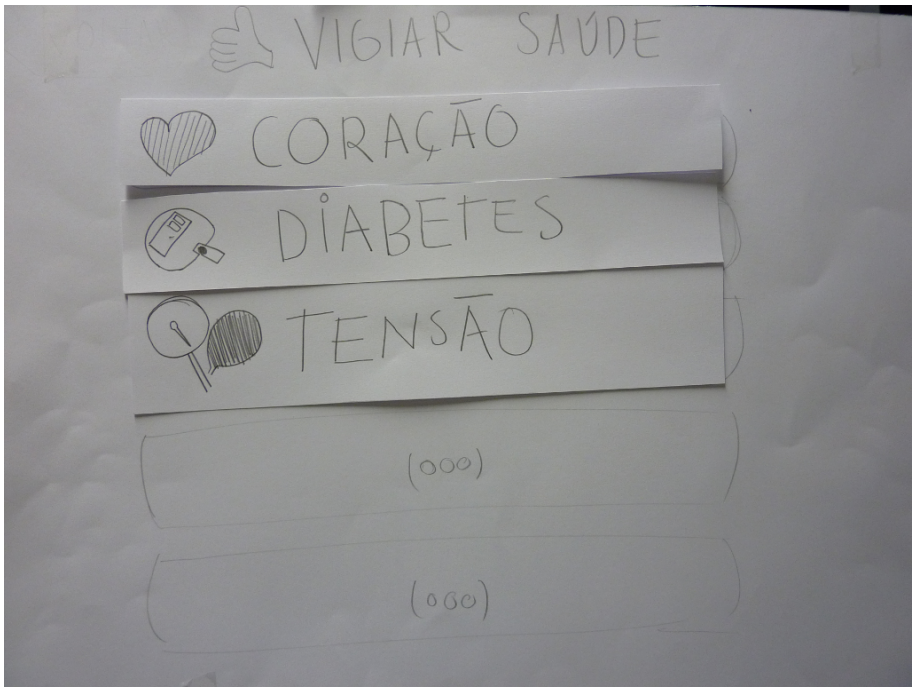


Figure 5.24: Watch Health screen without "Watch" in every option. Although this version was graphically simpler, it was not adopted since the verb (Watch) can help keeping context and therefore help older adults with short-term memory issues.

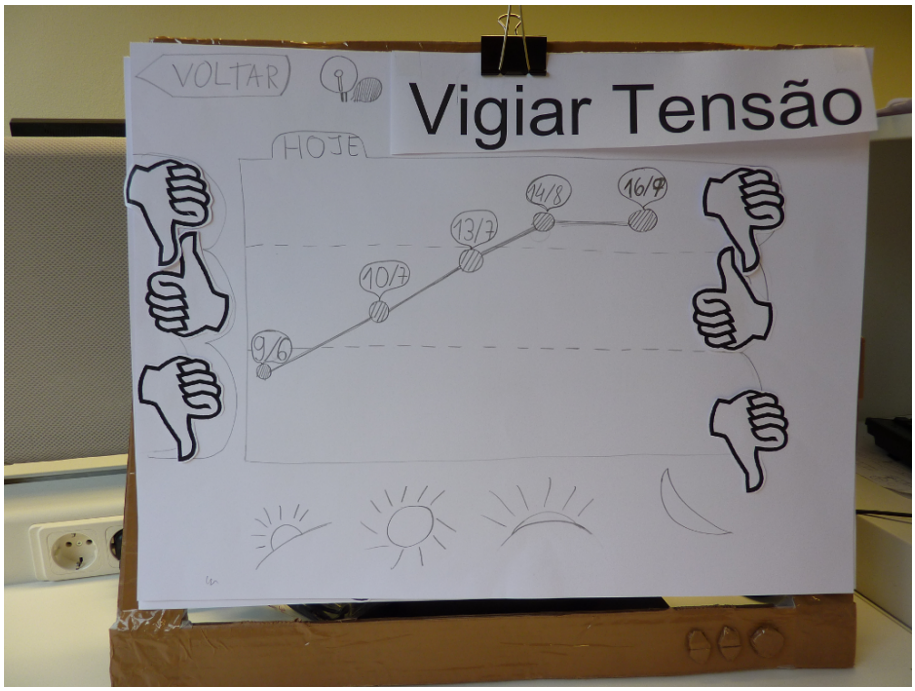


Figure 5.25: Watch Arterial Tension screen. Thumbs were present on the first version of the graph. However, they were removed because they created confusion.

to see the evolution of the diabetes during the last months. This navigation was tested in the fourth usability test (see Appendix B.4). Looking at today's graph, participants were asked to go to yesterday's graph (see Figure 5.27). Results showed that it was not obvious that clicking on the left arrow would allow them to see yesterday's graph since none of the eight participants had a clue of how to do it. However, because this visualization is reproduced by other user interface screens – like See Agenda or Watch Videos – great difficulties are not expected.

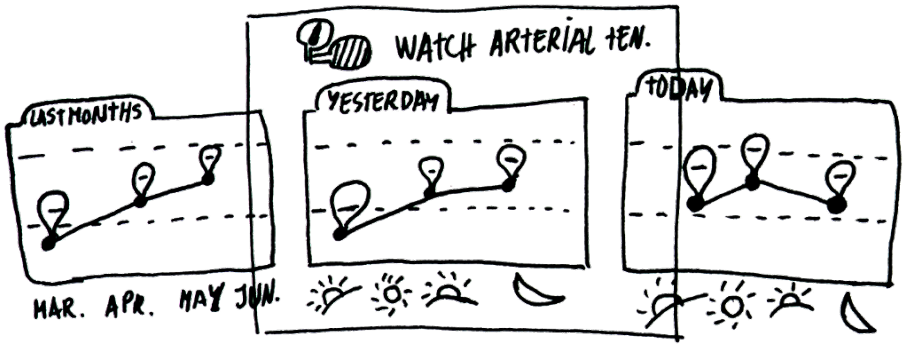


Figure 5.26: Watch Arterial Tension allows the user to see the evolution of his arterial tension today, yesterday and in the last months. Pressing the left or right arrows changes the graph one sees.

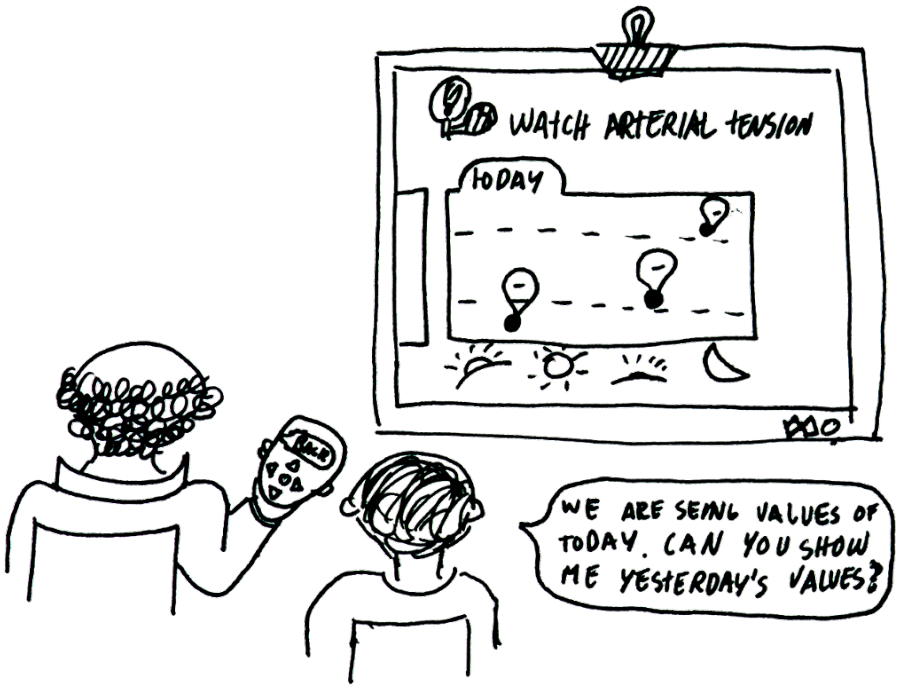


Figure 5.27: Participants were asked to switch to yesterday's graph of arterial tension in the fourth and fifth usability tests.

Now that the general user interface has been described, one will focus on the graph that shows the evolution of the condition. But first, it is important to explain the origin of the idea. As has been said, chronic patients need to monitor their condition. European diabetic patients, for example, use a special notebook to monitor their condition. This notebook keeps track of the glucose levels and is shown to the doctor to adjust treatment. The problem of the notebook is that it is just a list of values. While a list of values is good for checking a certain measure, it is not the best way to visualize the evolution of the condition. Graphical representations on the other hand, are good for showing the evolution of a variable over time. Based on this idea, the author created a very simple graph for the TV screen.

The graph visualization is vertically divided into three areas. While the middle area shows recommended values, the lower part contains very low measures and the higher part very high ones. The fourth and fifth usability tests also evaluated if these areas were understood (Appendix B.4 and B.5). Users were asked to indicate very high and very low values and did not have difficulties answering. It is also important to refer that, initially, this screen had thumbs on the right side of the graph (see Figure 5.25). The goal was to show that the values on the upper and lower parts of the graph were not recommended. For this reason, the middle area, had thumbs up and the other two areas thumbs down. During the fourth usability test (Appendix B.4) however, the thumbs were not even noticed. When asked about their meaning, two participants referred that the direction of the thumb indicated if values were going up or down. In order to avoid this misunderstanding, the thumbs were removed from the graph.

Each point on the graph is accompanied by its numerical value. This enhances the legibility of each value and spares the user from having to look at the axis values. Although identifying the value of a point is easy for someone that has learned how to read a graph, it can be significantly harder for someone that is not used to this kind of representation. On the other hand, the axis may fall out of the vision radius and make it impossible to compare the value against the scale. Although the graph is simple, it was important to understand if users could read the values represented on it. The fourth and fifth usability tests (Appendix B.4 and B.5) contained several tasks that asked the participant to read a certain value, none of which generated difficulties.

To represent the evolution of a condition during one day, twenty four hours need to be represented in the x-axis. However, minutes or hours are inappropriate for the television because they require too much space. The found solution was to use a scale that divided the day in four parts: the sunrise, midday, sunset and night (see the lower part of the screen in Figure 5.25). Although this scale does not allow knowing the exact hour of a measure, it shows how the condition evolved during the day. This part of the user interface was also tested during the fourth and fifth usability tests (see Appendix B.4 and B.5). In those tests, none of the eight participants experienced difficulties referring the values of

morning measures.

The scale presented above was used on Today's and Yesterday's graph. In addition to this scale, others were created for different time frames. The last week's graph also contained four divisions. If today was Saturday, the scale would contain last Sunday, Tuesday, Thursday and today. The Last Months graph shows the last four months.

5.2.2.4 Watch Health Videos

The watch videos functionality is composed by two screens: one to select videos and one to play the video. The screen to select the video (Figure 5.28) works like the user interface of the agenda (see Section 5.2.2.6). In this visualization, an image representing the video is at the center and two others cut in half, one at the right and one on the left. The image on the left represents the previous video and the one on the right is the next one (screens are ordered by the date in which they were sent by the doctor). The screen to play the video is a common video player containing the buttons to stop and play de video (see Figure 5.29). Because the user interfaces are similar to other screens that were tested previously, the author chose not to test them. However, details of the user interfaces were tested.

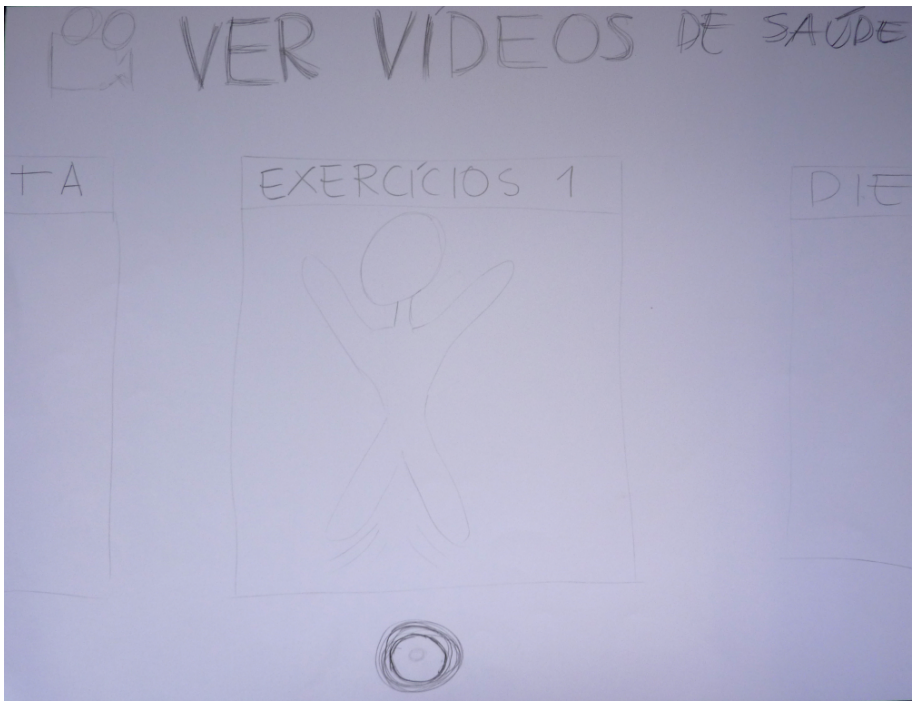


Figure 5.28: Screen to select which video to see.

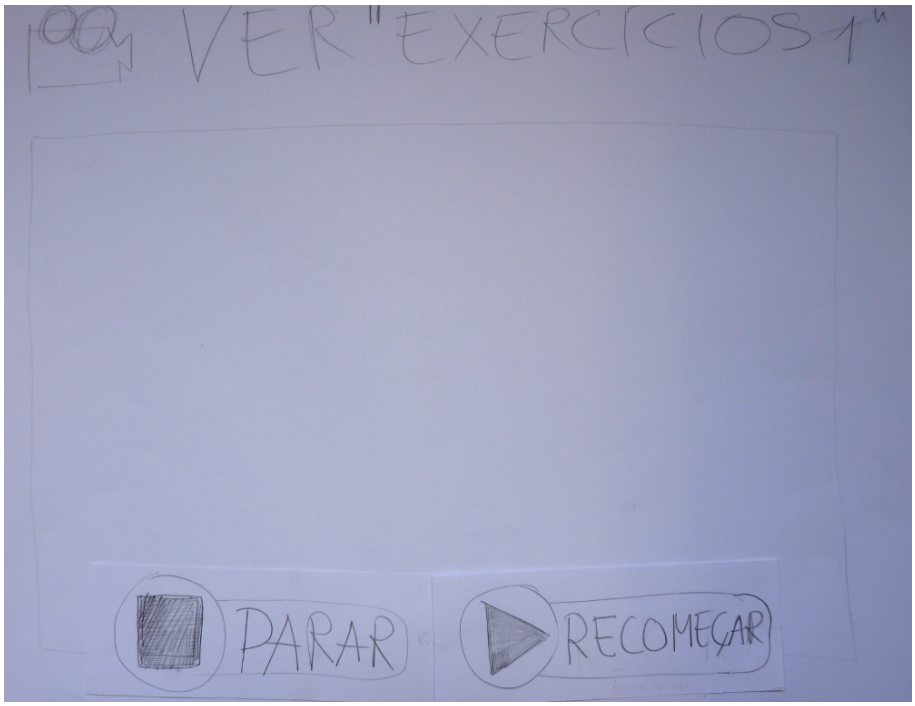


Figure 5.29: Watch Health Video player. At this moment the video is paused, therefore there are two buttons Stop (Parar) and Replay (Recomeçar).

The user interface that plays the video has two buttons: stop and depending on the situation pause or replay. It is important to refer that the video starts playing after it is selected; therefore there is no button to start playing. At the beginning of the process, it was important to know if older adults knew the common video buttons. If they did, the user interface could be simpler and take less space in the screen since button labels were not required. In order to test if users knew the video symbols, the author created a task in the seventh usability test (see Appendix B.7). In this task, users were shown the play, pause and stop buttons. However, only one participant (in six) recognized the play button. The other buttons were not recognized by any participant. Based on these results, it was crucial to have labels along with the player icons.

Now, that the author knew that older adults needed labels for the video buttons, there was another problem. Because the video controls are not usually translated to Portuguese, there isn't one standard name for all the buttons. The word play in English is used to start playing from the beginning or from a certain point. In Portuguese however these words are different (Começar vs Recomeçar). Predicting that older adults would not recognize the video icons, the author created a task in the seventh usability test (Appendix B.7)in order to know the best designation for the button that re-started playing the movie. From the proposed words, four of the six participants chose the option Play/Resume (Recomeçar). Therefore it was chosen.

5.2.2.5 Call Dr

Figure 5.30: Call Dr. will allow the user to video conference with his caretakers. Video conference was tested by opening a door in the user interface. This way, it was like the doctor was on the other side of the screen.

During a medical appointment, the doctor helps the chronic patient understanding the evolution of his disease and drawing a plan for the following weeks. Regular appointments do not create problems to a patient living in an urban area; however a patient living in a rural area may experience a difficult trip each time he comes to the doctor. In the future however, more communication problems are expected as the number of patients per doctors increases (see Section 4.1). For this reason, the Health Channel allows the older adult to videoconference with his caretakers (see Figure B.6.1.1). When the medical partners (of the project) suggested videoconference, they asked it to be unidirectional from caretaker to the patient. Previous experiments had shown that if patients were able to call directly, they will be always calling overloading their doctor's agenda with videoconference calls. However, not allowing the patient to easily ask for an appointment or to get some quick advice seemed like a bad option. The solution was to filter the calls. When the patient calls, he talks to an administrative, just like they would if they called the Health Center. Then, he can ask to make an appointment or to talk with the doctor. If the doctor can and wishes to answer the call, the administrative will transfer it. If the doctor

cannot answer the call, the administrative will ask the patient if he wishes to talk another caretaker or if she wants to wait for the doctor's call.

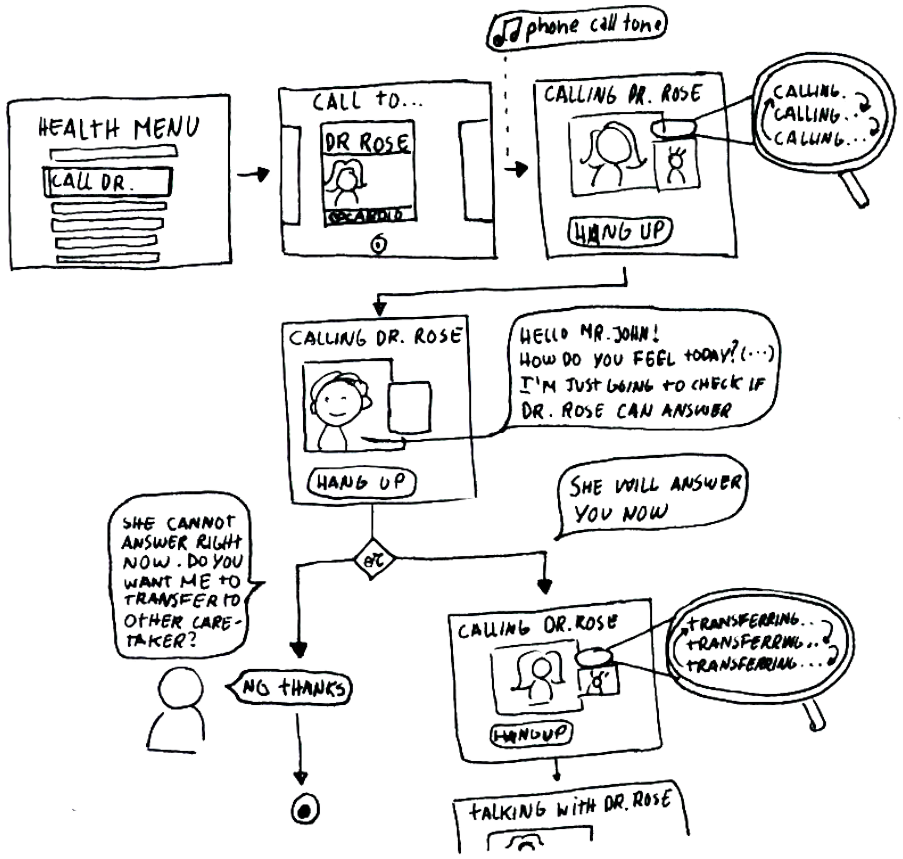


Figure 5.31: Call Dr. process diagram.

The Call Dr functionality is modeled by two screens: the user interface to select the doctor to call and the screen of the call itself.

The user interface to choose which doctor to call is similar to See Agenda and Watch Health Videos (see Sections 5.2.2.6 and 5.2.2.4). This visualization shows one contact on the center and two others cut in half, one on the right and one on the left. These three elements belong to a bigger list that is ordered alphabetically. Each of the contacts has the name of the doctor, a picture, the medical specialty and the icon of the medical specialty. Because this visualization is similar to other screens that have already been tested, the user was not required to look for one contact; however one aspect of the user interface was tested. After entering this screen (coming from the Health Menu), the participant was asked what was the medical specialty of the doctor they were trying to call, which all the six participants were able to answer without difficulties.

The user interface that models the videoconference changes slightly from situation to situation as the Figure 5.31 shows. One can distinguish four moments: before the administrative answers the phone, talking with the administrative, transferring the call and

talking to the doctor. Before the administrative answers the phone, the system plays the phone call tone and shows an animation indicating the system is calling. After being answered by the administrative, the sound and the animation stop. If the administrative transfers the call to the doctor, an animation will show that the call is being transferred. As soon as the patient is talking with the doctor, the title will change to Talking with Dr Rose (A Falar com Dra. Rose). This user interface was tested also in the sixth usability test (see Appendix B.6). In that test, the user was asked to phone Dr. Eloísa. After selecting her contact, in the Call To screen, the participant was answered by one administrative from the clinic. At this point it was important to understand if the user understood with whom he was talking. Therefore, after the administrative presented him-self, the scene froze and the participant was asked with whom he was talking with. None of the users had difficulties answering the question. Then, the process continued. After the medical appointment was finished, the facilitator asked the user to hang up the call and no difficulties appeared.

5.2.2.6 See Agenda

The Health Channel has an agenda (Figure 5.32) to enable the older adult to see when his next appointments will take place. The user interface allows to view information but not to edit it. Medical appointments are inserted by the doctor and the personal ones are inserted by the family. One could argue that some users would be able to create and edit their appointments. The problem is that the television is not the best platform to do this. At this point, the prototype only supports medical appointments and exams. However, in the future, it will support more personal appointments like birthdays. The idea of the user interface came from conversations with one individual from the day center. John (fictional name), keeps in his shirt's pocket all the information that needs to be remembered. The list of papers contains: medical appointment reminders, medication names, exam prescriptions and contacts of doctors. Although the list of papers is very big, it is sorted by importance. Everything is on the same place and it is fast to search. This conversation aroused when the author asked John how he remembered his medical appointments.

When the author was designing the user interface he noticed a problem. Medical appointments are usually associated with a large number of different information. Namely: date, time, name of the doctor, specialty of the doctor, place where the appointment takes place and list of exams that need to be brought. With so much information to show, only one appointment can be seen each time. The author created a visualization in which one item is fully displayed and two others cut in half, one at right and one on the left (see Figure 5.32). The element that is displayed on the left is the previous appointment and

Figure 5.32: See agenda screen.

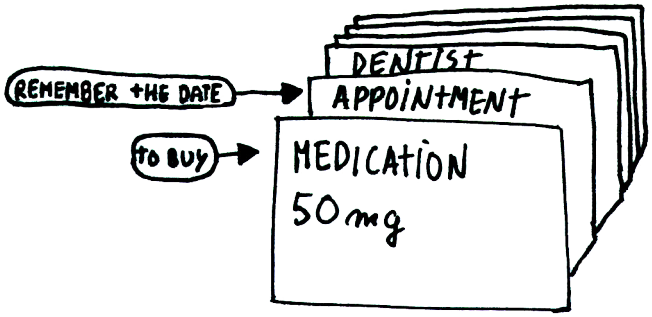


Figure 5.33: Papers in John's shirt pocket, the idea that gave origin to the See Agenda user interface. Like in the user interface prototype, the user can view a complete appointment and parts of others.

the one on the right is the next one. Although this seems like a good idea unless it is usability tested, it is just a guess. To test this visualization, the author created a task in the fifth usability test (Appendix B.5). When the participants were asked to look for one appointment, they did not know what to do. It was not immediate to them that a click on the left arrow would allow them to see the previous appointment. However, after they tried to use the arrows, they did not have any more problem finding items. Because this visualization is reproduced by other user interface screens great difficulties are not expected.

The user interface of the agenda was designed so that illiterate users could understand its information. For this reason, there is a picture of the doctor and of the place where the appointment will take place. The specialty of the doctor is represented by an icon and both the date and time are represented numerically. This design decisions will benefit the illiterate users but also older adults with few years of school.

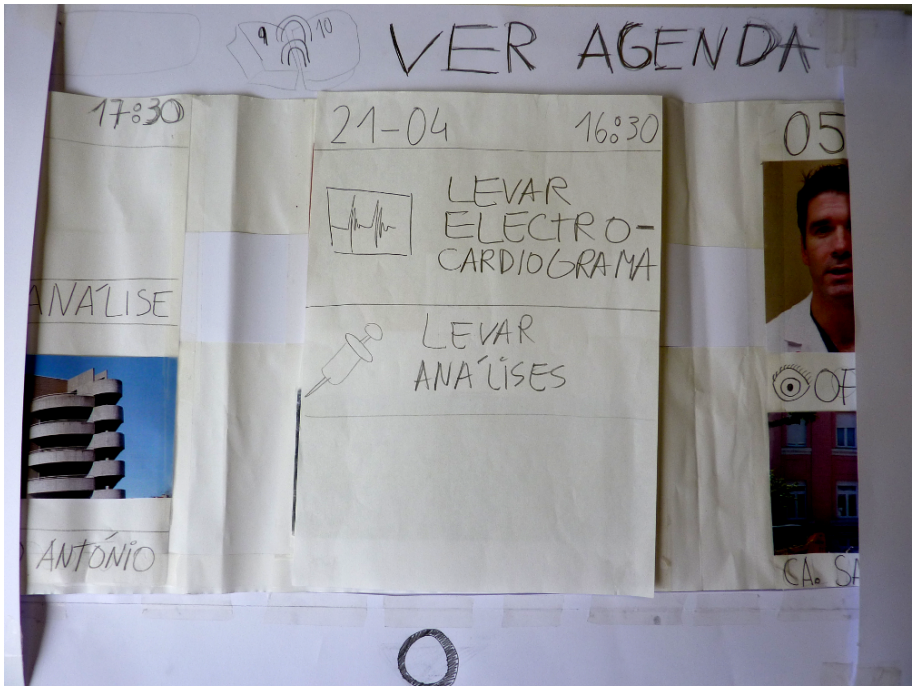


Figure 5.34: See agenda screen showing extra information of the medical appointment with Dr. Eloísa. To this exam, the patient should bring the electrocardiogram and the results of the blood tests.

Since there was still too much information to show, the author decided to divide the appointment in two parts. The most general information is shown by default. However, when the user presses the middle button, extra information like the names of the exams to bring is shown (see Figure 5.34). This behavior was also tested with older adults in the fifth usability test. Like in the previous case, pressing the middle button to see extra information was not immediate to the users. To make this behavior more visible, the author added an icon of the middle button to the bottom of the screen. Since this icon will be used in other screens where the middle button holds a behavior, users are likely to learn it. It is important to refer however, that these hidden behaviors should only be used for secondary information. If the information is very important it should not be hidden.

The date format was also tested with users. Although it may seem superfluous, it is

important to see how the target audience represents their information. This was tested in the fifth usability test (Appendix B.5). In this test, the users were asked to write their birthday dates in a sheet of paper. Three in five users chose the format 20-12-1987. The other two chose the 20-12-1987 format. For this reason the first format was chosen.

5.2.2.7 Emergency Call

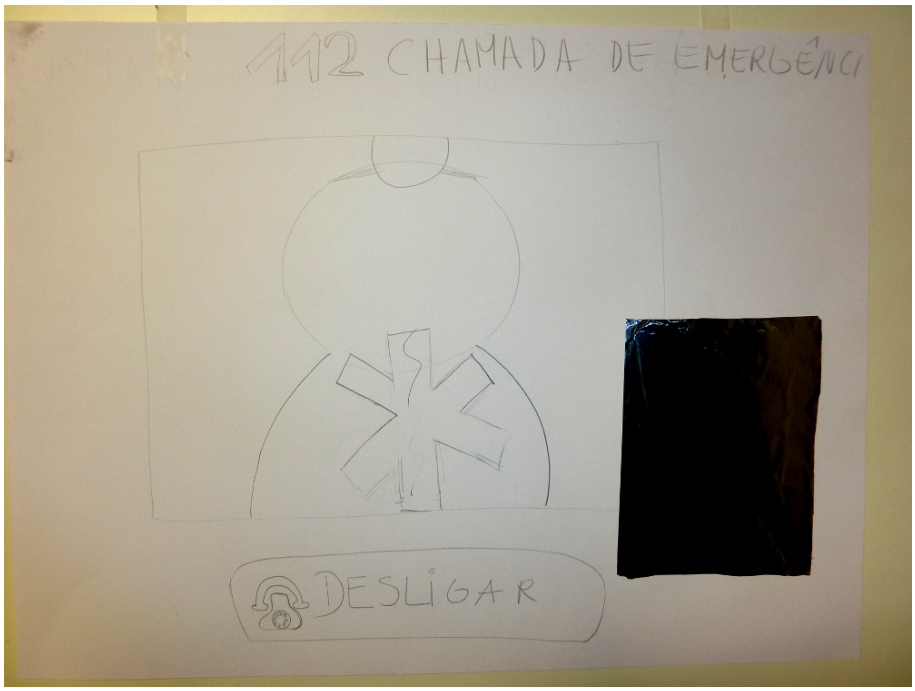


Figure 5.35: Emergency Call screen.

The objective of the Emergency Call (Figure 5.35) is to enable a faster emergency response for chronic patients. Ideally, the emergency services would have access to the patient's profile. With that information, when the patient calls he does not need to identify himself nor to describe his health problems. This user interface was not tested with users because it is very similar to the interface to call the doctor. The difference is that it does not have the intermediate step to talk with the administrative.

5.2.2.8 Remember Medical Appointments

Medical appointment reminders aim to help users dealing with memory problems. When the doctor inserts an appointment into his agenda, a reminder is created for the patient. This screen contains the date, time, name of the doctor, picture of the doctor and medical specialty. The photo of the doctor and the icon for the medical specialty are aimed at helping illiterate users or users with reading difficulties. After the screen appears, the user can: 1) choose to dismiss it, selecting I remember (Estou recordado); or 2) to be

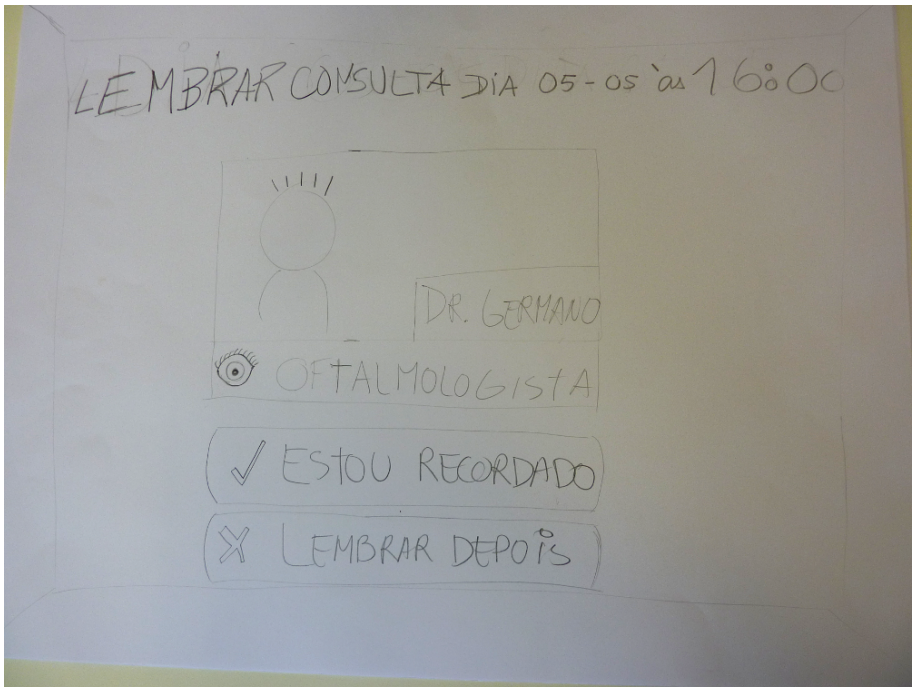


Figure 5.36: Remember medical appointment screen. The title says: "Remember appointment on the 05-05 at 16:00". The appointment is going to be at the ophthalmologist and the user can choose to receive the notification again, by clicking on Remember Me Later (Lembrar Depois) or not by clicking on I Still Remember (Estou recordado).

reminder later, selecting Remember Later (Lembrar Depois). Actions in the reminders – for medical appointments and medication – have been laid so that the user can easily see the reminder, accept it and continue with his previous activity. One could argue that the first option should have been to repeat the reminder which would not harm the user if by mistake he pressed the selection key without reading. This decision was discarded because many patients take more than 5 medicines at lunch and that would receive many reminders and consequently clicks. In order to keep consistency, all the reminders follow this principle.

This design was tested on sixth usability test (see Appendix B.6). When presented with the reminder, the first three participants had difficulties understanding the purpose of the screen because of its title ("Day 05-05 at 16:00"). The author decided to clearly state in the title that it was a reminder for a medical appointment. The words Remember Medical Appointment (Lembrar consulta) were added to the beginning of the screen title. The participants that followed this change had no difficulty understanding the new title.

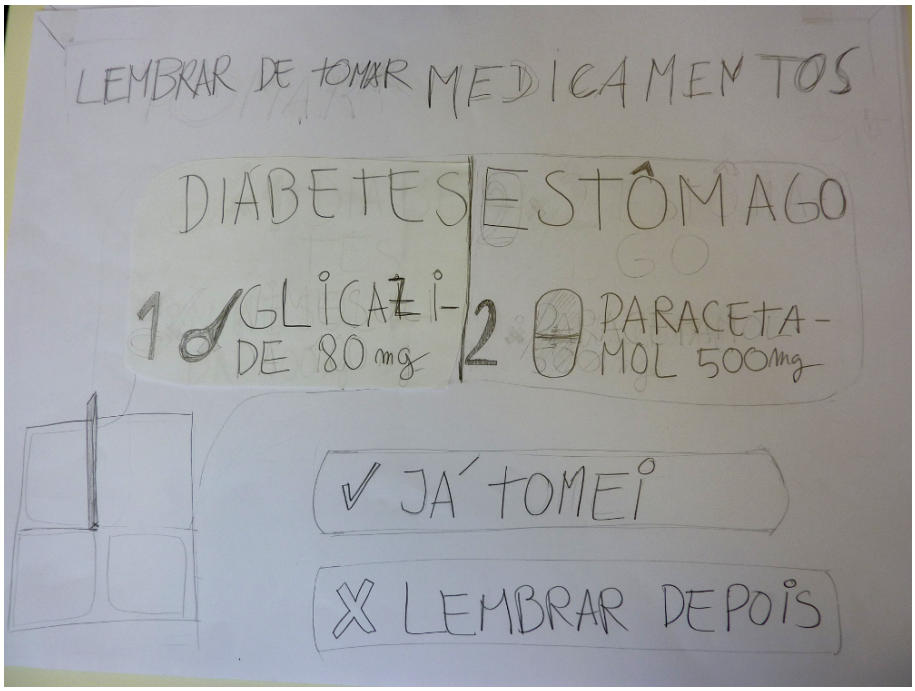


Figure 5.37: Medication reminder screen. The title says: "Remember to take the medication". Then it presents the doses and the names of the medication for diabetes and for the stomach. After seing the reminder, the user can choose to receive the notification again, by clicking on Remember Me Later (Lembrar Depois) or not by clicking on I Still Remember (Estou recordado).

5.2.2.9 Remember to Take Medication

Medication reminders' is another planned feature for the Health Channel. The doctor prescribes a medicine and the Health Channel reminds the patient to take it at the right time. But what information should be included in the reminder? The initial idea of the reminder contained the name of the medicine, its purpose, a photo of the package and of the pill. However, when a doctor prescribes by active substance, the name and the package the patient buys can greatly vary. In this scenario, the active ingredient and the take time are the only information available. This can be problematic because the social educators referred that the older adults of the day center usually remember their drugs by their purpose. Moreover, not understanding the purpose of a medicine is a reason why people stop taking it (Meadows, 2006).

Let's imagine that the function of the medication was available. A good way to remind the patient would be to say: take the stomach medicine. However, that information is not enough. As the medical partners referred, one can take multiple medications for the same problem and take one medication for several problems.

Since it was not possible to use only the function of the medication, it was important to know if users knew what the active substance was and if they could find it easily. With this purpose in mind, the author created two tasks in the third usability test (see Appendix B.3). Results showed that no user knew what the active ingredient was. On the other hand, it also showed that they do not took long to learn it and to find it in a package.

At this point it was decided that the medication reminder would include the name of the active substance, number of milligrams, function, dose and type (tea spoons, pills). Then the screen was evaluated in the sixth usability test (see Appendix B.6). Two users had difficulties understanding the screen because of its title. Take Medication (Tomar medicamentos) did not show clearly its purpose. For this reason, it was replaced by Remember to Take Medicine (Lembrar de Tomar Medicamentos). Also in this test, there was an "x" between the one (dose) and the tea spoon (type). Since the "x" was confused by number of times take in a day (during the usability test), it was removed.

Another issue that was discovered in the sixth usability test (Appendix B.6) was that older adults have difficulties understanding translineated words[5]. The name of the medication was translineated due to space reasons. When asked what the name of the medication was, test participants referred only half of the name. For this reason, the medication names were not translineated again.

The medication reminder appears when it is time to take the medication. After the screen appears, the user can: 1) choose to dismiss it, selecting I remember (Estou recordado); or 2) to be reminder later, selecting Remember Later (Lembrar Depois). Actions in the reminders – for medical appointments and medication – have been laid so that the user can easily see the reminder, accept it and continue with his previous activity.

5.2.2.10 Incoming Call

The doctor can also start a videoconference call with the patient (see Section 5.2.2.5). When he does, the patient sees the screen in Figure 5.38. This screen allows the patient to accept (Atender) or reject a call (Ligue Depois). The square on the right side will show the image of the patient of the camera of his patient before he answers the call. This way, privacy is kept and the user knows what the camera will show. This screen was evaluated during the sixth usability test (Appendix B.6) and patients had no difficulty understanding its purpose or the available actions.

[5] A word is translineated when it appears in two different lines separated by an hyphen.

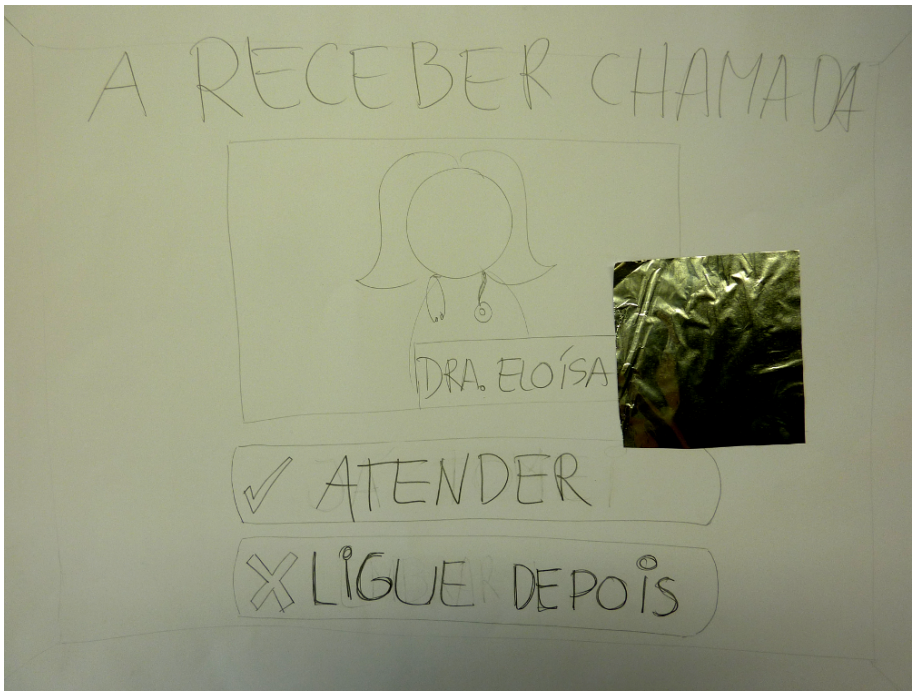


Figure 5.38: Incoming Call screen showing a call from Dr. Eloísa.

5.3 Evaluation

The Health Channel was evaluated with user based evaluation. In this section, we describe the test participants and the test methodology that was used.

5.3.1 Test Participants

One of the basic principles of UCD is the evaluation of design choices and prototypes with users (see Section 3). This section reflects on some of the problems that were encountered when choosing test sample. At the end of the section, this sample is described with more detail.

5.3.1.1 Recruitment Issues Dealing with Specific Audiences

Good practices advise user interface designers to test their systems with end-users. However, it can be a challenge to recruit participants when targeting at very specific audiences (Moffatt et al., 2004). In such cases, the system should be tested with users who have similar age, education, social background and interests to the target users (Doherty et al., 2010). This practice will provide access to a larger test audience enabling a more iterative and agile process.

The author felt also difficulties recruiting test users. The project eCAALYX supports very different diseases, but should one include several participants with the same disease? Users would understand well the information in the interfaces, but one had to create a diverse sample for each disease to have valid data. On the other hand, most of the information is general and can be understood by people without chronic conditions. The solution was to find a diverse sample of users that could be easily reachable.

After deciding to use a diverse sample of older adults, there were still different ways to recruit. The available options were: 1) a health institution like a hospital; 2) a senior association like a senior's university; 3) a nursing home or 4) a day care center. 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 be a good option; however these individuals usually have a very high academic background and therefore would bias the study. The nursing home would be a good option, however these individuals don't manage their health autonomously, something that the project requires. The author chose the day care centre. These institutions are places that welcome older adults during the day and enable seniors to get together, participate in the activities and play games. Nevertheless, seniors that go to the day centre are still independent, maintain their active life and live at their own homes. In day centre, the confidential issues are not so common, the academic background is diverse, and the individuals are independent.

Apart from the first, all the usability tests were performed on one day care centre in Porto. The initial plan was to use two day care centres, however, organization and logistics issues did not permit it. The approach to the centre was done in collaboration with a group of social education interns. These students of the School of Education Paula Frassinetti (ESEPF) were doing their licentiate internship. Besides planning activities for the older adults, they were responsible for managing the communication between the centre and the author.

5.3.1.2 Sample Description

The sample of the usability tests totals 16 participants belonging to two day care centres[6]. The average age is 79.4 and many individuals belong to the "older" older adults group (<80 years). The younger participant is 54 years and the elders are 92 years old. The background of these participants is very diverse with past professions like: craftsman, farmer, housemaid, moderator of psychometric tests, nurse, nurse assistant, office worker, professor, seller, seamstress and sewer of books. The level of education is also very

[6]The first usability test was performed in two day care centres contrary to the others that used only one day centre. Therefore, the sample of the tests contains two day centres.

diverse comprising: no education (˜19%), primary school (˜50%), high school (˜13%), and college (˜19%). From these participants only two had ever used a computer. One of them used the computer during classes in another day care center. And another a command line user interface at work.

5.3.2 Test Methodology

The author administered eight tests on a weekly basis (see Table 5.4). All tests were performed with at least six participants, except for two situations. On these two occasions either a large number of adults were absent or the older adults took much more time than expected to perform the tests.

Every usability test was prepared by the author and then presented to the social educators for discussion. In case a test needed more information about older adults, a meeting with the social educators was done before the test was prepared. These meetings helped gaining more knowledge from the social educators' experience with older adults.

After a test was finished, a reflection was done on the results. This reflection usually implied coming back to theory and discussing the requirements with the medical partners of the project. Conclusions were then incorporated as changes to the designs or notes for guiding the following interfaces.

Usability Test	Tasks
Usability Test #1 (Appendix B.1)	1 – Minimum Size of Type 2 – Navigation Test
Usability Test #2 (Appendix B.2)	1 – Meanings of options in the Health Menu
Usability Test #3 (Appendix B.3)	1 – Compare the initial names of the Health Menu options with the users' suggestions 2 – Choose the best icons for the menu options 3 – Active Ingredient
Usability Test #4 (Appendix B.4)	1 – Choose the best image for See Agenda and Watch Health Videos 2 – Watch Arterial Tension 3 – Watch Diabetes
Usability Test #5 (Appendix B.5)	1 – Choose the best image for See Agenda and Watch Health Videos 2 – Date format 3 – Watch Arterial Tension 4 – See Agenda
Usability Test #6 (Appendix B.6)	1 – Call Dr. Eloísa 2 – Appointement Reminder 3 – Medication Reminder
Usability Test #7 (Appendix B.7)	1 – Compare Labels for the re-play video button 2 – Distinguish video player icons 3 – Count the number of words in translineated medication names
Usability Test #8 (Appendix B.8)	1 – Order the images of the moments of the day 2 – Images of Watch Health 3 – Images of medical specialty 4 – Icons of the Health Menu options 5 – Icons for See Agenda extra information

Table 5.4: Tasks of each usability test.

Chapter 6

Guidelines for TV-based User Interfaces Targeted at Older Adults

In the last chapter, we analyzed some of the results of this dissertation including the generated personas and the prototype of the Health Channel. In this chapter, we will review some design guidelines that were created based on the User Research in Section 4 and on the author's experience with the target audience from the usability tests. First we present guidelines covering aspects of user interface design. Then we will concentrate on guidelines to create usability tests.

6.1 User interface design guidelines

As we have seen in Section 4, older adults are likely to suffer from perception and cognition issues. Unless user interfaces respect their specificities, key aspects of the interaction might not even be noticed. In this subsection, we present guidelines related to the content of user interfaces, text presentation, layout, user-interface elements, audio systems, navigation, errors, related to using TV and at the a number of more general guidelines.

6.1.1 Content

In this subsection, we review guidelines related to the content of user interfaces. When designing for older adults, it is important to present one message at a time and to be redundant in the information. Although this may seem adequate for all audiences, because of memory problems, older adults will benefit more from them.

Use simple phrasing. Although the older adults group is very diverse in education backgrounds, the percentage of users with a modest academic education is high (Fisk, 2009). Perception and cognition difficulties pose enough problems to speech comprehension, therefore the language employed should be as simple as possible. This can be

achieved by: 1) using common words; 2) reducing noise caused by connection words or slang; and 3) avoid mixing ideas (wikihow, 2010).

Present a single message in a single screen. A screen should not be overfilled with information (Carmichael, 1999). Ideally a screen should bare a single message.

Design for recognition rather than recall. Enabling the user to recognize elements and behaviors will reduce the task time by not requiring him to remember information he does not need to.

Avoid irrelevant information. It will be noise, distracting the user from what he wants to do.

6.1.2 Text Presentation

Text presentation is very important in user interfaces because it is the main vehicle of information. In this subsection, we present some guidelines to maximize legibility and some aspects related to the way older adults read.

Use a very large font type. Visual acuity problems are very common among older adults. Furthermore, it is common to find individuals with incorrect graduation in the usability tests due to their high cost. Type sizes were tested and 50pt was the smaller that could be read by most participants at a distance of three meters.

Use an easy to read font family. Decorative fonts are harder to read and should be exchanged with serif or sans serif font families (Fisk, 2009). Older adults read sans serif fonts faster than serif (Bernard et al., 2001). However, when asked about their preference, serif fonts are chosen. If the objective is to achieve greater speed, sans serif fonts should be used. On the other hand, if preference is the objective, serif family should be used.

Allow the older adult to adjust the size of the font in the user interface. Not all older adults will suffer from very serious vision problems. A size that is ok for some individuals might not be for others. If it is possible, the option of adjusting text size should be available.

Use left justified text. Older adults are more used to left justified text, therefore it is the easier to read (Kurniawan and Zaphiris, 2005).

Avoid moving text and other animations. Older users are more likely to have problems reading moving text (Kurniawan and Zaphiris, 2005). On the other hand, it may also catch their attention and make them forget their task.

Give them time to read. Older adults usually read more slowly (than younger adults) (Kurniawan and Zaphiris, 2005). Because of this, it is important to give them enough time to read and understand the information presented.

Avoid forcing users to read at very close distances. Due to presbyopia, many older adults are required to put on their glasses to read the numbers in the remote control (Gill and Perera, 2003). This can take a couple of seconds and led the user to forget what he was trying to do. In this project, a remote control with arrows was used for controlling the Health Channel. The position and volume of the arrows allows an experienced user to select a button while looking at the TV.

6.1.3 Layout and User-Interface Elements

The reduction in periphery vision and short-term memory impacts the amount of information that can be perceived and treated at a certain time. In this subsection, we present some guidelines to improve the understanding of the user interface.

Concentrate information on the center of the screen. Because of the reduction in the peripheral vision, details on the sides are more likely to be missed.

Remove unnecessary information from the interface. Irrelevant elements might be especially distracting for older adults.

Remove user interface elements calling attention as soon as they are not needed. The older adult has difficulties ignoring distractions (Fisk, 2009; Charness and Schaie, 2003). Therefore, the use of such elements should be minimized.

Use icons along with labels. A great percentage of older adults does not know how to read. Graphic symbols will enable them to use the system. Individuals who can read will also benefit if icons are present since they are easier to distinguish than words (Norman, 1991). However, this benefit is only possible if the icon's metaphor is familiar to the older adult.

Avoid the use of scroll. Because of short-term memory decrease, scrolling may cause the older adult to lose context of his task. It is preferable to present information on the same screen.

Maintain consistency in the user interface. Positioning elements on the same position across screens will help the older adult dealing with reduced short-term memory.

Do not use blinking elements or other elements that capture attention. Because of memory issues, the older adult will have much more difficulty remembering what he wanted to do. The blinking elements will be always calling his attention.

Provide large targets. Because of vision impairments targets have to be larger to be noticed by older adults.

Use high contrast between the elements of the user interface. Older adults need increased levels of luminance contrast to see (Charness and Schaie, 2003). For more information refer to (Blackwell and Blackwell, 1971, 1980).

Provide a cursor showing clearly the selected target. Older adults are more likely to forget what they were doing or to press the wrong button in the remote. Having a clear answer from the system when changing the selection in the screen ensures they know where they are and what to do.

6.1.4 Audio

Auditory information may also help when designing user interfaces for older adults since the percentage of older adults that cannot read or has reading difficulties is significant. However, the perception of auditory information is also affected by age. In this subsection, we present some guidelines to help delivering auditory information effectively.

Enable older adults to adjust the volume at their will. Not all older adults have hearing difficulties, what is ok to some persons might not be for others. Therefore they should be able to adjust the volume to their needs.

Allow users to replay auditory messages. Hearing limitations are common among elders (Charness and Schaie, 2003). On the other hand, cognitive limitations can also affect the comprehension of speech. Repeating audio messages will help coping with

hearing limitations.

Increase duration of sound signals. Hearing limitations can negatively affect sound localization. Increasing sound duration, will improve sound localization (Kline and Scialfa, 1997).

Use male voices for delivering auditory information. Changes in the ear can limit the ability to hear high frequency sounds. Since women and children usually have a higher pitched voice, they are not so adequate for delivering information. Male voices should be used for delivering auditory information (Lines and Hone, 2002; Fisk, 2009).

Do not use synthetic speech unless it resembles natural speech correctly. Because of hearing limitations, older adults rely more on the contextual and nonverbal aspects of speech such as rhythm and tone (Fisk, 2009). However, if synthesized speech does contemplate these characteristics, communication is likely to be poorer. For more information refer to (Lines and Hone, 2002).

Create speech that is redundant, semantically well structured. Speech intelligibility can be greatly enhanced if the message is well structured and redundant (Charness and Schaie, 2003).

Read speech at a consistent and reasonable pace. If the reading speed is too fast, individuals with hearing impairments will not understand. On the other hand, if the speed is too slow, individuals will have problems processing information due to decrease in short-term memory.

Control the background noise. Although one cannot control the background noise of the place where the interaction happens, if a system contains hardware modules, sound should be reduced or attenuated.

Remove sound distractions. When reproducing speech, others sounds are likely to become background noise, therefore they should be removed (Fisk, 2009).

6.1.5 Navigation and Errors

Navigation and errors can have a great impact on the user that is not accustomed to user interfaces. Therefore, this section presents guidelines that will improve the way an inexperienced older adult uses the system.

Provide a good navigation. Older adults are "less enamored with the coolness of technology than they are about getting a specific task done" (Greengard, 2009). When confronted with problems using a user-interface, they are less likely to try things out. If they do not understand navigation, they will solve their problem in another way.

Show the current location clearly. Because of short-term memory decrease, older adults are more likely to forget what they wanted to achieve when changing screens. Therefore, knowing where they are is even more important.

Design error messages that make it clear that the user is not the cause of the error. Older adults have less experience with technology and more prone to blame themselves for errors (Greengard, 2009).

Make it easy for user to correct input errors. Since most input is done using selection, it is easy to miss the right element. Being so, it should be easy to undo actions.

6.1.6 TV

This project intended to approach some of the characteristics that are important when designing TV user interfaces for older adults[1]. Therefore, this subsection presents some guidelines important when designing user interfaces for the TV.

Use a remote control with few buttons. As the number of buttons increase, so do the complexity and the probability of error.

Use a remote control with well spaced large buttons. Because of in fine motor control problems, it is likely that the older adult will have difficulties pressing small buttons very close to each other.

Use a remote control with high contrast in the buttons. If the labels in the buttons are not clearly readable, older adults will have problems using it.

Do not forget that interacting with a TV is different from interacting with a computer. Interacting with the TV is a lean back experience while using the computer is a

[1] The author considered TV systems that only have a remote control and did not evaluate, for example, TV systems with keyboards. For information on that subject, a larger body of knowledge exists related to interactive TV systems. For examples, refer to (Lu, 2005; Chorianopoulos, 2007; Hansen, 2005).

lean forward experience (Chorianopoulos, 2007). The TV is associated with entertainment and relaxation while the computer is related with work.

Prefer word selection over text input. With so little space in the user interface, it is very difficult to have a virtual keyboard for text input. If possible, it should be switched for selection.

Allow the user to choose when to watch the content. Do not use predetermined timing for presenting the material unless you have a compelling reason for it (Lekakos et al., 2007).

Show the remote control keys that start actions in the screen. If the user interface uses, for example, the remote control numbers for starting actions, it is important to show them on the screen (Lekakos et al., 2007). Otherwise it will be impossible to know how to start that specific action.

6.1.7 General Guidelines

In this section, we present a number of guidelines that although general, might contribute to designing better user interfaces.

Provide a humanly rich experience. As older adults age, losing family and friends may force them to "reconstitute a meaningful social world" (APA, 2003). The system's interface might be a "gate" connecting to one of few human contacts; it is crucial that the older adult feels the communication medium as satisfactory.

Provide redundant channels of communication. Because of perception limitations, older adults rely more on the contextual and nonverbal aspects. Videoconference for example is better than pure-audio communication because of the visual cues it provides (Fisk, 2009).

Plan the interaction for the older adult but also for his caregivers. Older adults with chronic conditions probably live accompanied. If a health system excludes the caregivers, not only it ignores an important piece of the patient's life, it also makes the helpers feel useless.

Describe clearly the objective and the outcomes of using your product. The accommodation of older adults to losses – be them physical abilities or even loved ones –

brings an awareness of the limited opportunities, causing the individual to concentrate on the best rewarded activities (Baltes et al., 1999; APA, 2003). If the reward is not found relevant, the product won't enjoy acceptance.

Be prepared for older adults that refuse to learn. According to Lindberg et al. (2008), the ideas one has of old age affect the way that individual learns. The old saying "Burro velho não aprende lÃnguas (an old donkey does not learn languages) bares in itself the idea that learning is not possible later in life. This (outdated) old saying was referred to the author in two different occasions by the older adults.

Give them time to learn. Cognitive changes are responsible for a decrease in short-term memory and a slower "processing speed" (see Section 4.2.2). By holding a smaller amount of information, short-term memory will likely cause problems to learning.

Minimize the need to unlearn well "learned" procedures. Each time a product changes, one must replace a previous procedure with a new one. Older adults have shown greater difficulties unlearning procedures (Fisk, 2009), so this should be minimized.

Maximize remote management. Older adults may live in rural places with little access to resources like transports (APA, 2003). Because of this, maintenance tasks can be difficult. To deal with these situations, the system should be prepared to be managed remotely. As one woman remarked, "bits and bytes was all Greek" to her, but she "could use the electricity in a home without understanding how to put the wiring in" (Mayhorn et al., March 2004).

Plan carefully the prices of products and services for the user. This audience is often coping with economic issues (Smyer et al., 1996). For this reason, prices for the user should be carefully thought as they also determine acceptance.

Don't forget older adults wear glasses. Recent studies revealed that a percentage of 92% of the individuals above 70 years wear glasses (Charness and Schaie, 2003).

Make use of behaviors developed by older adults to cope with memory loss. Older adults will notice that they are losing short-term memory and will start using notes and other mechanisms to remember things. These notes taken when starting using products can be of great help for the user, so they should be incentivated.

Don't forget older adults did not grow up using computers, "the odds are stacked against them" (Greengard, 2009). They may feel more intimidated and will (naturally)

enjoy more difficulties because they are not familiar with many metaphors used by such devices.

6.2 Usability Testing Design Guidelines

Older adults understand usability tests in a different way than adults. For this reason, it is important to understand the differences to maximize the feedback received during the test. In this section, we present guidelines related to the day care center (our test setting), good practices, related to culture or personality and related with communication.

6.2.1 Related to the Day Care Center

The usability tests in this project were applied to volunteers from mainly one day care center. This subsection points some advice on how to prepare tests for this test setting.

Participate in their games. At one point, the social educators told us that it was becoming difficult to convince the older adults to collaborate in the tests. The arguments of the older adults were: "I am tired of the tests. When is it going to end?", "I've already helped many times". On the following week, instead of conducting a test, the author let the users control and choose what they wanted to do. On that day, the author's role was then to just participate in whatever activities the older adults would want him to join; the author ended up playing card games. This shared experience enabled the author to better understand the test participants and to answer some of their doubts about the work that was being carried out with their help.

Do not ask them to move. Older adults usually sit in the day center common lounge. The first usability tests were conducted in a separate room that was two minutes (walking) away from the common room. 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 room that was slightly colder than the common lounge. Later, one started doing tests in a room that was next to the common lounge and when possible in the common lounge. Older adults were suddenly more willing to participate in the usability tests.

Some usability tests can be performed while in a group. In the day center, older adults were usually in the common area playing card games, participating in the activities of the center or talking with each other. In two occasions, the author created a test that was applied to a group. The facilitator asked a question and then presented several icons to choose from. The rules were 1) they could only choose one image when the moderator

said so and 2) they had to point at the image simultaneously. Testing in groups reduced interruptions and made the tests shorter and more efficient.

6.2.2 Good Practices

Any target audience requires the facilitator to be nice and respectful for the autonomy of the participants. In this section, we explore how these issues arise and how they should be dealt when working with older adults. This subsection also includes explaining the test situation and including the reality of test participants in the tasks of the test.

Always respect participants will. A report from the World Health Organization WHO (2002) on Active Aging defends that older adults should maintain their autonomy as much as possible. Unless participants have cognitive limitations, they should be able to do what they wish to do. One of the participants said in the first test that she did not want to participate more. Even if you do not agree or do not understand the reasons, their will should always be respected.

Create noise free test settings. Older adults experience more difficulties keeping attention in one task than young adults (Fisk, 2009). Therefore, you should try to reduce noise as much as possible during tests.

Provide users with sufficient information about the purpose of the tests. Before starting the test, the facilitator should provide the older adults with detailed information about the purpose and context of the tests and the project these fit in. Also, older adults easily forget this information therefore they need to be reminded of these goals in order to maintain their will to help in the tests.

Make it clear that participants of the tests are not being tested. The author's experience showed that older adults are very self-aware and always concerned about their performance, therefore it is important to clearly state that the goal of the test is to pinpoint what is right or wrong with the designs being tested and that there are no right or wrong answers. Not rarely, , participants would ask how they performed after the test was finished. In such cases is important to state that they are not being tested, instead they are enabling facilitators to gathered valuable input for the project.

Relate the tests to the participants' world. Test participants expect the tests to relate to their own reality and have shown more difficulty in performing the tests when this does not happen. An example of such situation occurred during a test with a paper prototype,

when a stomach medication name was shown to a patient with no stomach problems. When faced with this information, the test participants uttered: "No, that is not me." and "No, I don't take that." The difficulty in separating the participant's owns reality from the reality that is being represented in the test often resulted in a change of topic (for e.g. an explanation of why that medicine was not appropriate for the test participant) and in the main objective of the test being forgotten. Taking this into consideration, tests should specifically relate to the participant's owns reality.

Role-play helps participants performing tests that do not relate to their reality. Usability tests should, whenever possible, be performed by the end-users. However, due to availability or safety issues it may not be possible. When this is the case, researchers usually look for participants who are as similar as possible to the end-users. Nevertheless, tests will never be about the reality of this "similar audience" and will fall into the problem described in the previous guideline. In order to allow them to incorporate the personality of the target users, role-play should be used.

Respect the opinions of the test participants. Older adults are very keen on expressing their opinions and, during the tests, participants are likely to say something with which the facilitator does not agree. This is an issue other health professionals, like psychologists have faced before. For this reason the American Psychological Association's principles of ethics refer that no unfair discrimination shall be caused to the patient (APA, 2002). The respect of rights, dignity, and worth of all people is above all. Therefore, the opinions of the testing participants should always be respected, with no further judgment or discrimination.

Give test participants time to think. Older adults will probably need more time than younger adults to complete tasks (Dickinson et al., 2007). Plan your tests with this premise. Don't interrupt their line of thought.

Explain some of the test details after the test is finished. Sharing these details will not only help gaining the trust of the user but also to improve their understanding of your project. If one knows why you do the tests and thinks the project is useful, it will be easier to have volunteers for the next test.

Don't forget to say thanks. Make a big smile and explain to the participant that his hard work helped you seeing what needs to be fixed. The value of the information you received cannot be measured, so be sure to express your thanks.

6.2.3 Related to Personality or Cultural

Designing usability tests for older adults includes also designing for their culture and personality. In this subsection, we present advice concerning for example, time organization and historical narratives.

Don't say the word computer on the first approach. From fifteen people included in the tests, only one had used a computer before. When arriving at the center for the first time, older adults asked the author what their academic background was. When informatics was mentioned the answer was quick: "No, that is not for me", "I cannot participate, I don't know how to use a computer." or "I don't like computers". The fear of an 'unknown' artifact was clear, even though the goal was to test paper prototypes. After this episode, the author started telling the work was within the interaction area.

Let them know the plan beforehand. Retirement forces the older adult to re-organize his day (Rossell et al., 2004). The individual will try to give a purpose to the time that was previously spent working by filling it with as much activities as he can. Older adults also tend to value routine and will have problems changing their schedules (Pikunas, 1979). When remembered of the usability tests, they can include it in their planning. In this case study, the social educators remembered the users one or two days before the test and on the same day as they arrived.

Inform the older adult of the goal of the project beforehand. Before starting the test, introduce the project you are working on and why you need their help for. Once, the facilitator forgot to explain the goal of the project before explaining the task to the user. Seconds after the older adult asked: "What am I doing here? What is this for?". One thinks that the facilitator attitude was understood as patronizing.

Listen to the patient's historical narratives. The impact of listening to the patient has been studied by health practitioners in the past. This attitude creates an environment of trust and security that enables the expression of feelings (Antai-Otong, 2007). In the usability tests, hearing unrelated stories was common. In one test, one participant even showed wallet photos of a granddaughter. Although these moments did not contribute to the test itself, they contributed to the well being of that person and encouraged her to participate in the tests. On other situation, one participant said he did not want to participate as he did not feel well. Naturally the practitioner asked what was going on. After being listened for about three minutes, the older adult decided that we wanted to do the test. On the other hand, older adults always made a parallel between the user interfaces and their lives. Important details about how they organize their medicine and their medical appointments was made available, which would not happen if the moderator did not listen.

6.2.4 Related to communication

Communication is very important during the usability test. The facilitator should be understood by the older adult and adapt his speech to the listener. The adaptations range from rhythm and tone to simplification of speech and repetition.

Use simple language. Although the older adults group is very diverse in education backgrounds, the percentage of users with a modest academic education is high (Fisk, 2009). Perception and cognition difficulties pose enough problems to speech comprehension, therefore the language employed should be as simple as possible. This can be achieved by: 1) using common words; 2) asking one question at a time; 3) asking direct questions; 4) reducing noise caused by connection words or slang; and 5) avoid mixing ideas (wikihow, 2010).

Adjust your volume appropriately. Speak in a volume that is neither too soft nor too loud (Servellen, 1997). Communicating with older adults involves dealing with sensory limitations which requires patience (Antai-Otong, 2007).

Repeat and paraphrase what you are saying. Hearing limitations are common among elders (Fisk, 2009). On the other hand, cognitive limitations can also affect the comprehension of speech. Do not hesitate to repeat or rephrase your sentences if you feel that the older adult did not understand you (Simpson, 2002; wikihow, 2010). When you talk, give attention to the face of the participant, not hearing well has a negative stereotype and people might be uncomfortable saying they did not understood (Burke and Laramie, 2004).

Don't use elderspeak. Elderspeak is similar to the way adults talk to very young children (Simpson, 2002). It is usually characterized by: 1) exaggerating the pronunciation of words; 2) reducing complexity of sentences; 3) speaking very slowly; 4) using limited vocabulary; 5) using terms like "dear," "sweetie" and 6) repeating or rephrasing what the other said. Although it is meant to help, older listeners with no cognitive impairment may feel it as patronizing (Leland, 2010; Carstensen and Hartel, 2006). This way of speaking transmits the idea that they are no longer equal to the young or middle aged adults, and therefore their wills, opinions and choices are not relevant.

Chapter 7

Discussion

The previous chapter presented a number of design guidelines to guide the design of TV based user interfaces for older adults. This chapter reflects on some of the results of our work for the Health Channel of the eCCALYX project. For the development of this project we applied a User-Centered Design methodology with the goal to create a product that better suits the needs and characteristics of its target audience. As defined in Chapter 3 we used User Research, Personas, low-fidelity prototyping and user based evaluation.

As detailed in Chapter 4, user research was applied to understand the target audience. Our user research was mainly based on the analysis of the literature. In a perfect situation however, user research would also be grounded on other contextual inquiry techniques such as ethnographic studies and observation. The use of those techniques requires direct access to users, which was impossible in the beginning since there was no available user group. However, we believe we did an extensive and thorough work based on the literature, namely medical and cognitive psychology.

Since this project addressed very different diseases, personas were created to concentrate on the goals of each of them (see Section 3.1.2). Although the personas with higher priority, for the project, have been created, there are still diseases that lack a persona to "defend" their goals.

Based on eCAALYX requisites and the knowledge acquired using user research and personas, we developed a low-fidelity prototype of the Health Channel that is described in Section 5.2. This prototype was iterated with older adults from one day care center in Porto as described in Section 3.1.4. Most users from the day care center did not have any of the diseases described in the project. That issue is better described in Section 3.1.4, however the main reason was because of problems recruiting these individuals. Nevertheless, it is important to refer that in an ideal situation, the test participants would have at

least one of the diseases addressed by eCAALYX. However, we did work with the closest population sample that was available; our users might not all have one of the diseases the project addresses, but were very close to the target audience in the remaining factors. The usability tests had six participants following Nielsen's advice to divide the test pool into small groups and do iterative tests (Nielsen, 2000). Nevertheless, some of the dialogues of the user interface could have been more iterated if there was more time. The problem was that usability tests were very long not because of the tasks but because of the time the facilitator listened to their historical narratives. One might argue that the number of tests should have been greater than eight. However, a balance had to be done between tiring the older adults and doing more tests. When preparing the tests, we were fortunate enough to work in collaboration with social educators and to incorporate their experience into our project. In an ideal situation however, they would have been involved more and since the first test and not only in the middle of the process.

The experience gathered throughout the analysis, design and evaluation of the Health Channel enabled us to derive a number of guidelines to guide the design of user interfaces for older adults that use the TV (detailed in Chapter 6). Since these guidelines were based in one project it is likely that they could be improved with the experiences of other projects.

Chapter 8

Conclusions

It is not news that the population is growing older. In the future, there will be a smaller number of young people supporting a large older population which may render the current health systems unsustainable. eCAALYX's – Enhanced Complete Ambient Assisted Living Experiment – is an European project that aims to create a sustainable alternative for healthcare and at the same time to improve the treatment of older adults with chronic conditions. eCAALYX has among other features a Health Channel with which the older adult interacts directly to manage his health. The Health Channel, the basis of this work, is based on the TV and includes self-monitoring of health conditions, videoconference with caretakers and an agenda.

This dissertation had mainly two objectives: the analysis, design and evaluation of a TV based user interface for the eCAALYX project and the elicitation of a set of design guidelines to drive the design of user interfaces for the TV targeted at older adults.

Designing for older adults is different from designing for younger adults. Older adults are usually less enamored with technology than they are about getting things done. If the benefit of using a technology is not explicit for the older adult, it will not be used. On the other hand, when older adults are convinced to use a certain technology, they often find systems impossible to use because their needs and characteristics are not respected.

Designing for a difficult audience like older adults, requires a design methodology that puts them at the center of the process. For this reason, User-Centered Design was used in this this dissertation for the development of the Heath Channel for the eCAALYX project. In this context, we used user research, personas, low-fidelity prototyping and user based evaluation (see Chapter 3).

To investigate the older adults' specificities, we conducted a careful user research as documented in the chapter 4. Our user research was mainly based on the analysis of

the literature and covers aspects such as the physical, cognitive, psychological and social changes caused by age.

Since this project addressed very different diseases, personas were created to concentrate on the goals of each of them and are presented in Section 3.1.2.

Having an understanding of the target audience, the author designed a low-fidelity prototype of the Health Channel. This prototype was iterated based on the feedback of user based evaluation and is documented in Section 5.2.

The experience gathered throughout the analysis, design and evaluation of the Health Channel enabled us to derive a number of guidelines to guide the design of user interfaces for older adults that use the TV (detailed in Chapter 6). Since these guidelines were based in one project it is likely that they could be improved with the experiences of other projects.

Although the literature involving younger adults is well documented, HCI research involving older adults appears to be giving the first steps. Technology is still very far from the older adult and it will only change if products are designed with older adults' specificities in mind. In this context, products are likely to be successful due to little or no competition. We imagine assistive technologies appearing in the future. In the short-term, simplified technologies are also likely to succeed bridging the gap between the info-excluded and technology.

As future work related with the Health Channel, we plan to support other diseases, add new functionalities and evaluate the system when it is implemented. We also plan to generalize the created guidelines to other platforms.

An interesting research theme aroused when writing the paper on usability testing with older adults: the relationship between emotions and affection in the interaction of older adults with products. We also aim to explore this research area.

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Appendix A

Maslow's Hierarchy of Needs

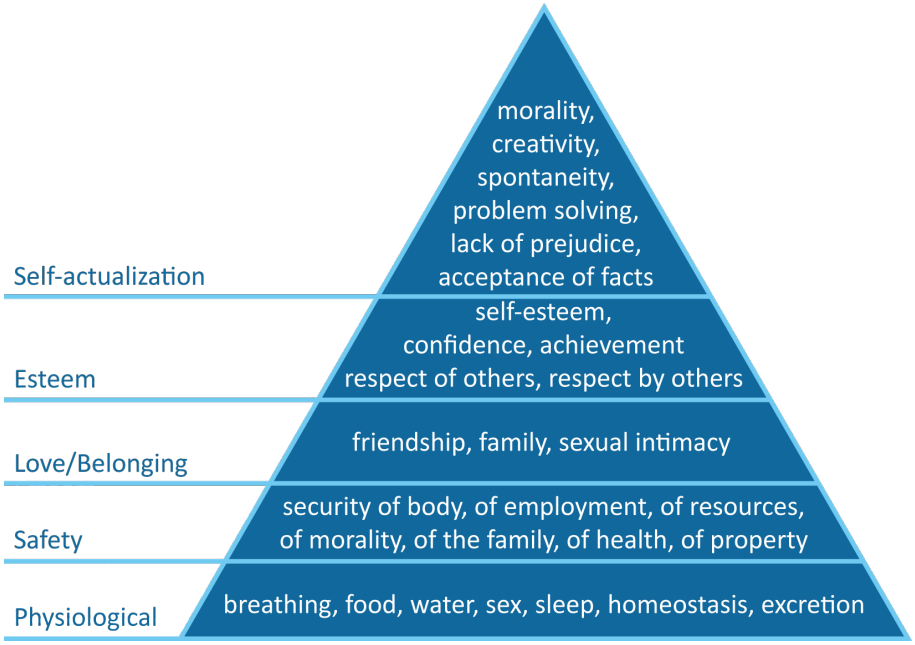


Figure A.1: Maslow's Hierarchy of Needs (Silva, 2009)

Appendix B

Usability Tests

This appendix presents the design and results of the eight usability tests. At the end of the appendix, the fatigue and happiness evaluation scales are presented.

B.1 Usability Test #1

In the first usability test, it was important to lay the foundations to design the user interfaces. For this reason, navigation and text readability were evaluated.

B.1.1 Test Design

My name is Francisco Nunes and I am on the last year of the informatics engineering degree. My final degree project is to design a system that helps older adults managing their health trough the use of television. What we will do today and in the following weeks are a couple of games that will help me build the system. We want a product that fits older adults, therefore, it is crucial to gather feedback from people like you.

What can I tell you... This system is being developed in the context of a European project and perhaps it will be used by your sons or grandsons. Now that I have explained why I am here, I would like to ask you if you want to participate in these sessions. Most sessions will be like to games, nothing hard or complicated.

I would like to refer that you are not being tested, I'm here to understand what is wrong with my designs and what is best for you.

Before starting today's test I would like you to tell me, which of these faces better represents the happiness you feel right now (see Figure B.9). I would also like to know if you are feeling tired or energetic. Can you choose the image that most resembles the way you feel right now (see Figure B.9)? **:MA,:MB**

B.1.1.1 1st Task – Minimum Readable Text Size

For our first game, we have several themes to choose from: farming, Portuguese kings, names of famous, Portugal's geography and Portuguese presidents. Which one do you prefer?

Agriculture

Excellent choice. I will tape some words related to agriculture on the wall and ask you to tell me what we can do with each of them. If I showed you, for example, the expression "green beans", you could say that will be useful for making soup. **:M1**

«The following words are taped to the wall: Lettuce (Alface), Potato (Batata), Carrot (Cenoura), Tomato (Tomate), Pumpkin (Abóbora), Corn (Milho), Strawberries (Morangos), Manure (Estrume), Hoe (Enxada), Water tank (Tanque com água).»

Portuguese Kings

Excelent choice. I will tape the names of some Portuguese kings on the wall and then I will ask you to tell me what you know about them. **:M1**

«The following words are taped to the wall: D. Afonso Henriques, D. Dinis, D. João Mestre de Avis, D. Sebastião, Filipe I, D. João IV, D. Maria I, D. Carlos I, D. Manuel II, D. Duarte.»

Names of Famous

Excelent choice. I will tape the names of some famous portuguese on the wall and then I will ask you to tell me what you know about them. **:M1**

«The following words are taped to the wall: Toni Carreira, Herman José, Amália Rodrigues, Simone de Oliveira, Luís Goucha, Ruy de Carvalho, Beatriz Costa, António Silva, Fernando Mendes, Marco Paulo.»

Portugal's Geography

Excelent choice. I will tape the names of Portuguese districts on the wall and ask you to tell me where they are located in the map. **:M1**

«The following words are taped to the wall: Aveiro, Beja, Braga, Guarda, Coimbra, Évora, Faro, Lisboa, Porto, Setúbal.»

Portuguese presidents

Excelent choice. I will tape the names of the last Portuguese presidents on the wall and ask you to tell me something about them. **:M1**

«The following words are taped to the wall: Óscar Carmona, Oliveira Salazar, Craveiro Lopes, Américo Tomás, António de Spínola, Costa Gomes, Ramalho Eanes, Mário Soares, Jorge Sampaio and Cavaco Silva.»

We have finished this activity. The results will hep me choosing the size of the text in the system.

B.1.1.2 2nd Task – Navigation Test

Now, we will start a little different activity. I brought a television remote with me and we will Play a game similar to "Who Wants to be a Millionaire"[1]. The rules are simple. First we read the question and then you select the right answer. You can select an answer in two different ways. Pressing the number of the answer in the remote control or use the

[1] For more information on Who Wants to Be a Millionaire, visit http://millionaire.itv.com

arrows to select the right option.

First Riddle
«The user was presented with the riddle in Figure B.1(a) in case he can read and Figure B.1(b) if he cannot.»

What is the food that is good for the eyes?[2] **:M2**

Second Riddle
«The user was presented with the riddle in Figure B.3(a) in case he can read and Figure B.3(b) if he cannot.»

What is the thing that before being already was?[3] **:M3**

Third Riddle
«The user was presented with the riddle in Figure B.2(a) in case he can read and Figure B.2(b) if he cannot.»

What is the thing that has bear but is not a man, has teeth but does not eat?[4] **:M4**

Fourth Riddle
«The user was presented with the riddle in Figure B.4(a) in case he can read and Figure B.4(b) if he cannot.»

What is the animal that has the legs on the head?[5] **:M5**

Similarly to the beginning, I would like you to tell me, which of these faces better represents the happiness you feel right now (see Figure B.9). I would also like to know which of these puppets better resembles the energy you feel right now (see Figure B.9). **:MA, :MB**

We are done for today. Thank you very much for your help, it was really helpful.

In case it is the first test: Now that the test is finished, I have to ask if you want to continue collaborating with us.

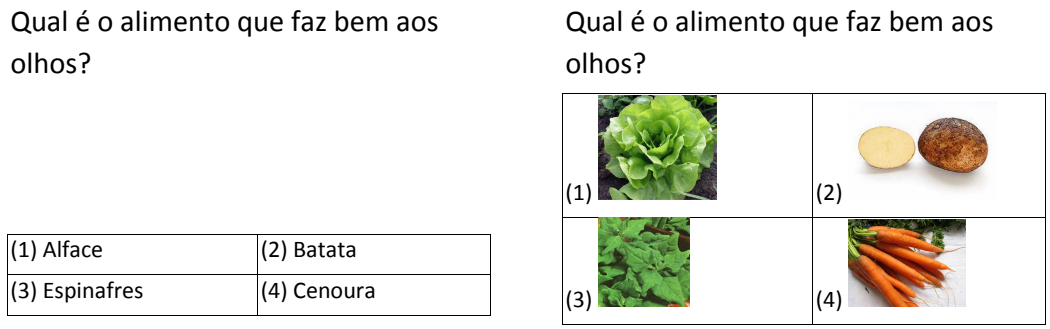
[2] There is an traditional Portuguese riddle that says it is the carrot
[3] The translation for "hake fish" in Portuguese is "pescada", the same as being fished "pescada". Before being fished ("pescada"), the fish was already named "pescada".
[4] Another traditional Portuguese riddle
[5] The louse normally inhabits the head of the person. Therefore, it has the legs on the (person's) head.

B.1.1.3 Measured Variables

:MA – Level of happiness according to a scale of seven faces (the most happy is image is number one and the sadder is seven)
:MB – Level of fatigue according to a scale of four puppets (the most tired is number one and the most energetic is number four)
:M1 – Minimum readable text size
:M2 – Errors using arrows and errors using numbers
:M3 – Errors using arrows and errors using numbers
:M4 – Errors using arrows and errors using numbers
:M5 – Errors using arrows and errors using numbers

B.1.2 Materials

In this subsection the riddles that were tested in the usability tests are presented.



(a) Version used with users that could read.

(b) Version used with users that could not read.

Figure B.1: What is the food that is good for the eyes? The available options were: Lettuce (Alface), Potatoes (Batatas), Spinach (Espinafre) and Carrots (Cenouras). The answer is Carrots.

B.1.3 Results

In this section, the results of the first usability test are presented.

Name	Chosen Task	Size of Text
Smith	Farming	40
Linda	Farming	42
Mary	Farming	50
Laura	Geography	32

Table B.1: Results of the task testing the minimum readable text size from the first usability test.

Qual é a coisa qual é ela que tem barbas e não é homem. Tem dentes e não come.

(1) Cão	(2) Botas	(3) Alho	(4) Galinha

(a) Version used with users that could read.

Qual é a coisa qual é ela que tem barbas e não é homem. Tem dentes e não come.

(b) Version used with users that could not read.

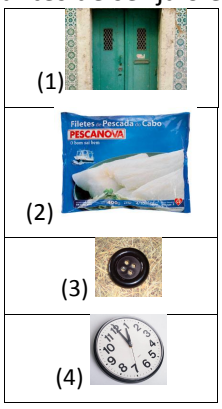
Figure B.2: What is the thing that has bear but is not a man, has teeth but does not eat? The available options were: Dog (Cão), Boots (Botas), Garlic (Alho) and Chicken (Galinha). The answer is Garlic.

Qual é a coisa qual é ela, que antes de ser já o era?

(1) Porta
(2) Pescada
(3) Botão
(4) Relógio

(a) Version used with users that could read.

Qual é a coisa qual é ela, que antes de ser já o era?



(b) Version used with users that could not read.

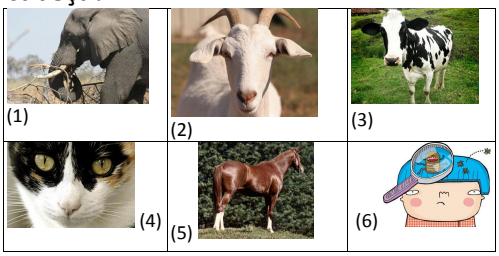
Figure B.3: What is the thing that before being already was? The available options were: Door (Porta), Hake Fish (Pescada), Button (Botão) and Clock (Relógio). The answer is Hake Fish (Pescada).

Qual é o animal que tem as patinhas na cabeça?

(1) Elefante	(2) Cabra	(3) Vaca
(4) Gato	(5) Cavalo	(6) Piolho

(a) Version used with users that could read.

Qual é o animal que tem as patinhas na cabeça?



(b) Version used with users that could not read.

Figure B.4: What is the animal that has the legs on the head? The available options were: Elephant (Elefante), Goat (Cabra), Cow (Vaca), Cat (Gato), Horse (Cavalo) and Louse (Piolho). The answer is the Louse.

Name	First Riddle		Second Riddle		Third Riddle		Fourth Riddle	
	Errors Using Numbers	Errors Using Arrows	Errors Using Numbers	Errors Using Arrows	Errors Using Numbers	Errors Using Arrows	Errors Using Numbers	Errors Using Arrows
Smith	0	0	-	1	3	3	-	4
Linda	0	2	0	0	-	0	-	0
Mary	-	2	0	4	0	0	-	0
Laura	0	0	-	0	-	0	-	0
Betty	0	0	1	0	0	2	-	0
Karen	-	3	-	2	-	4	-	1
Nancy	-	0	-	0	-	1	-	5

Table B.2: Results of the task to test navigation from the first usability test.

Name	Initial Fadigue	Initial Satisfaction	Final Fadigue	Final Satisfaction
Smith	2	3	-	-
Linda	2	3	-	-
Mary	-	-	-	-
Laura	2	3	2	3
Betty	4	2	-	-
Karen	1	4	-	-
Nancy	4	1	-	-

Table B.3: Results of the fatigue and satisfaction evaluation before and after the first usability test.

Name	Notes
Smith	The participant had more difficulties using the arrows than using the numbers. The function of the middle button is easy to forget.
Linda	The middle button causes confusion. After the garlic's riddle, the participant completed all the selections with no problem.
Mary	The participant could only read part of the water tank word, which means even the 50pt size is complicated. The participant had no difficulties understanding that clicking on the number selected the option. In the riddle of the hake fish, the user tried all the arrows. After the hake riddle, the participant did not experience any more difficulties with the arrows. On the last riddle, the participant forgot how to select an option
Laura	The participant had no difficulties understanding that clicking on the number selected the option. The participant had no difficulties using the arrows, maybe it is due to its past experience using computers.
Betty	The participant forgot how to select an option in the Garlic's riddle
Karen	The task had to be explained several times. The participant proved to be uninterested in the task. "I'm not going to learn now that I am old". The participant forgot the function of the middle button in the riddle of the hake. It's difficult to use the arrows in the begining; needed three examples. The participant did not notice the numbers under the options.
Nancy	In the riddle of the louse, the participant knew what to do but was experimenting.

Table B.4: Notes from the first usability test.

B.2 Usability Test #2

The Health Menu provides links to the (main) functionalities of the system. However, unless these names are meaningful to the older adult, the system will be difficult to use. In the second usability test, the idea was to receive feedback from the users concerning the meaning of the options in the Health Menu.

B.2.1 Test Design

My name is Francisco Nunes and I am on the last year of the informatics engineering degree. My final degree project is to design a system that helps older adults managing their health trough the use of television. What we will do today and in the following weeks are a couple of games that will help me build the system. We want a product that fits older adults, therefore, it is crucial to gather feedback from people like you.

What can I tell you... This system is being developed in the context of a European project and perhaps it will be used by your sons or grandsons. Now that I have explained why I am here, I would like to ask you if you want to participate in these sessions. Most sessions will be like to games, nothing hard or complicated.

I would like to refer that you are not being tested, I'm here to understand what is wrong with my designs and what is best for you.

Before starting today's test I would like you to tell me, which of these faces better represents the happiness you feel right now (see Figure B.9). I would also like to know if you are feeling tired or energetic. Can you choose the image that most resembles the way you feel right now (see Figure B.9)? **:MA,:MB**

B.2.1.1 1st Task – Meanings of options in the Health Menu

For our first task, I will lay six labels on the table with the names of the functionalities of the system we are designing. After reading the name of the functionality, I would like you to tell me what functionality could have a name like that.

«The following options are laid on the table: Make Call, Watch Educational Videos, See Personal Agenda, See Health Status, Personalize and Emergency Call »

What functionality could be named Make Call (Fazer Chamada)**:M1**?
In case of a very diverse idea: Now that you have told me your ideas about Make Call, I would like to ask you, how would you name a functionality that enabled you to call your doctor to ask some advice or to make an appointment.**:M2**
In case of a similar idea: You got the idea. Make Call allows you to call your doctor to ask some advice or to make an appointment. Do you remember a better name for this functionality?

What functionality could be named Watch Educational Videos (Ver Vídeos Educativos)**:M3**?
In case of a very diverse idea: Now that you have told me your ideas about Watch Educational Videos, I would like to ask you, how would you name a functionality that enabled you to watch a video that the doctor sent with some exercises you should do.**:M4**
In case of a similar idea: You got the idea. Watch Educational Videos allows you to watch a video that the doctor sent with some exercises you should do. Do you remember a better name for this functionality?

What functionality could be named See Personal Agenda (Ver Agenda Pessoal)**:M5**?
In case of a very diverse idea: Now that you have told me your ideas about See Personal Agenda, I would like to ask you, how would you name a functionality that enabled you to see an agenda that has your next medical appointments.**:M6**
In case of a similar idea: You got the idea. See Personal Agenda allows you to see an agenda that has your next medical appointments. Do you remember a better name for this functionality?

What functionality could be named See Health Status (Ver Estado de Saúde)**:M7**?
In case of a very diverse idea: Now that you have told me your ideas about See Health Status, I would like to ask you, how would you name a functionality that enabled you to see if your heart or your arterial tension have been working well.**:M8**
In case of a similar idea: You got the idea. See Health Status allows you to see if your heart or your arterial tension have been working well. Do you remember a better name for this functionality?

What functionality could be named Personalize (Personalizar)**:M9**?
In case of a very diverse idea: Now that you have told me your ideas about Personalize, I would like to ask you, how would you name a functionality that enabled you to personalize the system to your taste.**:M10**
In case of a similar idea: You got the idea. Personalize allows you to personalize the system to your taste. Do you remember a better name for this functionality?

What functionality could be named Emergency Call (Chamada de Emergência)**:M11**?
In case of a very diverse idea: Now that you have told me your ideas about Emergency Call, I would like to ask you, how would you name a functionality that enabled you to to call the 112 (the european emergency number).**:M12**
In case of a similar idea: You got the idea. Emergency Call allows you to to call the 112. Do you remember a better name for this functionality?

Similarly to the beginning, I would like you to tell me, which of these faces better represents the happiness you feel right now (see Figure B.9). I would also like to know which of these puppets better resembles the energy you feel right now (see Figure B.9). **:MA, :MB**

We are done for today. Thank you very much for your help, it was really helpful.

In case it is the first test: Now that the test is finished, I have to ask if you want to continue collaborating with us.

B.2.1.2 Measured Variables

:MA – Level of happiness according to a scale of seven faces (the most happy is image is number one and the sadder is seven)
:MB – Level of fatigue according to a scale of four puppets (the most tired is number one and the most energetic is number four)
:M1 – Understands the functionality Make Call
:M2 – Name suggestions for the functionality Make Call
:M3 – Understands the functionality Watch Educational Videos
:M4 – Name suggestions for the functionality Watch Educational Videos
:M5 – Understands the functionality See Personal Agenda
:M6 – Name suggestions for the functionality See Personal Agenda
:M7 – Understands the functionality See Health Status
:M8 – Name suggestions for the functionality See Health Status
:M9 – Understands the functionality Personalize
:M10 – Name suggestions for the functionality Personalize
:M11 – Understands the functionality Emergency Call
:M12 – Name suggestions for the functionality Emergency Call

B.2.2 Results

Name	Make Call			Watch Educational Videos		
	Meaning	Understood	Suggestion	Meaning	Understood	Suggestion
Barbie	Make Phone Call	Yes	Call Doctor	Videos that teach people how to be educated. Videos to keep our knowledge updated.	No	Watch Videos about Health
Laura	It means to call someone. Maybe send an e-mail to start videoconference, my daughter does that.	Yes	-	To know more than what I know, like a TV show. To improve one's general culture.	No	-
Donna	-	No	Contact Doctor	It would be great to have videos teaching how to dance.	Yes	-
Sarah	Make a phone call for example to a friend.	Yes	-	-	No	-

Table B.5: Results of how the test participants understand Make Call and Watch Educational Videos functionalities.

Name	See Personal Agenda			See Health Status		
	Meaning	Understood	Suggestion	Meaning	Understood	Suggestion
Barbie	It is like a telephone that can keep you appointments. I can see my appointments.	Yes	-	It is like going to a place that does a checkup so that you don't need to go to so many medical appointments.	No	-
Laura	It allows keeping the phone numbers and the anniversaries of family. It is also a place to write where you have to go.	Yes	-	Measure my arterial tension or diabetes. Advise me what medication to take. See how I feel and tell the doctors my symptoms.	Yes	Watch Health
Donna	It allows other people to see my personal information.	No	-	Check if one is ok or not.	Yes	-
Sarah	It keeps my medical appointments. But I don't use an agenda any more; I only keep the papers that they give me when I make an appointment.	Yes	-	It will show that I need to be operated but I don't want to.	Yes	-

Table B.6: Results of how the test participants understand See Personal Agenda and See Health Status functionalities.

Name	Personalize			Emergency Call		
	Meaning	Understood	Suggestion	Meaning	Understood	Suggestion
Barbie	Make the system more adapted to the person.	No	-	Someone is feeling very bad and needs a hospital. He calls to the INEM (the name of the Portuguese medical emergency institute) to come.	Yes	-
Laura	See the general state of a person.	No	-	It is the 112 service.	Yes	-
Donna	-	No	Configure	-	No	-
Sarah	-	No	-	Call my niece. She always helps me when something goes wrong. If the situation is really bad call the 112.	Yes	-

Table B.7: Results of how the test participants understand Personalize and Emergency Call functionalities.

Name	Initial Fadigue	Initial Satisfaction	Final Fadigue	Final Satisfaction
Barbie	3	2	3	2
Laura	2	3	3	3
Donna	2	4	3	1
Sarah	2	3	3	2

Table B.8: Results of the fatigue and satisfaction evaluation before and after the second usability test.

B.3 Usability Test #3

In the previous test, users evaluated the names given by the system's designers. Some were not very clear and thus suggestions were asked. In the current test, different users evaluate the suggestions of the test participants against the initial names. In the end, the preferred designations will be chosen. This test also includes one task to evaluate the icons of the menu options. At the end of the test, the author tries to understand if the users know what the active ingredient is in order to receive information to design the medication reminder.

B.3.1 Test Design

B.3.1.1 1st Task – Compare the initial names of the menu options with the users' suggestions

«The facilitator lays on the table the following menu option names: Make Call (Fazer Chamada), Contact Doctor (Contactar Médico) and Call Doctor (Telefonar a médico)»

As you can see, I have laid a couple of functionalities' names in the table. Which of them is the best name for a functionality that would allow you to call your family doctor or your cardiologist so that you don't need so much medical appointments? **:M1**

«The facilitator removes the previous names and lays on the table the following ones: Watch Health Status (Ver Estado de Saúde) and Watch Health (Vigiar Saúde)»

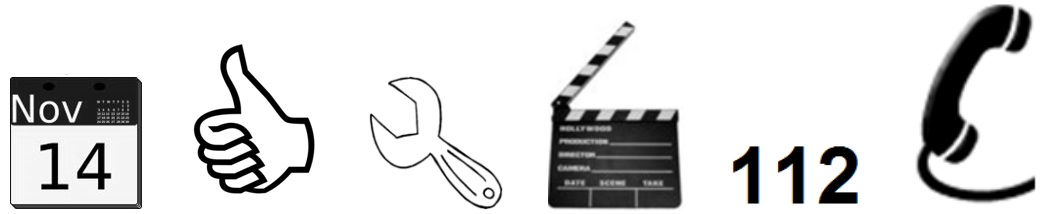
As you can see, I have laid a couple of functionalities' names in the table. Which of them is the best name for a functionality that would allow you to see some graphs showing how your arterial tension and your heart were today or yesterday? **:M2**

«The facilitator removes the previous names and lays on the table the following ones: Watch Educational Videos (Ver Vídeos Educativos) and Watch Health Videos (Ver vídeos de Saúde).»

As you can see, I have laid a couple of functionalities' names in the table. Which of them is the best name for a functionality that would allow you to see videos that teach how to take care of your health? Those videos could give examples of nice recipes that you can eat and exercises to ease that pain on the back. **:M3**

B.3.1.2 2nd Task – Choose the best icons for the menu options

«The facilitator lays the names chosen by the test participant on the left side of the table. Then, the icons for the different functionalities are laid on the right side.»
As you can see, we have divided the table in two parts. On the left side, there are names



(a) See Agenda (b) Watch Health (c) Personalize (d) Health Videos (e) Emergency Call (f) Make Call

Figure B.5: Icons for the Health Menu options.

of the functionalities and on the right the icons for those names. What I would ask you to do is to choose the most appropriate icon for each functionality name. **:M4**

B.3.1.3 3rd Task – Active Ingredient

Do you know what the active ingredient of a medication is? **:M5**

If the user does not know: If we were on Formula 1, Michael Schumacher would be the active substance of Ferrari. The active substance is the element of the medication that is responsible for the effect. It is a scientific name. Now I would like you to find the active substance in this box of Benuron. **:M6**

Similarly to the beginning, I would like you to tell me, which of these faces better represents the happiness you feel right now (see Figure B.9). I would also like to know which of these puppets better resembles the energy you feel right now (see Figure B.9). **:MA, :MB**
We are done for today. Thank you very much for your help, it was really helpful.

In case it is the first test: Now that the test is finished, I have to ask if you want to continue collaborating with us.

B.3.1.4 Measured Variables

:MA – Level of happiness according to a scale of seven faces (the most happy is image is number one and the sadder is seven)
:MB – Level of fatigue according to a scale of four puppets (the most tired is number one and the most energetic is number four)
:M1 – The best name for making a call
:M2 – The best name for watching health status
:M3 – The best name for watching educational videos
:M4 – Understands the icons of the functionalities
:M5 – Knows what the active ingredient is (yes/no)
:M6 – Number of errors when trying to find the active ingredient. Time needed to find the active substance

B.3.2 Results

Name	Best Name for:		
	Making a call	Watching health status	Watching educational videos
Barbie	Make Call	Watch Health	Watch Health Videos
Susan	Contact Doctor	Watch Health	Watch Educational Videos
Dorothy	Call Doctor	Watch Health	Watch Health Videos
Smith	Contact Doctor	Watch Health	Watch Health Videos
Margaret	Call Doctor	Watch Health	Watch Health Videos
Helen	Contact Doctor	Watch Health	Watch Educational Videos

Table B.9: Names chosen by test participants on the third usability test.

Name	Understood the Image:					
	Telephone	Claket	Calendar	Tool	112	Thumb
Barbie	yes	yes	yes	no	yes	no
Susan	yes	yes	no	yes	yes	yes
Dorothy	yes	no	yes	yes	yes	yes
Smith	yes	yes	yes	no	yes	yes
Margaret	yes	no	no	no	yes	yes
Helen	yes	no	yes	yes	yes	yes

Table B.10: Results of how users understood the icons of the Health Menu in the third usability test.

Name	Active Ingredient		
	Knows definition	Time required to find it in the medicine box	Number of errors finding
Barbie	no	1s	0
Susan	no	9s	0
Dorothy	no	40s	1
Smith	no	3s	0
Margaret	no	7s	0
Helen	yes	10s	0

Table B.11: Results of the active ingredient task from the third usability test.

Name	Initial Fadigue	Initial Satisfaction	Final Fadigue	Final Satisfaction
Barbie	3	3	3	3
Susan	3	3	3	1
Dorothy	1	6	3	1
Smith	2	3	3	2
Margaret	3	1	3	1
Helen	4	2	4	1

Table B.12: Results of the fatigue and satisfaction evaluation before and after the third usability test.

B.4 Usability Test #4

The icons of the Health Menu were not decided in the previous test since some of them were confusing. The fourth usability test evaluated different alternatives of icons for the agenda and for the health videos. Besides this task, this test also evaluates the watch health screens.

B.4.1 Test Design

My name is Francisco Nunes and I am on the last year of the informatics engineering degree. My final degree project is to design a system that helps older adults managing their health trough the use of television. What we will do today and in the following weeks are a couple of games that will help me build the system. We want a product that fits older adults, therefore, it is crucial to gather feedback from people like you.

What can I tell you... This system is being developed in the context of a European project and perhaps it will be used by your sons or grandsons. Now that I have explained why I am here, I would like to ask you if you want to participate in these sessions. Most sessions will be like to games, nothing hard or complicated.

I would like to refer that you are not being tested, I'm here to understand what is wrong with my designs and what is best for you.

Before starting today's test I would like you to tell me, which of these faces better represents the happiness you feel right now (see Figure B.9). I would also like to know if you are feeling tired or energetic. Can you choose the image that most resembles the way you feel right now (see Figure B.9)? **:MA,:MB**

B.4.1.1 1st Task – Choose the best image for See Agenda and Watch Health Videos

«The user interface of the Health Menu is put in front of the user. The options of the menu have the names chosen in previous usability tests. Besides the name, there is an icon next to each menu option except for the See Agenda and Watch Health Videos. The user is also handed with ten images, five for each of the options that is lacking an icon. »

(a) Daily Agenda (b) Daily Agenda (c) Daily Calendar (d) Pocket Agenda (e) Table Calendar

Figure B.6: Different icons for the agenda evaluated on the fourth usability test.

This is the Health Menu, the main menu of the system. Each of the options in the menu is going to help you managing your health in a different way. As you can see, there are

(a) Film Strip (b) Claket (c) Film Reel (d) Cassette (e) Movie Projector

Figure B.7: Different video icons evaluated on the fourth usability test.

two images lacking. I gave you two stacks of images, one for the See Agenda and one for the Watch Health Videos. What I would like you to do is to choose the right image for the options that don't have one. See Agenda will store the information of your next medical appointments and Watch Health Videos will show videos sent by the doctor, for example, for helping you ease the pain on your back. **:M1,:M2**

B.4.1.2 2nd Task – Watch Arterial Tension

«Before starting this task, the participant is taught how to use the remote control if he has never used it or does not remember how to use it.»

Now we will role-play. Your name is Mr/s Joaquim/na. You have diabetes and your arterial tension is usually very high. This is your television. Every box in this menu will help you manage your health. Now it is 20:30 in the night and it is the fourth time you measure your arterial tension today.

«The user measures the arterial tension using a standard device»

Now, I would like you to show me how your arterial tension was during the day. In order to do it, you will have to select one option from the following menu. **:M3,:M4**

«The user goes through the Watch Health Screen and gets to Watch Arterial Tension.»

Now, I would like you to tell me what the minimum arterial tension value was. **:M5**

Can you tell me the values that were too high? **:M6**

Currently we are seeing the values of your arterial tension from today. Can you show me the values of yesterday? **:M7**

B.4.1.3 3rd Task – Watch Diabetes

Now, I would like you to go back and to show me the values of your diabetes. **:M8,:M9**

My last question is what was your diabetes value at breakfast? **:M10**

Similarly to the beginning, I would like you to tell me, which of these faces better represents the happiness you feel right now (see Figure B.9). I would also like to know which of these puppets better resembles the energy you feel right now (see Figure B.9). **:MA, :MB**

We are done for today. Thank you very much for your help, it was really helpful.

In case it is the first test: Now that the test is finished, I have to ask if you want to continue collaborating with us.

B.4.1.4 Measured Variables

:MA – Level of happiness according to a scale of seven faces (the most happy is image is number one and the sadder is seven)
:MB – Level of fatigue according to a scale of four puppets (the most tired is number one and the most energetic is number four)
:M1 – Selected image for See Agenda
:M2 – Selected image for Watch Health Videos
:M3 – Errors (physical and wrong option) until selecting Watch Health
:M4 – Errors (physical and wrong option) until selecting Watch Arterial Tension
:M5 – Finds the minimum value of arterial tension (yes/no)
:M6 – Understands how high, low and normal arterial tension values are represented
:M7 – Understands how to change from today's graph to yesterday's
:M8 – Errors (physical and wrong option) until going back to Watch Health
:M9 – Errors (physical and wrong option) until selecting Watch Diabetes
:M10 – Understands that the values are displayed according to the time of the day in which they were measured (yes/no)

B.4.2 Results

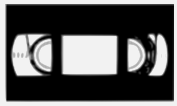
Name	See Agenda's Icon	Watch Health Videos' Icon
Barbie		
Helen		
Laura		
Margaret		
Dorothy		
Rose		

Table B.13: Icons chosen by test participants for the agenda and health videos on the fourth usability test.

Name	Watch Health Physical Errors	Watch Health Option Errors	Watch Arterial Tension Physical Errors	Watch Arterial Tension Option Errors	Finds the minimum value of arterial tension (yes/no)	Understands how high, low and normal arterial tension values are represented (yes/no)
Barbie	0	0	1	0	yes	yes
Helen	1	0	0	0	yes	no
Laura	1	2	0	0	yes	yes
Margaret	0	3	3	0	yes	yes
Dorothy	2	0	5	0	yes	yes
Rose	0	0	4	0	yes	yes

Table B.14: Results of the task to see the arterial tension from the fourth usability test.

Name	Watch Health Physical Errors	Watch Health Option Errors	Watch Diabetes Physical Errors	Watch Diabetes Option Errors	Understands that the values appear ordered by time (yes/no)
Barbie	2	0	0	0	yes
Helen	2	-	-	-	-
Laura	1	0	0	0	yes
Margaret	1	0	0	0	yes
Dorothy	2	0	3	0	yes
Rose	2	0	1	0	yes

Table B.15: Results of the task to see the diabetes status from the fourth usability test.

Name	Initial Fadigue	Initial Satisfaction	Final Fadigue	Final Satisfaction
Barbie	3	2	3	2
Helen	1	3	1	3
Laura	3	2	3	2
Margaret	1	4	1	4
Dorothy	1	3	2	3
Rose	1	3	1	4

Table B.16: Results of the fatigue and satisfaction evaluation before and after the fourth usability test.

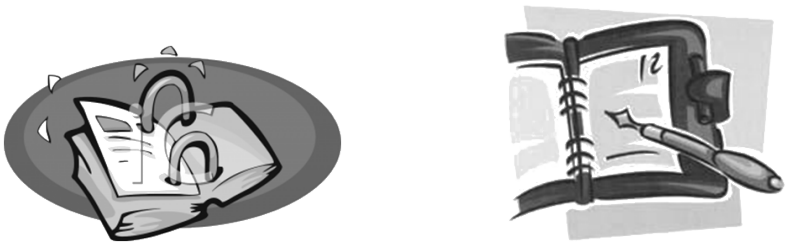
B.5 Usability Test #5

Part of this test is an iteration of the fourth usability test. Therefore, only the participants that did not use the system in the previous test evaluated the tasks that are similar. In the other part of the test, the screen See Agenda was evaluated.

B.5.1 Test Design

B.5.1.1 1st Task – Choose the best image for See Agenda and Watch Health Videos

«The user interface of the Health Menu is put in front of the user. The options of the menu have the names chosen in previous usability tests. Besides the name, there is an icon next to each menu option except for the See Agenda and Watch Health Videos. The user is also handed with four images, two for each of the options that is lacking an icon. »



(a) Daily Agenda (b) Pocket Agenda

Figure B.8: Different agenda metaphors evaluated on the fifth usability test.

(a) Cassette (b) Movie Projector

Figure B.9: Different video metaphors evaluated on the fifth usability test.

This is the Health Menu, the main menu of the system. Each of the options in the menu is going to help you managing your health in a different way. As you can see, there are two images lacking. I gave you two stacks of images, one for the See Agenda and one for the Watch Health Videos. What I would like you to do is to choose the right image for the options that don't have one. See Agenda will store the information of your next medical appointments and Watch Health Videos will show videos sent by the doctor, for example, for helping you ease the pain on your back. **:M1,:M2**

B.5.1.2 2nd Task – Date format

Now I would like you to write your birthday date in a format that has numbers. **:M3**

B.5.1.3 3rd Task – Watch Arterial Tension

«Before starting this task, the participant is taught how to use the remote control if he has never used it or does not remember how to use it.»

Now we will role-play. Your name is Mr/s Joaquim/na. You have diabetes and your arterial tension is usually very high. This is your television. Every box in this menu will help you manage your health. Now it is 20:30 in the night and it is the fourth time you measure your arterial tension today. Your arterial tension is 16.9.

Now, I would like you to show me how your arterial tension was during the day. In order to do it, you will have to select one option from the following menu. **:M4**

«The user goes through the Watch Health Screen and gets to Watch Arterial Tension.»

Now, I would like you to tell me what the minimum arterial tension value was. **:M5**

Can you tell me the values that were too high? **:M6**

Can you tell me the value that was measured in the middle of the afternoon? **:M7**

B.5.1.4 4th Task – See Agenda

«The user interface of the See Agenda is put in front of the user. »

When is your next appointment going to take place? What is the specialty of the doctor? **:M8**

What is the appointment that you will have on the 21st April? What exams should you take? **:M9**

In Which day will you do blood tests? How many hours before the test should you not eat? Where are the tests taking place? **:M10,:M11,:M12**

We are done for today. Thank you very much for your help, it was really helpful.

In case it is the first test: Now that the test is finished, I have to ask if you want to continue collaborating with us.

B.5.1.5 Measured Variables

:M1 – Selected image for See Agenda
:M2 – Selected image for Watch Health Videos
:M3 – Format used for writing the date(dd/mm/yy or dd-mm-yy or dd.mm.yy)
:M4 – Understands Watch Health without Watch in the name of the options
:M5 – Finds the minimum value of arterial tension (yes/no)
:M6 – Understands how high, low and normal arterial tension values are represented
:M7 – Understands that the values are displayed according to the time of the day in which they were measured (yes/no)
:M8 – Finds the date of an appointment (yes/no)
:M9 – Understands how to see the exams that need to be taken to an appointment
:M10 – Finds the day of the blood tests (yes/no)
:M11 – Understands how to see the extra information of an exam appointment
:M12 – Finds the place where the blood tests will take place (yes/no)

B.5.2 Results

Name	See Agenda's Icon	Watch Health Videos' Icon
Smith		
Susan		

Table B.17: Icons chosen by test participants for the agenda and health videos on the fifth usability test.

Name	Date Format
Smith	dd/mm/yy
Susan	dd–mm–yy
Laura	dd/mm/yy
Dorothy	dd–mm–yy
Helen	dd–mm–yy

Table B.18: Date format used by the test participants on the fifth usability test.

Name	Understands the new Watch Health (yes/no)	Finds the minimum value of arterial tension (yes/no)	Understands how high, low and normal arterial tension values are represented (yes/no)	Understands that the values appear ordered by time (yes/no)
Smith	yes	yes	yes	yes
Susan	yes	yes	yes	yes

Table B.19: Results of the task to see the arterial tension from the fifth usability test.

Name	Finds the date of an appointment (yes/no)	Understands how to see the exams that need to be taken to an appointment	Finds the day of the blood tests (yes/no)	Understands how to see the extra information of an exam appointment	Finds the place where the blood tests will take place (yes/no)
Smith	yes	difficulties	yes	difficulties	yes
Susan	yes	difficulties	yes	difficulties	yes
Laura	yes	difficulties	yes	difficulties	yes
Dorothy	yes	difficulties	yes	difficulties	yes
Helen	yes	difficulties	yes	difficulties	yes

Table B.20: Results of the task that evaluated the agenda in the fifth usability test.

B.6 Usability Test #6

In this test, the general objectives were to: 1) test the user interfaces of the Call Dr functionaly; 2) test the user interfaces of the appointment and medication reminder; and 3) test the user interface of receiving call.

B.6.1 Test Design

My name is Francisco Nunes and I am on the last year of the informatics engineering degree. My final degree project is to design a system that helps older adults managing their health trough the use of television. What we will do today and in the following weeks are a couple of games that will help me build the system. We want a product that fits older adults, therefore, it is crucial to gather feedback from people like you.

What can I tell you... This system is being developed in the context of a European project and perhaps it will be used by your sons or grandsons. Now that I have explained why I am here, I would like to ask you if you want to participate in these sessions. Most sessions will be like to games, nothing hard or complicated.

I would like to refer that you are not being tested, I'm here to understand what is wrong with my designs and what is best for you.

«Before starting the test, the participant is taught how to use the remote control if he has never used it or does not remember how to use it.»

B.6.1.1 1st Task – Call Dr. Eloísa

«The Health Menu is put in front of the user.»

Facilitator1 – The screen in front of you is the Health Menu. One of its options will allow you to make calls using the television. Now, I would like you to select the options that take you to call Dr. Eloísa.

«The Call To screen becomes the visible user interface. »

Facilitator 1 – Before you call Dr. Eloísa, I would like you to tell me what her medical specialty is. **:M1**

Facilitator1 –Thank you. Now you may call Dr. Eloísa. **:M2**

«At this moment, Facilitator1 holds the Call Dr. Eloísa (Ligar à Dr. Eloísa) user interface and reproduces the phone call tune while Facilitator2 simulates an animation (see Image B.6.1.1) by swapping labels that say Calling. After some seconds, the animation and the sounds stop and Facilitator1 opens a little door on the screen that allows the older adult to see the facilitator's face inside the user interface to simulate what would happen when using videoconference (see Image B.6.1.1).»

Figure B.10: The videoconference functinality was simulated by a door that opened on the low-fidelity prototype of the user interface.

Figure B.11: Call Dr. Eloísa screen has an animation to show that the system is making a call.

John (Facilitator 1) – Good Morning, you called Boavista Health House (Casa de Saúde da Boavista). My name is John. How are you today Mrs. Joaquina?

«After the participant answers, the scene freezes.»

Facilitator2 – Can you tell me with whom were you talking right now? Where was he talking from? What do you imagine he does there? **:M3**

Facilitator2 – Now, please tell him the doctor told you to call on Thursday to know the results of the exams.

«The scene unfreezes and the test participant talks to John.»

«Facilitator1 hums a waiting call music. After a some seconds however, he stops.»

John (Facilitator1) – Dr. Eloísa can answer you now. I will just transfer the call to the

doctor. Take care Mrs. Joaquina.

«At this moment, Facilitator1 passes the Call Dr. Eloísa user interface to Facilitator2. Holding the user interface in front of his face, Facilitator2 hums a waiting call music. This music, signaling a call transfer is accompanied by an animation done with text labels saying Transferring (Passando) by Facilitator1. Suddenly the animation and the sound stop and Facilitator2 (as Dr. Eloísa) opens the door of the user interface.»

Dr. Eloísa (Facilitator2) – Hello Mrs. Joaquina. How are you?

«After the participant answers, the scene freezes.»

Facilitator1 – Now, imagine that you have talked with Dr. Eloísa. Can you please hang-up the call? **:M4**

Facilitator1 – Thank you. Now, please go back to the Health Menu, the one we were looking at when we started. **:M5**

B.6.1.2 2nd Task – Receiving Call from Dr. Eloísa

«When the user arrives to the Health Menu, a screen showing he is receiving a call from Dr. Eloísa appears.»

Facilitator1 – Oh, it looks like something showed up. Can you explain to me what you are seeing? What happens if you click the Answer (Atender) button? And if you clicked on the Call Later (Ligue Depois) button? **:M6,:M7**

Facilitator1 – Your granddaughter just arrived and you must give her attention. This is not a good time to answer. Can you ask the doctor to call later?

Facilitator1 – Thank you.

B.6.1.3 2nd Task – Appointement Reminder

«After the participant presses the Call Later button, the appointment reminder screen appears.»

Facilitator1 – Can you tell me what is on the screen? What happens if I click on Remind Me Later (Lembrar Depois)? **:M8**

Facilitator1 – Now, can you please select the Remind Me Later option? **:M9**

Facilitator1 – Thank you.

B.6.1.4 3rd Task – Medication Reminder

«After the participant presses the Remind Me Later button, the medication reminder screen appears.»

Facilitator1 – Can you tell me what is on the screen? How many spoons should you take of the diabetes medicine? What happens if you click the Remind me Later (Lembrar depois) button? **:M10,:M11**

Facilitator1 – You still haven't taken the medication yet. Can you select the option that reminds you to take it later? **:M12**

Facilitator1 – Thank you.

We are done for today. Thank you very much for your help, it was really helpful.

In case it is the first test: Now that the test is finished, I have to ask if you want to continue collaborating with us.

B.6.1.5 Measured Variables

:M1 – Difficulties finding medical specialty (easy/hard)
:M2 – Difficulties selecting which doctor to call (easy/hard)
:M3 – Difficulties understanding who answered the phone (easy/hard)
:M4 – Difficulties hanging up the call (easy/hard)
:M5 – Difficulties going back to the Health Menu (easy/hard)
:M6 – Difficulties understanding how to answer a call (easy/hard)
:M7 – Difficulties understanding how to reject a call (easy/hard)
:M8 – Understands the purpose of the appointment reminder (yes/no)
:M9 – Difficulties snoozing the appointment reminder (easy/hard)
:M10 – Understands medication reminder (yes/no)
:M11 – Understands how many spoons to take (easy/hard)
:M12 – Difficulties snoozing the medication reminder (easy/hard)

B.6.2 Results

Name	Finds the specialty of the doctor (easy/hard)	Selects doctor to call (easy/hard)	Knows who answered the phone (easy/hard)	Hangs-up Call (easy/hard)	Goes back to the Health Menu (easy/hard)
Margaret	easy	easy	easy	easy	easy
Dorothy	easy	easy	easy	easy	easy
Smith	easy	easy	easy	easy	easy
Laura	easy	easy	easy	easy	easy
Sarah	easy	easy	easy	easy	easy
Helen	easy	easy	easy	easy	-

Table B.21: Results of the tasks to evaluate Call Dr from the sixth usability test.

Name	Answer a call (easy/hard)	Reject a call (easy/hard)	Understands appointment reminder (yes/no)	Snooze appointment reminder (easy/hard)	Understands medication reminder (yes/no)	Understands how many spoons to take (easy/hard)	Snooze medication reminder (easy/hard)
Margaret	easy	easy	yes	hard	yes	easy	easy
Dorothy	easy	easy	no	yes	hard	yes	yes
Smith	easy	easy	yes	yes	easy	yes	yes
Laura	easy	easy	yes	yes	easy	yes	yes
Sarah	easy	easy	yes	yes	hard	yes	yes
Helen	easy	easy	yes	yes	easy	yes	yes

Table B.22: Results of the tasks to evaluate the reminders and the incoming call from the sixth usability test.

Name	Initial Fadigue	Initial Satisfaction	Final Fadigue	Final Satisfaction
Margaret	3	1	3	1
Dorothy	1	7	3	1
Smith	2	5	3	2
Laura	2	4	3	3
Sarah	2	3	3	3
Helen	2	2	2	1

Table B.23: Results of the fatigue and satisfaction evaluation before and after the sixth usability test.

B.7 Usability Test #7

The seventh usability test had two objectives: 1) evaluate parts of the Watch Health Videos screen and 2) test the readability of translineated words. While the first part of the test evaluates, for example, if users know the standard video player icons, the second evaluates if more users have the difficulty that was observed in the sixth usability test reading the name of a medication that was translineated.

B.7.1 Test Design

My name is Francisco Nunes and I am on the last year of the informatics engineering degree. My final degree project is to design a system that helps older adults managing their health trough the use of television. What we will do today and in the following weeks are a couple of games that will help me build the system. We want a product that fits older adults, therefore, it is crucial to gather feedback from people like you.

What can I tell you... This system is being developed in the context of a European project and perhaps it will be used by your sons or grandsons. Now that I have explained why I am here, I would like to ask you if you want to participate in these sessions. Most sessions will be like to games, nothing hard or complicated.

I would like to refer that you are not being tested, I'm here to understand what is wrong with my designs and what is best for you.

B.7.1.1 1st Task – Compare Labels for the re-play video button

«The facilitator lays four labels on the table: Play (Tocar), Start (Iniciar), Reproduce (Reproduzir) and Re-play (Recomeçar).»

Imagine you were watching a video and paused it to go the bathroom. Now that you came, you want to continue watching it. Which of this words best describes playing the video from the previous point? **:M1**

B.7.1.2 2nd Task – Distinguish video player icons

«The facilitator lays the three video player symbols on the table.»

These symbols in front of you are icons that enable you to control a video player. I would like you to tell me, which of these images enables you to stop the video? Which enables you to pause the video? And what about the other one, what does it do? **:M2**

B.7.1.3 3rd Task – Count the number of words in translineated medication names

For our last task, I will show you two pieces of paper with medication names.

«The facilitator lays the two pieces of paper in the table»

How many words do you see on this paper without counting the milligrams? And on the other one?

We are done for today. Thank you very much for your help, it was really helpful.

In case it is the first test: Now that the test is finished, I have to ask if you want to continue collaborating with us.

B.7.1.4 Measured Variables

:M1 – Choose the best word to describes playing the video from the previous point (Play/Start/Reproduce/Re-play)
:M2 – Knows the standard video icons (no/which one)
:M3 – Recognizes translineated test (yes/no)

B.7.2 Results

Name	Replay Word	Knows the standard video icons	Recognizes Translineated text
Donna	Re-play	No	No
Michelle	Play	No	No
Susan	Start	No	No
Laura	Re-play	No	No
Helen	Re-play	Only the Play	Yes
Barbie	Re-play	No	Yes

Table B.24: Results of the tasks from the seventh usability test.

B.8 Usability Test #8

Since a prototype of greater fidelity has been designed – based on the low-fidelity prototype in Section 5.2 – it was important to evaluate some of the icons created. With that purpose in mind, the facilitator took a couple of icons for a usability test. Among others, the test included the icons of the menus and from other screens like the agenda.

B.8.1 Test Design

B.8.1.1 1st Task – Order the images of the moments of the day

(a) (b) (c) (d) (e)

Figure B.12: Different icons for the moments of the day evaluated in the eighth usability test. These icons belong to the bottom of the graph of Watch Health.

«Five images with the sun and the moon are laid on the table.»

These images show different moments of the day. What I would ask you to do is to choose four that represent a full day, from sunrise to night. Then I would like you order them. **:M1**

B.8.1.2 2nd Task – Images of Watch Health

(a) Watch Heart (b) Watch Arterial Tension (c) Watch Diabetes I (d) Watch Diabetes II

Figure B.13: Different icons for watch health menu.

«Four images are laid on the table representing watch arterial tension, watch diabetes and watch heart.»

Which of these images represents watch arterial tension? And watch diabetes? And what about watch heart? **:M2,:M3,:M4**

(a) Ophthalmologist (b) Cardiologist (c) Otorhinolaringologo-gist

Figure B.14: Different icons for medical specialties to appear in the agenda of the medium fidelity prototype.

B.8.1.3 3rd Task – Images of medical specialty

«Three images are laid on the table representing the otorhinolaringologist, ophthalmologist and the cardiologist.»

Which of these images represents the otorhinolaringologist? And the ophthalmologist? And the cardiologist? **:M5,:M6,:M7**

B.8.1.4 4th Task – Icons of the Health Menu options

(a) Watch Health (b) Watch Health Videos (c) Contact Doctor

(d) Emergency Call (e) Personalize

Figure B.15: Icons for the Health Menu of the medium-fidelity prototype.

«Six images are laid on the table representing the icons of the Health Menu.»

I have laid the icons of the Health Menu on the table. Which of this images represents the Watch Health? And Watch Health Videos? And Contact Doctor? And See Agenda? And Emergency Call? And Personalize? **:M8,:M9,:M10,:M11,:M12,:M13**

(a) Do not eat (b) Do not drink (c) Blood tests I (d) Blood tests II (e) Blood tests III (f) Electrocardiogram

Figure B.16: Icons for the extra information of the agenda appointment.

B.8.1.5 5th Task – Icons for See Agenda extra information

«Six images are laid on the table with the icons that belong to the extra information of the agenda appointments »
What is the image that refers that you should not drink liquids? And what is the one that says you should not eat? And which of them better relates to blood tests? And to an electrocardiogram? **:M14,:M15,:M16,:M17**

We are done for today. Thank you very much for your help, it was really helpful.

In case it is the first test: Now that the test is finished, I have to ask if you want to continue collaborating with us.

B.8.1.6 Measured Variables

:M1 – Order of the images of the moments of the day
:M2 – Difficulties understanding the image of watch arterial tension (yes/no)
:M3 – Which image is chosen for watch diabetes (Finger (Figure B.13(d)) / Device (Figure B.14(c)))
:M4 – Difficulties understanding the image of watch heart (yes/no)
:M5 – Difficulties understanding the image of otorhinolaringologist (yes/no)
:M6 – Difficulties understanding the image of ophthalmologist (yes/no)
:M7 – Difficulties understanding the image of cardiologist (yes/no)
:M8 – Difficulties understanding the image of Watch Health (yes/no)
:M9 – Difficulties understanding the image of Watch Health Videos (yes/no)
:M10 – Difficulties understanding the image of Contact Doctor (yes/no)
:M11 – Difficulties understanding the image of See Agenda (yes/no)
:M12 – Difficulties understanding the image of Emergency Call (yes/no)
:M13 – Difficulties understanding the image of Personalize (yes/no)
:M14 – Difficulties understanding the image of prohibition to drink liquids (yes/no)
:M15 – Difficulties understanding the image of prohibition to eat (yes/no)
:M16 – Which image is chosen for blood tests
:M17 – Difficulties understanding the image of the electrocardiogram (yes/no)

B.8.2 Results

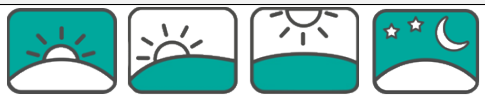
Name	Order of the images of the moments of the day
Susan	
Barbie	
Laura	
Margaret	
Smith	
Sarah	

Table B.25: Results of the ordering of Watch Health graph icons in the eighth usability test.

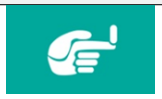
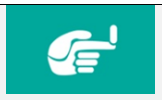
Name	Difficulties understanding the image of watch arterial tension (yes/no)	Image chosen for watch diabetes	Difficulties understanding the image of watch heart (yes/no)
Susan	yes		no
Barbie	yes		no
Laura	no		no
Margaret	no		yes
Smith	no		no
Sarah	no		yes

Table B.26: Results of the task that asked the participants of the eighth usability tests to choose the images of Watch Health conditions like watch arterial tension or watch diabetes.

Name	Difficulties understanding the image of otorhinolaringologist (yes/no)	Difficulties understanding the image of ophthalmologist (yes/no)	Difficulties understanding the image of cardiologist (yes/no)
Susan	no	yes	no
Barbie	no	no	no
Laura	no	no	no
Margaret	no	no	no
Smith	no	no	no
Sarah	no	no	no

Table B.27: Results of the task that asked the participants of the eighth usability tests to choose the images of the otorhinolaringologist, ophthalmologist and the cardiologist.

Name	Difficulties understanding the image of Watch Health (yes/no)	Difficulties understanding the image of Watch Health Videos (yes/no)	Difficulties understanding the image of Contact Doctor (yes/no)	Difficulties understanding the image of See Agenda (yes/no)	Difficulties understanding the image of Emergency Call (yes/no)	Difficulties understanding the image of Personalize (yes/no)
Susan	no	yes	no	no	no	no
Barbie	yes	no	no	no	no	no
Laura	no	no	no	no	no	no
Margaret	yes	yes	no	no	no	no
Smith	no	no	no	no	no	no
Sarah	yes	no	no	no	no	no

Table B.28: Results of the task that asked the participants which were the icons that corresponded to each menu option.

Name	Difficulties understanding the image of prohibition to drink liquids (yes/no)	Difficulties understanding the image of prohibition to eat (yes/no)	Which image is chosen for blood tests	Difficulties understanding the image of the electrocardiogram (yes/no)
Susan	no	no		no
Barbie	no	no		no
Laura	no	no		no
Margaret	no	no		no
Smith	no	no		no
Sarah	no	no		no

Table B.29: Results of the task that asked the participants which were the icons that corresponded the extra information of the agenda.

B.9 Evaluate Fatigue and Happiness

In most tests, users were asked to rate their happiness and fatigue on the beginning and at the end of the test. The goal of this evaluation was to understand the effect of the tests on the test participants. One can see from the results of the usability tests that the happiness increased and the fatigue decreased in almost all tests.

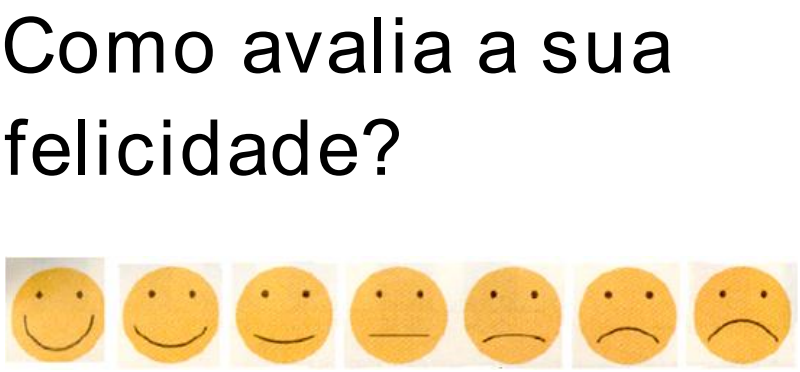


Figure B.17: Scale used to measure the level of happiness of the test participants. The first image is the number one and the last one is number seven.

Figure B.18: Scale used to measure the level of fatigue of the test participants. The first image is the number one and the last one is number four.

Appendix C

Human-Computer Interaction and the Older Adult: An Example Using User Research and Personas

Human-Computer Interaction and the Older Adult: An Example Using User Research and Personas

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ABSTRACT
This paper reports on the outcomes of the first phase of the eCAALYX project – an European project which aim is to develop a complete solution that improves the quality of life of the older adult with chronic conditions by monitoring his health and by improving the communication with his caretakers. Specifically, the authors are responsible for creating a TV user interface for older adults with chronic conditions.

The work described followed a multi-disciplinary approach strongly influenced by Human-Computer Interaction (HCI) methodologies. The main contributions of this paper are two-fold and materialize into i) a user research study that covers aspects such as perception, cognition, mental and psychosocial changes that occur with age and ii) an example-based description of the process of creating personas. John, the diabetic persona, is the example provided that abstracts the process followed to generate the remaining personas in the project.

Categories and Subject Descriptors
H.1.2 [**User/Machine Systems**]: Human factors; Human information processing. H.5.2 [**User Interfaces**]: User-centered design. H5.m [**Miscellaneous**]: HCI.

General Terms
Design, Experimentation, Human Factors.

Keywords
Human-Computer Interaction, User Research, Personas.

1. INTRODUCTION
Population is getting older. The United Nations predict that in 2050 the number of older adults in Europe will represent 38% of the population [1]. This demographic change is in fact a great triumph of civilization [2]. On the other hand, there will be fewer young adults to support an aging population. In this scenario, our healthcare systems will have to treat more patients, often suffering from (multiple) chronic conditions, using the same professionals and resources.

The growing number of older adults leads to the creation of new services and the adaptation of the existing ones to this specific type of audience. However, in order to design products for the older individual, it is important to understand and respect their characteristics. The older adult is usually less accustomed to technology and is likely to develop age-related conditions, namely related to perception and to cognition. Ignoring older adult's characteristics will probably result in a product with low acceptance level.

Human-Computer Interaction (HCI) is the discipline that studies the quality of the interaction between the human and technology [3]. And in that context, the main goal of HCI professionals is to create products that are useful, usable and used. Experimental research however, rarely reflects the demographics [4]. HCI is not an exception and not rarely grounds its research on younger individuals, often university students. In order to create adequate products for this audience, research ought to focus in the older adult, being that HCI provides us the right methods and tools.

This paper describes an experience using user research and personas in the context of the design and development of a system aimed at older adults. The paper reports the progress made on understanding the final user's needs and characteristics that will support the design of the system. This work was done within the context of the eCAALYX – "Enhanced Complete Ambient Assisted Living Experiment – project.

2. BACKGROUND ON: AGE RELATED CHANGES
The acceptance of a product or service depends, mostly, on its ability to solve a particular problem and on the facility of its integration into the user's life. Therefore, designing for the older adult requires the professionals to be knowledgeable into what concerns the older adult's characteristics. This section describes the physical, cognitive, psychological and social changes of this particular type of user. Our analysis mainly focused on the characteristics that are more relevant to the implementation of a user interface for the TV (see our case study in Section 4); nevertheless many points are general and can be applied to different systems.

The human is not a 'sum of physical parts'; as Carstensen and Hartel (2006) refer, humans are the sum of all that they have experienced, a reflection of the social and cultural environments where they have lived [5]. Therefore if one forgets the context of today's older adults, products will not achieve great acceptance.

PETRA'10, June 23 - 25, 2010, Samos, Greece.

The elder did not grow up using computers or other devices, and what might seem like a very common technology to us might be very strange or even 'rocket-science' to the older adult of today.

2.1 Physical Changes

The aging process introduces significant changes to the human perceptual system. To understand those changes, a distinction should be done between perception and sensation. Sensation is the apprehension of simple stimuli's properties through the senses; perception is the interpretation of those sensations. Seeing the red color is a sensation; recognizing an apple is a perception [6]. Many problems of the older adult however, are a mix of sensation and perception limitations; therefore our focus will be on problems rather than on their causes.

The next section reports changes in vision and is followed by a section on hearing and another on motor changes.

1.1.1 Changes in Vision

Vision is one of the most relevant human sensory systems, since the human acquires information (mainly) using sight [3]. Therefore it is fair to conclude that if the user cannot see the interface, most probably he will have problems using it. Fisk (2009) explains that "if we live long enough, nearly all of us will have vision problems" [6]. Vision can be affected in multiple ways, this section introduces the most important changes: visual acuity, presbyopia, peripheral vision and dark adaptation.

Charness and Schaie (2003) define visual acuity as "a measure of the visual system's ability to resolve fine spatial detail" [7]. According to Burke and Laramie (2004) a visually impaired individual has a 20/40 visual acuity or lower and can read an eye chart at 20 meters while fully sighted person can read at 40[1] [8][9][6]. Recent studies revealed that a percentage of 92% of the individuals above 70 years wear glasses [7]. Although (near and far) acuity problems are so common, Fisk (2009) argues that the acuity of 20/40 – which most older adults have (> 80%) – is more than enough for most activities [6].

Presbyopia is characterized by a decrease in the competence of the eye to change its focal length [10][6]. In other words, it is the difficulty of changing focus between objects at different distances. Our eyes are designed to look at objects which are 6 meters away or farther; each time the eye focus closer objects, the crystalline lens in the eye have to bend into a more convex shape [7]. The problem, as the same authors conclude, is that as we grow older the crystalline lens become harder to bend. The normal eye experiences difficulties in focusing objects at a reading distance since 45 years of age [11]. Although presbyopia can increase the difficulty of some tasks, it can be corrected by wearing glasses [7]. Based on this, and if a system requires the interaction with close objects, it is important to consider that the older adult may have extra difficulties due to the use of glasses. One example would be changing the TV channel, when the elder would have to put on the glasses in order to be able to read the channels number on the TV remote.

Age-related changes also bring the decrease in peripheral vision [7][6]. As objects move away from central vision into the periphery, it becomes more difficult to resolve their details [7]. Driving is one activity in which peripheral vision plays a critical role by allowing the driver to see cars coming from other directions. Similarly, user interfaces employ pop-ups often appearing on the corners of the screen. When dealing with older adults however, that information by itself might not be noticed, therefore other strategies for signaling events, such as sound signals should be used.

The adaptation from a very well illuminated environment to a very poorly one reduces the sensitivity of the vision [7]. Recovering the visual sensitivity is known to be a slower process for the older observer [8]. The older eye only recovers part of its sensitivity in poorly illuminated environments [7], which means that if the environment is not correctly illuminated, some details will be missed by these observers.

1.1.2 Changes in Hearing

The success of user interaction with a system or environment can be affected by the user's ability to hear [6]. Therefore if there is the need to include auditory information in a system, age related changes in audition have to be considered in the design process. About 10% of the middle-aged adults suffer from hearing losses to a point that they inhibit their social interaction. At the age of 65, half of the men and 30% of the women exhibit the same symptoms. This difference is usually attributed to the distinct noise exposure at the workplace; nevertheless, this difference should be attenuated as more and more women engage in work activities that are detrimental to hearing [7].

As far as the volume is concerned, humans can hear sounds from 8 decibels (dB) (similar to a whisper) to 130dB. There are severe hearing damages when the individual's threshold is greater than 35dB. It is important to underline that this loss of sensitivity is especially pronounced for high-frequency sounds [7][6]. Systems depending on sound should enable their users to easily adjust the volume.

The audible frequencies also decrease with age. A young adult can normally hear sound frequencies up to 15000 vibrations per second. However, for an older adult sound vibrations greater than 4000 vibrations per second may be inaudible [6]. Citing Corso (1981), Charness and Schaie (2003) refer that complex tasks such as speech recognition and sound localization are affected by the inability to detect some frequencies [7]. Moreover, the hearing loss is worse for consonants than it is for vowels, which makes it very difficult to fully understand some words. The statement frequently used by the hearing impaired: "I can hear you, but I cannot understand what you are saying" is an example of this difficulty [8]. Similarly, the sentence "The thinner cat is red" may be heard as "The dinner hat is red", because of the listener's difficulty understanding consonants.

The intelligibility of speech is also conditioned by the background noise and architectural echo or reverberation [7].

Accent is also an influential factor that can improve speech intelligibility by helping the listener to cope with background noise and hearing deficits; however, accent is only useful if the user is familiar with it [6].

Finally it is imperative to understand that the hearing loss may be denied by the older adult because of the negative stereotype of people not hearing well [8]. This loss can create the feeling of social status loss or inability to compensate for his (hearing) problems, which would increase the problem even more.

[1] Visual acuity is a comparison coefficient. We could change the units of the example to feet and it would also be valid.

1.1.3 Motor changes

The human motor system also experiences age effects. Modifications occur throughout the whole body. This section concentrates in the problems that may occur when manipulating a TV remote. In this context, Fisk (2009) reports the increased response times, lesser ability to maintain continuous movements and difficulties in coordination [6]. Arthritis is also very common among older adults [12]; swelled fingers in pain will most likely reduce the speed and accuracy of the movement.

The changes expressed above can contribute to greater difficulties performing fine motor control actions. The following paragraph presents some of these difficulties as described in the literature.

Fisk (2009) discovered that older adults had difficulties double-clicking a mouse; however, when the time interval between clicks was increased, errors were eliminated [6]. Given these results one can conclude that the problem was not the complexity of the task, but the speed of movement. Helander et al. (1997) explained that declines in the spatial abilities were known to create difficulties using devices like the mouse [12]. This difficulty assumes greater importance as it can block the interaction with the user interface. When testing the usability of PDAs, older adults expressed their concerns about their 'fat fingers' preventing them from completing the task; the users 'feared' to push multiple buttons at the same time. Siek et al. (2005) concluded however that not many errors were registered in that task [13].

Physical changes are inevitable for the older adult. Since these changes can greatly impact the interaction of older adults with products, it is crucial not to forget them when designing a system. Cognitive changes also occur; these are introduced in the next section.

2.2 Cognitive Changes

Perceptual limitations are not the only ones that affect the older adult. Limitations in the cognitive ability might also create difficulties. Interacting with products usually requires the user to reason and choose over a set of options. Memory is crucial to this task; therefore its limitations should be explored in order to create an acceptable user experience. This section will start introducing memory considerations and then some reflections on attention.

1.1.4 Changes in Memory

There is a common belief that as we get older our memory gets worse. Memory is an ability that involves complex processes such as the storage and retrieval of information in the brain [14]. Like with other parts of our body, changes occur in the brain that affect the way older adults learn and assimilate information. However, although changes occur, not all memory functions are affected [15][6].

Working memory – or short-term memory – is "the capability to temporarily keep information active while we 'work on it' or until we use it" [6]. This type of memory has an ephemeral character and a limited capacity [15][3]. This capacity is usually limited by normal aging [6]. Satre et al. (2006) also state that limitations in short-term memory can influence the learning process and affect language comprehension [15].

O'Neill (2002) documents that older adults may recognize this changes and try to cope with them by taking notes that will, for example, help them in the first usages of a product [14].

If short-term memory is our working-memory, long-term memory is a permanent storage of information, containing everything we "know" [6][3]. Long-term memory differs from working-memory in capacity (very big, if not unlimited), in retrieval time (much slower) and in occurrence of forget (very slow, if at all) [3]. This type of memory can be categorized according to different forms like semantic memory, prospective memory and procedural memory. As changes in memory occur differently in each form, they are described separately.

Semantic memory is responsible for storing factual information like the meaning of words, historical facts and general knowledge [6]. Its capacity declines minimally with aging. On the other hand, Satre et al. (2006) citing Salthouse (1996), refers that age causes a reduction in the processing speed [15]. Even though reaction time can be decreased doing exercises, age differences are most of the times noticeable. The "tip-of-the-tongue" phenomenon is an example of this slower access of information, in which the older adult tries to remember the correct word.

Prospective memory is characterized by remembering to do something in the future [6]. This form of memory can be divided in two types: "time-based" – remembering to do something later, like for example to take medication in 4 hours – and "event-based" – remembering to perform some action after the occurrence of an event, like for example to take medication after breakfast. The decline in prospective memory is more accentuated in the "time-based" type than in the "event-based". Being so, it is important to optimize for the "event-based" memory making use of the appropriate reminders.

Procedural memory is the name of the form of long-term memory that represents the knowledge of how to execute a certain task [6]. Procedural memory includes not only the activities we do without thinking, like tying up shoes, but also less automatic ones like doing a multiplication. Older adults may experience difficulties developing new automatic processes in some domains and remembering activities not executed for long time. "Automatized" activities however, are not likely to be lost.

1.1.5 Changes in Attention

Attention is our capability of concentrating on one task instead of a number of competing thoughts and stimulus [3][6][7]. Each second, the human body receives a massive amount of information through the senses, and each second, through selective attention, the human selects which stimuli to attend [7][3]. This selection is our mechanism for switching tasks back and forth and it is based on our level of interest or need [6][3]. Fisk (2009) states that "if we did not selectively attend to the stimuli coming into our senses, we would be overloaded". When required to execute more than one task at once – like for example driving and looking for street signs – older adults have shown more difficulty than younger persons [6]. According to the same author, in general, older adults would need more time to change between tasks.

Older adults will have more difficulty distinguishing between target and non-target stimulus if the number of distracters increases [16]. On the same subject, Fisk (2009) refers that older adults are usually "more affected by salient events such as flashing, high-intensity lights as well as stimuli that appear to pose an immediate 'threat'" [6].

To better design with the attention constraints in mind, it is important to require the minimum of search to perform a task, remove information that captures user attention as soon as it is not needed, and to remove elements that might capture attention, such as blinking elements [6][7].

2.3 Psychological and Social Changes

There are many myths about the psychological and social effects of aging. Stereotypes of the senile, mentally ill, depressed and isolated man; although inaccurate, these stereotypes are very common [17]. This section presents a short summary of the most relevant changes. Covered themes include the characteristic problems of the older adult, personality and self-acceptance, social networks and treatment issues.

Although some problems only arrive at a late stage in life, many are similar to difficulties in other stages of life [17]. Dealing with losses and limitations is one of the most relevant issues. Inevitably, aging brings the need to adapt to physical limitations and functional impairments. The individual is forced to choose the most important goals, to refine the means to achieve them and to find new strategies to deal with losses [18][17]. Losing loved ones is a problem that the older adult will encounter [5]. The older adult will have to deal not only with emotional ramifications but sometimes with the difficult task of building a meaningful social world [17]. However, facing loss in the context of one's life often creates a unique possibility of achieving reconciliation, healing or deeper wisdom [17] citing works on wisdom.

Wisdom takes us to our next subject: personality and acceptance of the self. The individual personality shapes according to the events and the decisions of one's life. However, age does not significantly change the core of the individual. When someone gets old, one is like what he was before, not an older person stereotype [5].

Although personality does not change much, the acceptance of the self seems to increase. People are increasingly sure about who they are, their competencies and their weaknesses [5]. These changes lead them to a better self-acceptance.

Social networks are a subject where older and younger adults differ. Younger adults are likely to grow large social networks with the objective of finding a mate; later in life, the focus changes to maintaining emotional balance [15][5]. Confronted with limited opportunities, the older adult invests in the most satisfying and humanly rich relationships [5][17]. This is also true for the relationship with their care takers, so it is important to consider and support this type of interaction when designing systems for this particular type of user.

Treatment is the last point we approach in this section. Optimism is related to lower distress, better coping with the disease and faster recovery periods [5]. The well-being of the older adult is strongly related with the quality of the relation with adult children [5] referring the work of Ryff et al. (1994).

3. USER RESEARCH AND PERSONAS

In order to design a good user interface it is crucial to conduct a thorough user research and analysis. There are several user research methods, including literature research, ethnographic research and surveys. However, regardless of the method or the combination of methods used, requirements, stated and implicit, need to be exhaustively uncovered. This will enable the design team to have a clear definition of the user profile, i.e.: characteristics, roles, needs, stories, etc. Once the design team has a clear understanding of whom it will be developing to, it can also define the design objectives, constraints, use cases, etc. Given that the information gathered and discovered on the requirements analysis and specification phases will guide the rest of the project, all information should be thoroughly documented by the end of this phase so that everyone involved in the project understands the solutions proposed and how they should be developed. .

For the work reported in this paper, most of the user research was based on the review of the literature, of which findings were partly described in the previous section. Some informal interviews were also carried out with the medical partners of the project. Once gathered and analyzed this information fed into the development of the personas.

Personas are made up of archetypes that express the motivations, expectations and goals of a particular user group when using an artifact [19][20]. As an HCI tool, personas improve the design process by moving the focus to the user [21]. One of the most important advantages of personas is to convey information across the team. In general, people have different ideas on who the final user is; with this technique, those ideas can be discussed to create a common vision, since having a blurred concept of the end user is half the way to design for every possible feature and therefore to create a product that is difficult to use.

Alan Cooper [22] coined the term personas when trying to describe a process of creating and evaluating software [23]. In that process, Cooper would question who was using a certain product and what did that particular user wanted to achieve.

When using personas, the intention is really to incorporate the persona character and try to reason on the persona's objectives, characteristics and difficulties. The information that fills the persona profile is usually based on ethnographic research, focus groups or demographics and therefore represents the real users and not the (designer's) self [19].

Besides a name and a picture, a persona profile also includes motivations, expectations and goals [24]. Redish (2007) argues that the picture and the name of the persona are of crucial importance as these have the power to turn a user profile into a persona. Personas usually assume the graphical form of posters; more original forms like collages with pieces of life from the group of users are also possible. Another possibility consists of creating an e-mail address that sends e-mails for the team [21].

4. THE eCAALYX PROJECT

The work presented in this paper was developed in the context of the eCAALYX project. eCAALYX 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 the older adult with chronic conditions by monitoring his health and by improving the communication with his caretakers. In this context, the authors of this paper are responsible for the design of the TV user interface. This TV system, placed at the older adult's home, should enable him to communicate with his caretaker, to check his health

condition and to remember his medical appointments and medication.

Specifically, eCAALYX's objective is to address problems caused by chronic conditions that can have severe consequences to the older patient's health condition. These include cardiovascular disease (heart-failure), chronic obstructive pulmonary disease (COPD), diabetes mellitus type 2, arthritis, dementia and chronic wounds. The objective is not only to detect and monitor risk situations, but also to educate the patient in order to avoid them.

The project is currently on its first year and the activities reported in this section were developed in the scope of the requirements analysis and specification phases. Given its potential, discussed in the previous section, the authors decided to take an approach based on user research and personas.

The following sections report on the process that led to the creation of personas. The example of John, the diabetic patient, is analysed in detail and illustrates the process that was followed for the remaining personas created in the context of the eCAALYX project. A review on related projects is followed by a more specific analysis of the diabetes disease that feeds into the development of John's persona. Finally, a discussion on how personas impacted and were used in the context of eCAALYX is presented.

4.1 Related Projects

eCAALYX will develop a telecare solution, but since other solutions have been already proposed that approached the remote health management of patients, we also looked at those. Chan et al. (2004) conducted an experiment in Hong Kong to evaluate the feasibility of a diabetes group care program using telemedicine in elderly community centers [25]. The study involved 22 older adults with type 2 diabetes [2]divided into three groups. Each of the groups received education regarding diet, glucose monitoring and management, foot care, as well as exercise prescription. The participants concluded that after the program they had a better understanding of their disease, felt better, happier and were more active. Results showed significant changes in the management of the disease.

Barnet (2006) studied the effectiveness of a different approach to remote health management [26]. Instead of being focused in education, as the previous example, it was aimed to improve the communication between the doctor and the patient. For a period of 24 months, 800 older individuals were divided into two groups: one to test the new treatment and other as control group. The elements of the treatment group received a messaging device to communicate with their caretakers. This device enabled them to communicate with a nurse that would help manage their health and medication, schedule medical appointments and assist with technology difficulties. The results of this research showed a significant decrease in the number of hospitalizations of the treatment group. This supports the thesis that a closer contact to caretakers can improve the management of the disease. On the other hand, the number of home visits also increased, which leads us to think that the worst problems were solved with home visits instead of hospitalizations.

Brown (2007) analyzed some studies that used the Internet as a channel and noticed changes in the patient's health and life habits [27]. Web sites are the most used technology to aid the management of the diabetic health. These systems give attention to different dimensions of the treatment like the management of weight, blood pressure or physical activity and the monitoring of blood glucose and cardiovascular disease risk. Since these systems hold updated information on its user, it is possible to create a personalized treatment for the patient. Web sites can also stimulate group discussions which enable its users to gain confidence and increase engagement by exchanging their stories.

Videoconference also creates an effective alternative to direct contact between the patient and the caretaker. It has resulted in a lesser need for physical encounters and an increased patient satisfaction [27].

Interactive voice response systems send automatic messages to its users. The patients then respond using their voice or pressing phone buttons. By increasing the caretaker's information on the patient's status, these systems are capable of reducing hospitalizations and office visits [27]. One important point referred by the author is that the number of home visits increased, which can be justified by the prevention of expensive hospitalizations and emergency room visits. Just like web sites, these systems are capable of quickly providing a personalized treatment. By doing so, they allow the older adult to learn more about his condition, which is crucial at the beginning when his knowledge is scarce.

The analysis of treatment approaches led us to notice some important points that were present. Communication, education and feedback are addressed, although in different ways, by every study.

4.2 From Problems and Goals to Personas

As reported in section 3, personas can be used to improve the understanding of the objectives, goals and needs of the final users. By creating a different persona for each actor, it is possible to focus on the characteristics of each of the different users at the same time. Specifically for this project, it becomes easier to focus on the needs of patients with different diseases.

To create the persona that represents the diabetic patient, John, the authors started by searching for the causes and characteristics of the disease itself. This was followed by investigation on the treatment that is applied to that disease, in order to understand the major issues that needed to be addressed.

Diabetes Mellitus or simply Diabetes is characterized by the inability to produce (type 1) or to respond to insulin (type 2). This inability prevents the body from keeping the right level of sugar in the blood [28][29]. When very high levels of glucose (sugar) are present for years in the blood, they can impact the blood vessels, heart, eyes, kidneys and nerves [29][28].

The regulation of sugar level in the blood can be done in different ways. Insulin injections are part of type 1 diabetes treatment from start. The purpose of insulin is to mimic the body's natural production to control sugar level. On the other hand, type 2 diabetes, with 90% of the cases, may also be treated with lifestyle changes, mainly exercise and diet [29][11][28]. The

[2] Diabetes type 2 is characterized by the inability to respond to insulin. By preventing the body from keeping the right level of sugar in the blood, this disease, has a severe impact on the body. Unlike type 1 diabetes, this kind of diabetes may also be controlled through diet and exercise (see Section 4.2).

recommended diet for the diabetic suggests regular meals and a reduced intake of sugar, salt and fat. Introducing changes to one's lifestyle is a difficult task [30]. If someone develops diabetes because is overweight, lifestyle should be changed as part of the treatment. In the same line of thought, the authors believe that in order to commit lifestyle changes, older adult should be very well informed of their ailment.

Another important detail on the treatment for diabetes is that the level of insulin injected will depend on the amount of food ingested and the amount of exercise taken. As one can predict, this balance is not always easy to handle. However, devices that measure the glucose in the blood can help patients manage this balance better by improving their knowledge of their body. Nevertheless, when one is learning to manage a new disease, it is normal to have doubts about the treatment, but also difficulties handling it. Changes will have to be made in one's life; adverse outcomes include limb amputations.

4.3 John: The Example of the Diabetic Persona

Within eCAALYX project, eight personas were developed representing primary users – older adults – as well as secondary users – caretakers and caregivers. This section illustrates the process followed for the creation of the eight personas by describing John's persona.

Figure 1 shows the persona template, which includes a name, a picture and information on background, goals and motivation. The background, introduces the reader to key points of the persona's personality.

At this point, the team had understood the major problems to address. However, a persona is not a disease description. To be effective, it has to capture the cause of the problems. Many chronic conditions are caused by incorrect lifestyle habits. If one does not understand the origin of the problems, it will be very difficult to 'get under the skin' of the persona. With this premises in mind, the team searched for relatives that suffered from diabetes. While not being a very scientific method this contact provided us with insight on the lifestyle of these individuals and helped us to create the diabetic persona.

One of the diseases eCAALYX has determined to address is Diabetes type 2. This type of diabetes is related to incorrect lifestyle habits; therefore, John is described as someone that really enjoys eating. To John, eating is a social activity that he feels as one of the pleasures of life that still has not been taken from him. Also, since "time-based" and "event-based" memory types are affected, John is described as someone who experiences difficulties remembering to take medication. The problem of loss, as described in Section 2.3, was also analyzed.

The section of goals and motivation of the persona presents some points that cause distress to the older adult and that can be improved. For instance, independence is a very important issue/need to the older adult. Because of his difficulty managing the disease, John has been hospitalized and deprived from this need. However, John wants to keep his independence, therefore that information has been included. As a last goal, the persona references the need to being remembered of medication and appointments, since this is something that cannot be changed.

In order to validate the generated personas, these artifacts were presented and discussed with the medical partners of the project. During these discussions, the doctors confirmed the relevance of the aspects included in the created personas, including John's. Nothing significant changed, however the conversations with the doctors enabled us to gain confidence in the results and insight into the general doctors' experience treating older adults.

John

[33]

Background

John is a 70-year-old man that suffers from a dangerous type of diabetes. He is a very social person and a good fork. John does not understand his disease and has problems handling it.

John also has problems remembering his medication and his medical appointments.

Goals and Motivation

John wants to be better informed so that he can act effectively and avoid staying at the hospital.

John wants to have a system that remembers him to take his medication and of his medical appointments.

Figure 1: Excerpt of the diabetic patient persona.

The personas were also used during the phase of requirements and feature discussion and specification. Since some features were more important for some personas than others, each (persona) included information on the system's answer to its case.

4.4 How Personas Fit in eCAALYX

The knowledge and understanding of the user that is developed during the process of creating a persona is as important as the persona itself. This information ultimately enables the team to

achieve a more clear and detailed vision of the user. Not just the 'general' user of the system, but also more specific ones such as Specifically, John has a problem controlling his appetite, therefore, in this sense, John is not equal to the general user and therefore features are filtered accordingly. John has to control his glucose levels. He balances amount of food, insulin doses and exercise. Therefore, the system should offer him information on how his glucose levels have been. Other patients might not need this information, but for John it is crucial.

The work reported in this paper refers to the first phase of the project, specifically the requirements analysis and specification phases. For this phase, different personas were created for each significant type of user. These personas are now being used as a baseline for the design and development of the low-fidelity prototypes of the eCAALYX system. For instance, the eCAALYX system features educational videos. And in this respect, John will benefit from videos that teach him how to have a better diet and how to exercise, while videos that explain how to react in case of a respiratory emergency (suited to COPD patients) wont be much useful to John.

Personas have been important not only as a communication tool, but also as a reminder for the overall project team that we are not merely designing for general users but for users with specific needs.

5. DISCUSSION

Personas are useful to keep everyone who is part of the design team focused. By having a description of the problems of a user with a specific chronic condition, the design team is able: i) to understand this user better and therefore fulfill his needs; and: ii) to evaluate the users' potential satisfaction with a certain product.

McGinn and Kotamraju (2008) suggest that personas should be created from statistical information, however, since we did not have a testing group from the beginning of the project, the personas presented in this paper were mainly designed based on user research [31]; similar approaches are proposed by [32]. Still, it is important to refer that, as briefly described in Section 4.3, the medical partners of the project – who have close contact with the end users – validated our proposal, by confirming the specificities included in the generated personas. Although this does not replace the contact with the real users or the limited possibility for the generalization of results, it does add confidence to the process and the personas constructed throughout. Personas are not static and are likely to change based on the feedback of the target audience. Recent negotiations established partnerships with users' organizations and, if needed, personas will be revised, as studies progress inside the project.

Another interesting point of discussion for this paper concerns the ease of use of technology by older adults. Experimental Research in Human-Computer Interaction rarely focuses on the older adult. However, this situation is likely to change due to the increasing number of older individuals, particularly in Europe. The challenge is great since the elderly normally experiences more problems (than younger adults) when using technological devices. Older adults did not grow up using computer or smartphones and are likely to have developed limitations in perception and cognition with age. One can argue that older adults of the future will handle technology more easily. While this assumption might be correct or at least partly correct, it is not possible to ignore older adult physical and cognitive characteristics. Despite their computer literacy, the authors believe that physical, cognitive and social characteristics, as the ones described in Section 2, ought to be considered in the design in order to create products that are actually useful and usable.

6. CONCLUSIONS AND FUTURE WORK

This paper described the application of personas and user research as tools to focus on the needs, problems and goals of different users. These techniques were applied to the first part of the development of eCAALYX. The objective was to create the user interface of a TV system, placed at the older adult's house that enabled the elder to communicate with his caretaker, to check his health condition and to remember his medical appointments and medication.

We have conducted user research to better understand our audience. Our results (see Section 2) cover aspects such as perception, cognition, mental and psychosocial changes that occur with age.

Based on user research, we created a set of personas to represent a type of final user in our design process. From those personas, we have chosen to present John the diabetic persona. In this context, we have described the process that led us to create this persona.

Currently, the project is at the beginning of the prototyping phase of the TV sub-system. The use of user research and personas has contributed to the conceptualization of our problem. Personas were especially useful when discussing features, to keep everyone on the same line of thought. Future work will detail on the effect of the use of personas on the entire process.

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Appendix D

3 x 7 Usability Testing Guidelines for Older Adults

3 x 7 Usability Testing Guidelines for Older Adults

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ABSTRACT
The literature is scarce in what respects how to perform usability evaluation with and for older adults. The feedback from users regarding the user interfaces being tested can be maximized if the differences from younger adults are understood and subsequently respected.

The work presented in this paper is based on the work developed for 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 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 3 groups of 7 guidelines each. The 1st group includes guidelines to facilitate user drive and control; the 2nd refers to the test setting and preparations and the 3rd of considerations on care, communication and listening. These guidelines were always created with the older adults in mind that were carefully observed along 13 weeks.

Categories and Subject Descriptors
H.1.2 [**User/Machine Systems**]: Human factors; Human information processing. H.5.2 [**User Interfaces**]: User-centered design. H5.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) [27] and Participatory Design (PD) [18] 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 [33]. Given this difference in the terminology and due to the difficulty in involving the user in all the phases of the development process, projects usually follow a UCD methodology; this is also the case for the study this paper builds upon.

UCD was defined in 1986 by Norman and Draper [27] and consists of a design philosophy that focuses on the goals and needs of the user [26]. Its basic principles 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 the mainstream user, however the same cannot be said for children or older adults [10][17].

Research involving older adults tends to focus on age related changes and their potential impact on user interfaces [9][5][7][15][32][14] with others studies covering the relation between technology and the older adult [8][23][7][14][16][35]. Specifically, studies on how to perform usability evaluation with older adults are scarce, therefore it is valid to ask if conventional UCD evaluation methods are applicable to this audience. The authors' experience with older adults leads them to believe some aspects are certainly different. Dickinson et al. present methodological and organizational advice from their experience with this audience [10]. They provide guidance on how to recruit older adult users or on how to run usability test with this particular type of audience. With a similar approach and based on the authors' experience with the eCCALYX project (described in the following section), this paper presents a set of guidelines on how to design and perform usability tests with and for older adults.

This paper is composed by 8 sections. Section 2 explains the importance of prototyping and usability testing. The third section presents eCAALYX, the project that is that origins this work. Section 4 details our test settings. Section 5 presents the guidelines for creating usability tests 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 our conclusions.

2. PROTOTYPING AND EVALUATING USER INTERFACES
Usability testing aims at ensuring that a product is easy to use by its intended audience [20]. 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 [22]. As a result, it reduces commitment with designs and time spent implementing early decisions. Paper prototypes also enable design teams to start usability testing very early in the design process. Testing early is very important since it will enable the design team to solve design problems before the system is implemented, allowing them to save time and to create better products [8][1].

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 this technique see [20][13][8][11][36].

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 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 [28] 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 recommends the evaluation of design choices and prototypes with end-users (see Section 2). This section starts by presenting details related with the recruitment of participants of this study. Then, details concerning the organization of our usability tests are presented.

4.1 Recruiting Users

Recruiting participants is sometimes challenging, especially if the target audience is very specific [21]. 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. This variety posed the authors with a difficult task, since recruiting a sample that includes all the diseases can be difficult. Based on the fact that most information in the user interfaces is almost common sense and can be understood by individuals without chronic conditions, the authors searched for a diverse sample of older adults.

After deciding on using a diverse sample, there was still a number of available options concerning where to recruit them from: i) a health institution such as a hospital; ii) a senior's association like a 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 receive seniors during the day. Seniors that go to a day centre are independent, maintain their active life and live at their own homes. In this particular setting, the confidential issues are less noticeable, the academic level is diverse, and the individuals are independent. From the options available, the authors chose the day care centre, since this option was the one that best fitted the project requirements.

In the selected day care centre, older adults talk with each other, play card games and participate in the activities of the centre. The centre activities include singing, dancing, exercise and learning new things. These activities aim for example to amuse them, train their cognitive functions and improve their lifestyle habits.

From a universe of thirty-one individuals, fifteen (only one man) agreed to volunteer for the usability testing. Ages varied from 54 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 introduction courses taken at another day care centre.

4.2 Performing Usability Tests

The approach to the day care centre where the tests took place was done in collaboration with a group of social education interns from the Paula Frassinetti's School of Education (ESEPF). These students were responsible for planning the activities for the older adults and acted as intermediaries between them and the authors.

The authors performed eight tests 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. The usability tests had a minimum of six participants. This 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 [25]. It is worth noting that older adults may be slower than younger adults [10] and that their pace should always be respected, as explained in TSP 7.

Figure 1 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 of pills to take at lunch). The meeting after preparing the test was done to inform the social educators of the designed test and, if necessary, perform some minor final changes. The meetings with the social educators consisted of them sharing their experience with older adults and would ultimately enable the authors improving the knowledge and understanding of this particular audience. This might not have an immediate impact but would be valuable for the preparation of the subsequent tests.

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 test tasks

5 - Re-evaluation of happiness and fatigue

6 - Questionnaire administration

7 - Explanation of some details of the test

8 - Thank you

Figure 1 - Stages of a typical usability test.

A particular example of a test that required the help and experience of the social educators was the test concerning the user interface of the medication reminder. The authors asked the social educators how did older adults referred to a certain medication, 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.

After a test was finished, a reflection was done on the results and findings. This reflection usually implied coming back to theory and discussing the features with the medical partners of the project. Conclusions were then incorporated as changes in the designs or notes for guiding the following interfaces. The next section presents a number of recommendations to guide the design of usability testing with and for older adults.

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 based on the authors' experience gathered with the design and evaluation of eCAALYX's TV system. Also, whenever possible, the authors looked for evidence for the guidelines in previous studies. The guidelines 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 the participant during the test by giving the control of the situation and keep them motivated to participate in the tests. Test Settings and Preparation guidelines concern aspects of the older adult that should be in mind when preparing the test and its setting. Care, Communication and Listening guidelines include directions on how to improve the communication 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 this uncertainty situation, it is important to put them in control in 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: Participate in their activities. Older adults may get tired of the tests and may not understand their purpose. Therefore, it is important to give them the opportunity to clear their doubts. With this in mind, the authors participated in a number of activities of the day care centre so that the older adults had the opportunity to know the authors and question them about their work.

UDC 2: Always respect the participant's will. Active Aging[1] defends that the older adult should maintain autonomy as long as possible [37]. In this case study, one test participant said that he 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, introduce the project you are working on and why you need their help for. Otherwise, the test participant might understand your 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. If they know the goal of the tests and think the project is useful, they will participate.

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 you can gather from usability testing with older adults cannot be measured, therefore take the time to express your gratitude.

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 [30]. The individual will try to give a purpose to the time he spent working by filling it with activities. Older adults also tend to value routine and will have problems changing their schedules [29]. For these reasons, they should be 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 changes. Limitations can impact, for example, the time older adults take to complete tasks and their ability to move from one place to other. This section presents some advice related to the setting of the test and details that should not be forgotten when preparing them.

[1] Active aging is the process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age.

TSP 1: Do not ask them to move. The first usability tests were conducted in a room that was two minutes away from the common lounge where the older adults usually hang around. 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 started doing tests in 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 faster tests and reduced the number of interruptions. However, this situation was only found valid for tests in which there was a 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 better tests.

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 owns 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. Older adults interpreted role-play as a fun game and enabled them to use interfaces created for people with different diseases.

TSP 7: 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.

5.3 Care, Communication and Listening

Communication is very important during usability tests. If the older adult cannot understand the facilitator, it is likely that a number of important information will be lost. This section presents tips to improve the communication with older adults.

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 performed. Therefore, it is important to clearly state that the goal of the test is to pinpoint what is right or wrong with the designs being tested and that there are no right or wrong answers.

CCL 2: Respect the opinions of the test participants. Older adults are very keen on expressing their opinions and may say something, the facilitator disagrees with during the tests. In this situation, the facilitator should respect the opinion of the patient, 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 would be useful to the project later like the agenda screen that 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 also pose problems to speech comprehension. For this reason, the language employed should be as simple as possible.

CCL 5: Adjust your volume appropriately. 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 [31].

CCL 6: Repeat and paraphrase what you are saying. Hearing impairments may hinder the older adult's ability to understand speech [14]. Therefore, the facilitator should repeat or rephrase his sentences if he feels that the participant did not understand him [34][38]. 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 understood [4].

CCL 7: Do not use elderspeak. Elderspeak is similar to the way adults talk to very young children [34]. 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," "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 an equal and therefore his wills and opinions are not relevant [19][6]. 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, participants were asked to evaluate their happiness and fatigue. In order to do it, participants received two scales of images in the beginning and at the end of the test from which they had to choose the image that resembled their feelings the most.

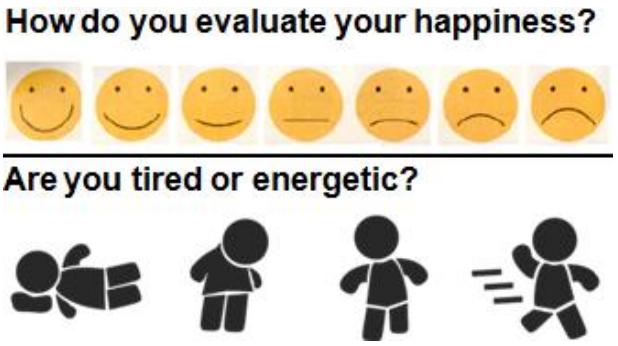

Figure 2 - Image scales used to evaluate happiness [24] and fatigue.

Results have shown that at the end of the test, participants were less tired and happier. While the fatigue average image to be chosen in the beginning was the second from left, at the end it was the third. Happiness also increased from third face in the beginning of the test to the second evaluated at the end of the test. It seems that having someone to hear their historical narratives can make them feel better and to forget some of their problems. Older adults were always eager to help, so it is also likely that they felt better also because they felt useful.

The aspects of emotion seem to be very important in usability tests with older adults. This subject should be covered in another paper of 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 are the result of the experience gathered conducting the usability tests of eCAALYX TV system.

The goal of this paper is to present the authors' reflection findings and conclusions on how to run usability tests with and for older adults. These findings build upon the authors' experience while working in the eCAALYX project and are mainly presented in the form of guidelines to: User Drive and Control, Test Settings and Preparation and Care, Communication and Listeninfg.

If on the one hand, one may question the robustness of such guidelines to a larger extent since they are the outcome of the experience of one project only, on the other hand, the authors believe they consist of a solid starting point that was constructed along a period of 13 weeks of careful observation.

The 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 are the right path to follow. However in the future, in order to validate this belief, the authors would like to run experiments in which the effect of the applications of these guidelines could be carefully studied.

8. FINDINGS AND CONCLUSIONS

In general, the same 'good practices' that are valid for usability testing with adults also apply to usability testing with older adults. Adapting the testing situation for older adults essentially means to tailor the environment to their characteristics, objectives and experience with computers.

The benefits of gathering data from older adults as users are unquestionable since usability testing with this audience gives insight into their perspectives and allows creating better suited products.

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.

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