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Elderly Gaming on Tabletop Interfaces

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Abstract

Designing systems for older adults can be a challenge. It is different from designing for any other age group. Older adults use less technology than younger ones that were born surrounded by it. The older adults do not use technology if they do not see benefits on using it. On the other hand, sometimes they do not use it because they are not able to; they face barriers in its use due to finding systems that do not suit their characteristics and needs.

This dissertation documents the analysis, design and evaluation of an elderly game on tabletop interfaces. User-Centered Design was the methodology used for this project, in order to place the end-users at the center of the design process. In this context, it was used to understand the older adults' specificities and characteristics and therefore to design an interface suitable for their needs. The use of this methodology allowed to create a product easy to use by the older adults. In the context of User-Centered Design, we applied user research, informal interviews and observations, low-fidelity prototyping and user-based evaluation. The user research and the informal interviews and observations were used to understand the target audience of the project and to define the requirements for the game. Then, these requirements were projected on low-fidelity prototypes for the game and its menus interfaces. These prototypes were created and iterated with the feedback of the user-based evaluation.

The designed game is suitable to older adults and aims the promotion of their well-being. It is a group game that aims the social interaction between the participants by having two teams competing to complete a goal. Each team has to collect images that have one subject in common defined by a category. The game finishes when the two teams collected all the images that meet their category. This game focuses on stimulating some of the human functions that may decrease with aging and on trying to avoid some of the problems that may arise from that decline.

Resumo

O desenho de sistemas para pessoas idosas pode ser um desafio. É diferente de desenhar para qualquer grupo de outra faixa etária. Nota-se um menor uso de tecnologia por parte dos idosos, em relação às pessoas mais jovens que nasceram envolvidas neste mundo. Esta população não usa tecnologia se não forem claros os benefícios da sua utilização. Por outro lado, por vezes não a usam porque não estão aptos a utilizar algumas interfaces; deparam-se com barreiras na sua utilização, encontrando sistemas que não satisfazem as suas características e necessidades.

Esta dissertação documenta a análise, desenho e avaliação de um jogo para idosos em *tabletops*. A metodologia usada durante o desenvolvimento do projecto foi baseada numa metodologia existente, designada por *User-Centered Design* (UCD). Foi utilizada esta metodologia para que se colocassem os utilizadores finais no centro do processo de desenho. Desta forma, foi usada para compreender as características dos idosos e, assim, desenhar interfaces adequadas às suas necessidades. A utilização de UCD permitiu criar um produto de fácil utilização por parte dos idosos. No contexto da UCD, utilizámos *user research*, entrevistas e observações informais, prototipagem de baixa resolução e avaliação baseada no utilizador. A *user research* e as entrevistas e observações informais foram usadas para compreender a audiência deste projecto e para definir os requisitos para o jogo. Assim, projectámos esses requisitos no jogo, através de protótipos de baixa resolução para o jogo e seus menus. Esses protótipos foram criados e iterados através do *feedback* da avaliação com os utilizadores finais.

O jogo foi desenhado e adequado às características dos idosos e tenta promover o seu bem-estar. É um jogo em grupo que se foca na interacção social entre os participantes ao incorporar duas equipas a competir para alcançar um objectivo. Cada equipa tem que coleccionar um conjunto de imagens que têm um assunto em comum, definido por uma categoria. O jogo termina quando as duas equipas finalizam a colecção de todas as imagens correspondentes à sua categoria. Este jogo passa por tentar estimular algumas das funções que, por vezes, sofrem declínio com o avançar da idade e por tentar sobrepor-se a alguns dos problemas que esses declínios possam causar.

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Abbreviations

HCI	Human-Computer Interaction
UCD	User-Centered Design
PD	Participatory Design
NUI	Natural User Interface
GUI	Graphical User Interface

ABBREVIATIONS

Chapter 1

Introduction

The world population is aging. This fact is explained by low birthrates due to, for example, life choices or difficulties finding a job, and by the increase of longevity caused by improvements in health care systems, medical and scientific progress and cleaning processes avoiding some diseases. The United Nations Population Fund has been carrying studies that predict the possibility of triplication of the number of 60s year old people, only between 2005 and 2050 [Fun09]. It seems not to be a problem at all. However, with the aging population, there will be fewer young people supporting them, as it has been happening. The older adults have to maintain their activity in order to be independent and have quality of life.

For health care of the population has been largely contributing the fast technological growth and development. This technological growth has been not only noted in the field of health, but also among other fields such as social networks, transports, etc. Although with this demographic changes it will be necessary to drive the adaptation of the new emergent technological services or the creation of new services. Much of this new technology has not been followed by that aging population. Technology is not too familiar and suitable to older adults as it is for any other age group guiding the older adults continue using traditional methods. However, older adults do not have any particular aversion on using new technology [Gre09]. They are receptive, but sometimes they do not know the benefits on using it or even they are not able to use some types of devices, so they avoid technology [Gre09]. In order to design products for the older population, it is important to understand their characteristics. The problem we identified was the lack of flexibility that some technology has. Considering older adults as a group of people that may have age-related changes (e.g. at physical, cognitive and psychosocial levels), it may be necessary some design adaptations if we want to offer them something really useful and usable. Thus, if their characteristics and possible limitations are completely ignored when designing a new product for them, it may result in a product with lack of acceptance.

Therefore, we found it necessary to try to improve the connection between older adults and technology, so that they can enjoy the benefits that can arise from that use. This way, we considered designing a product by respecting the older adults' characteristics and tried to make it more intuitively usable and without many difficulties in behavior adaptation or learning. In addition to the improvement of the acceptance of new technologies, we have as goal to promote the well-being of the elderly population. This way, we opted to design a game suitable for the older adults and that promoted their well-being by trying to stimulate some of their characteristics that change with aging. This game took advantage of the growing new technologies being designed to be played in multi-touch technology.

This thesis has a global goal that consists on the analysis, design and evaluation of the tabletop (the chosen device) interfaces for the game, in order to turn it suitable to the elderly people. It will include the study of the older adults and their characteristics and needs and the study of the emergent technologies as well as the iterative cycle of design of the user interfaces and the game creation.

The project arises in a Master Thesis context that is being developed in Faculdade de Engenharia da Universidade do Porto, in cooperation with Fraunhofer AICOS, the Research Center for Assistive Information and Communication Solutions.

This document is structured in six chapters.

After introducing the project, the Chapter 2 provides the literature review in three different subjects – the older adults, the Human-Computer Interaction (HCI) and the games. In the older adults' section we review the causes of the demographic changes; then we define the older adult and present some of the most considerable age-related changes for our project; finally, we make reference to the need of promoting their well-being and we define the relation they maintain with the technology. Then the next section introduces the Human-Computer Interaction discipline by presenting in few words the history that supports it and focus the attention on the new emergent devices, in particular the ones that support Natural User Interfaces. Finally, the games' section presents the items that should be part of our game, in order to bring the expectable results.

Chapter 3 explains the methodology adopted during the project. An Human-Computer Interaction methodology named User-Centered Design. User Research, Interviews, Observations and user-based evaluations are some of the techniques described in this chapter.

The fourth chapter (4) focuses on the results of the analysis, design and evaluation of the game. The iterative process of design is described here, detailing on the game functionalities and user interfaces. The creation of the prototype of the game and its constant redesign are described. The end of the chapter presents the details on the evaluation process and an abstract with the main goals of the game.

Introduction

On the Chapter 5 we present the test of the actual final product with the users, the results obtained and their discussion.

Finally, Chapter 6 provides a summary of the main conclusions that arise from the whole project and the open issues that we keep to future work and that suggest a guide direction for the future.

Introduction

Chapter 2

Literature review

2.1 The older adult

At the beginning of our project, we defined the older adults as its target audience. Thus, in order to adapt the final product to this particular group needs, we found it necessary to study, meet and understand them. This could guide us to design an usable product with as few barriers as possible. Furthermore, considering elderly citizens as a particular group for which technology is not so directed, we identified the study of their characteristics as an essential initial approach. Therefore at the beginning we studied and defined the older adult.

It is not easy to find an age to be older adult. This definition may change from culture to culture, depending on the quality of people's lives and their cultural characteristics (e.g. there are countries where people cannot have an official record of their birthdate). The default definition of old age is, in the lack of an accepted and acceptable definition, the one at which a person becomes eligible for statutory and occupational retirement pensions [WHO]. On the other hand, if we want to establish an age to be an older adult, we may assume those aged 60 years or over [oED07].

So why did we choose older adults as target audience of our project? The older population has been growing faster than any other age group and will continue to grow more and more over the next years [WHO, Com06]. In Europe the number of people aged 60 or over surpassed the number of children in 1995 [oED07]. "By 2050, Europe will have twice as many older people as children" [oED07]. This guides us to an older population that continues to increase in the future. Among the factors which guide this increasingly aging population, we have the decrease of the fertility and mortality rates [Zim00, Fer97].

In this state of old population, we found the lack of new technology and devices that target the older adults as final users. Studies have demonstrated the fallacy to the myth

that older adults wish to avoid new technology. It has been reported that older adults are less likely than younger adults to use technology [NDSG06]. However they are really receptive if they know the benefits they can take [FRC⁺09]. On the other hand, the older adults have more life experience and more available time that gives them more ability to learn [Zim00]. With this project we aim to increase the use of new technologies by older adults. In order to try to satisfy our goals, we found it necessary to understand the age-related limitations aiming to surpass the barriers that elderly people face when trying to use technology [Gre09].

In this section we will focus on the older adults' specificities that come up with the advancing of the age and that deserve attention when designing their final product.

2.1.1 The age-related changes

Even if it does not happen the same way and at the same period of life in all people, there are limitations that arise when we are getting older. We identified these limitations along particular age-related changes that we will describe in this section: physical, cognitive, psychological and social. We are focusing only on some characteristics that may be relevant to consider when designing our final product for the tabletop.

2.1.1.1 Physical changes

In the aging process significant physical limitations may manifest themselves through changes for example in their sensory organs. These limitations do not appear at the same time neither with the same intensity in different people. Either way, they happen in many cases and we have to be prepared if we want to design a product that can be useful by the majority of our target audience. So, in this section we are going to focus on some age-related physical problems regardless of their causes. These characteristics can bring some barriers to older adults when using a new product.

Therefore, we will study motor changes, changes in vision and in hearing that may arise when we are aging.

Our motor control unit is one of the parts that suffers from aging effects. The most relevant changes in motor skills that arise in old age are, for example, slower response times, declines in the ability to maintain continuous movements, disruptions in coordination, loss of flexibility, and greater variability in movement [CS99]. These changes in motor skills may be one reason that cause difficulty for older people to use current input devices, such as a mouse or a keyboard, and manipulating other type of objects [CL07]. Another barrier that can arise and affect the way the people move is arthritis. Arthritis is a group of conditions involving damage to the joints of the body [Wika]. Aging increases

the probability of arthritis [APA98]. This disease can also make it difficult to move or simply the act of picking up objects.

Other changes that can arise when aging are related with vision. The limitations through this sensory system should be an important focus when designing the product. It becomes necessary to pay attention to the importance of the sight when designing the interfaces for older adults. According to Dix et al. [Dix04] the sight may be the most important sensory system in receiving information from the computer. Aging may raise problems in this sensory system. Although most older adults do not experience severe visual impairments, many of them experience declines in eyesight sufficient to make it difficult to perceive and comprehend visual information [CL07].

It becomes necessary to adapt some information to their needs, because vision changes have implications for the design of written instructions, manuals and display screens [CL07].

The stronger difficulties that can arise include problems with reading speed, seeing in dim light and brightness, reading small print and locating objects [APA98, Dix04].

Changes in hearing can also be relevant to be considered if we opt for auditory information in the interface of the system. Thus, it becomes necessary to meet the age-related changes at this level. Studies developed by the American Psychological Association [APA98] revealed that "hearing impairment among older adults is often moderate or mild, yet it is widespread; 48 percent of men and 37 percent of women over the age of 75 experience hearing difficulties". In many people it is observed that the ear becomes less elastic and suffers other changes that make them less able to respond to sound waves, contributing to hearing loss. Furthermore, with aging other limitations arise, mainly manifested as loss of sensitivity: losses in perception of high-frequency sounds arise first and only later it affects lower pitches [Rub07]. These are some limitations that should be taken into account if we include auditory information in our design process.

2.1.1.2 Cognitive changes

Similarly, when we are aging, some cognitive aspects are likely to decline. This can also create some difficulties when trying to use a product. "It is important to understand that our brains change over time, and it is helpful to be able to distinguish normal changes from those that require medical and psychological attention" [APA]. Therefore, in this chapter, we are going to study age-related changes at this level. We will focus on cognitive changes that may be related with memory and attention. These are some limitations we identified as interesting and important to have in mind when designing our product.

Memory is an important ability when we are trying to learn something or when we are dealing with information processing. However, there are functions of memory that are affected by aging. The most relevant one, to consider for our project, is the working memory. Working memory, or short-term memory, is "the ability to hold some information in consciousness while manipulating other information" [Cap07]. A good example of an activity that uses working memory is mental arithmetic; when a person is asked to attempt an arithmetic operation with different numbers spoken by another person, without being able to use pen and paper or a calculator, this person uses the working memory to manipulate the information. Some decline in this ability may affect comprehension and may contribute to poorer memory performance, especially when the person must learn or recall under conditions that tax processing ability [Cap07]. Considering this decline, we must pay attention to the quantity of information and the way this information is presented when we are in the designing process. With this in mind we considered the model most highly cited in psychology papers, "The Magical Number Seven, Plus or Minus Two" [GM91]. "Psychophysical measurements indicate that human subjects can store approximately seven short-term memories" [Lis95]. The plus or minus two depends on the properties of known brain oscillations [Lis95]. This way, we will have in mind this model when designing the user interfaces.

Nevertheless, there is a memory function that continues to improve for many people, even with aging – semantic memory. Semantic memory is the ability to recall concepts and general facts that are not related to specific experiences [APA]. In addition, procedural memory, which is the memory of how to do things, typically stays the same [APA].

Changes in the field of attention must also be considered, when designing a final product. Attention is one of the important requirements to perform computer-based tasks [CL07]. It can be defined as an element of cognitive functioning, in which the mental focus is maintained on a specific issue, object, or activity. Attention suffers significant changes with aging. "Declines in attentional capacity may make it difficult for older people to perform concurrent activities or switch their attention between competing displays of information. They may also have problems attending to or selecting task targets on complex displays" [CL07]. It becomes necessary to focus and to study these declines in order to understand how we can obtain the most attention by older adults when using our prototype.

2.1.1.3 Psychological and social changes

By the same way and also important, we identified psychological and social changes as important matters to pay attention if we want to attend older adults' needs.

As people age, their changes are also felt in their social relationships and self-esteem. Their social groups become smaller because of the loss of friends and loved ones and they face difficulties to leave their homes and to perform daily activities, because of the physical impairments [Zim00]. Those life aspects may result in psychological distressing by posing barriers to the ones that want to participate in their usual social activities and to live independently [BS10]. From that frustration it can arise the depression that became already common in the older adults' lives [APA98]. The difficulties to adapt to new roles in life, the loss of motivation and difficulties to plan the future, the need to adapt to fast changes in the social relationships and so on are some of the factors that guide that frustration and depression in some people when aging [Zim00].

The depression and frustration may guide the older adult to avoid his usual socialization and it tends to guide him to a deep isolation, closing himself in his own world. Stimulate that social interaction with their friends or relatives by providing group activities that initiate pleasure and well-being is a good way to prevent the isolation and the consequent psychological problems.

2.1.2 Promoting the well-being of older adults

It is more common to find energetic and youthful people that have the same chronological age than another with hard physical or psychological impairments [ONe02]. This way, the new trend is on supporting the older adults in order to induce them to try not to be old or feel like this. This new trend bases on promoting the well-being of older adults.

“The concept of well-being is closely related to the concept of the quality of life. Both concern the satisfaction of material, biological, psychological, social, and cultural needs and demands of an individual, which are necessary for his satisfaction with life.” [Zik03].

The individual's health and the changes that may arise with aging are directionally related with his well-being. “Health may be considered as the vital factor as concerns the capability of an individual to meet his aspirations and satisfy his needs and demands, and to manage the requirements of the biological and social environment as well.” [Zik03]. This way, the older adults must act in order to avoid some of the age-related changes. Thus, if they can achieve their goals at any level, they establish well-being in their lives. Therefore, the concept of well-being can be perceived as subjective.

When we approach the aging theme, sometimes we think in inactivity and complete decline. It does not have to be like that. If we want to turn aging into a positive experience, longer life must be accompanied by continuing opportunities for health, participation and security [WHO02].

This is what active aging may provide. According to World Health Organization, active aging is “the process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age” [WHO02]. It can be done with stimulation. The word "active" refers to continuing participation in social, economic, cultural, spiritual and civic affairs, not just the ability to be physically active or to participate in the labor force, but also to counteract the age-related changes that may arise in these fields [WHO02]. According to Zimmerman [Zim00], it is essential to promote physical, psychological and social stimulation to the older adults in order to promote an active and successful aging. This active and successful aging can be translated to a reduced probability of diseases, a maintenance of an high functional level in cognitive and physical skills and a preservation of the social involvement and well-being [Fon00]. In addition, Óscar Ribeiro suggests the use of the human capabilities and not to lose them, in order to justify the need to stimulate the brain and the body to keep them well functioning [RP11]. With this in mind, if we want to design a product with the goal of improving the overall well-being of the older adults, we need to consider the three referred attributes: physical, psychological and social.

2.1.3 Older adults and technology

It is not new that the computer and the internet have been changing the society. The new technologies are increasing everywhere. "Today, it's difficult to imagine a world without computers" [Gre09]. However, considering our target audience as end-users of that technology, we may verify that many of them face marked challenges when it comes to using computers [Gre09].

As it was explained above, older adults have different age-related changes that guide us to a diverse population. It is not easy to define our target audience and, when it comes to design for them, many problems may arise. The main cause to have a low use of technology by older adults is that the new emergent products do not suit their needs [LMN⁺08]. To benefit from the advances that technology brings, it becomes necessary to ensure that systems are designed considering the capabilities and limitations of the older adults [NC03]. Czaja says in [Gre09] that the older adults do not have aversion to the use of technology, "they are entirely receptive". The older adults are receptive and use any kind of technology if they understand the benefits that can arise and if they are completely able to use it [Gre09]. "Technology holds the promise of enhancing the quality of life and independence of older people by augmenting their ability to perform a variety of tasks and access information and services" [CL07].

Our aim with this project is to take advantage from the use of a new emergent type of technology, based on multi-touch, in order to offer older adults something useful in their lives. As it was mentioned, the benefits from its use are entirely linked with the improvement of active aging, enhancing the quality of life, independence, and well-being of older adults [Gre09].

In the next section we are going to overview the study we made on the discipline that studies the interaction between the user and the machine – Human-Computer Interaction.

2.2 HCI

As we mentioned before, the target audience of this project is the older adults. This particular group has different needs than any other group of people and faces barriers when trying to use new technology [Gre09]. Many times the barriers do not arise from the lack of receptivity by older adults [Gre09]. They happen because older adults feel overwhelmed and frustrated by the use of some devices [Gre09].

The use of new technology could become more acceptable if we offer them something that is presented as complementary to their skills, enhancing rather than replacing those skills [ZA08].

In order to cover this weakness, we decided to study the discipline that tries to offer software and technologies that the users will want to use and will be able to use [RH03] – *Human-computer interaction* (HCI).

HCI is a relevant discipline surrounding this whole project, in order to offer the consumers something they like and to improve their acceptance of new products. HCI is the discipline that studies the quality of the relationship between the human and technology [Dix04]. Therefore, this is the way to design interactive computer systems to be effective, efficient, easy, and enjoyable to use, so that people and society may realize the benefits of computational-based devices [Dix04].

This way, this section presents an overview of the history and the evolution of HCI and the advantages that may arise from its use when designing the final product. The HCI methodology that we used in the design process will be introduced and will be explained on Chapter 3. It will also be introduced and explored the concept of novel device and the advantages obtained from it when we consider the elderly people as end-users of our project.

2.2.1 Evolution of HCI

Always attached with new technologies comes the discipline which studies the interaction with it – HCI. According to Harper et al. [RHS08] "HCI has helped to produce a world in which interacting with computers is easier and richer." However, this interaction has been changing. In the past it was not too easy and rich, it has been evolving linked with computers' evolution.

"In the early days, engineers designed hardware systems for engineers to use. The computer interface was relatively straightforward, comprising various switch panels and dials that controlled a set of internal registers" [JPYRPHS02]. There was not a field of HCI directed to the target audience of a particular product.

The field of HCI was established during the eighties and nineties, when computers, mobile phones and the Internet were introduced as common work tools and consumer products. This created a need for interfaces that were easier to use, and it was obvious that in most cases it was not feasible to employ human factors experts to work on new interface designs [Str08]. At this time it became necessary to develop computers and technology that could be used by other people, besides engineers. "To make this possible, computer scientists and psychologists became involved in designing user interfaces" [JPYRPHS02].

Nowadays HCI is an essential part of the design process of computer science and systems design. It "involves the design, implementation and evaluation of interactive systems in the context of a user's tasks and work" [Dix04].

The interaction between the human and the technology continues to change and will continue in the future. Increasingly technology offers an interaction more and more natural and intuitive to ease and to encourage the users in relation with it. "The learning curve for working with computers is becoming less and less a barrier thanks to more natural ways to interact" [Cla11].

After the contextualization of HCI, it became clear that we should study and use an HCI methodology, in order to get more knowledge about the end-users and to adapt the user interfaces to their characteristics. In the Chapter 3 we are going to explain the HCI methodology we chose for our project and how we used it in order to meet the users' characteristics - User-centered design.

2.2.2 Interaction devices

At this point, we thought it was necessary to briefly study the emergent technologies that are appearing in the market aiming their use to the older adults. Thus, this section presents an overview of the technology progress, in order to introduce the Natural User Interfaces and the among devices in this area.

2.2.2.1 Technological progress

We live in a world that has become suffused with computer technologies. They have created change and continue to create change in our lives [RHS08]. Harper et al. (2008) pointed both positive and negative aspects need to be considered when looking to new technologies: as the positive aspects we have people using technologies "to healthier and more enjoyable lifestyles, expand their creative skills with digital tools and instantly gain access to information never before available"; as negative, "governments become more reliant on computers to control society, criminals become more cunning via digital means, and people worry more about what information is stored about them". Still, we find more and more people using numerous devices not only for work, but also for fun.

At the beginning of our work, we identified new technologies and their positive points as a possible way to pursue healthier lifestyles also for older adults in order to counteract the age-related paradigms like isolation or cognitive decline. Thus, it becomes necessary to adapt the interfaces to the particular needs of elderly.

2.2.2.2 From User Interfaces to Natural User Interfaces

The way users access digital information is changing. "Most of us learned how to use a computer by interacting with a personal computer, using a keyboard and mouse to point, click and select icons and options from menus" [RHS08]. This interaction was done through the *Graphical User Interface* (GUI), allowing us to interact with graphical objects instead of typed commands, how it was chronologically before. For us, who have grown surrounded by computers, a GUI may be considered an easy way to interact with some kind of technology. However there are particular people who did not have the same opportunity to begin interacting with computers early – novice users (e.g. elderly people). If they want to start using the current technology systems, they may have a steep learning curve if they use a GUI. Even so, there are several devices that use an emergent different way of interaction – *Natural User Interfaces* (NUI).

Natural User Interface (NUI) is an emerging paradigm shift used to refer an invisible user interface or possibly invisible with continued user's practice [Gro]. We mean invisible and natural by the inexistence of artificial control devices whose operation has to be learned, e.g. keyboard or mouse. The use of a keyboard or mouse may be difficult for some older adults and many of them need adaptive devices, for example because of motor impairments (see section 2.1.1) [CL07]. With NUI the user may control digital content by natural actions, movements or gestures traditionally used every day. These natural actions are related with human abilities such as "touch, vision, speech, handwriting, motion and more importantly higher level processes such as cognition, creativity and

exploration" [Gro]. The main goal we identified in NUI is the possibility it offers, through its study, to replicate the real world environments in the way we interact with technology. NUI may enable intuitive, direct and physical interaction with the device interfaces [dV].

"Natural User Interfaces can include sound, touch, gesture, tactile inputs and outputs and are really about making the most efficient use of the human senses when interacting with machines. The goal is to make computing and technology simple to use, everywhere around us, accessible to people with minimal technical expertise, reliable and more intuitive" [Gro]. We can find different ways to transpose human senses to the digital interfaces we use, e.g. voice recognition, finger identification, facial expression and so on. Furthermore it is believed that natural and intuitive technology can help improve health care, education, workplace productivity and other social issues [Cla11].

Therefore we found in this type of interface a potential facilitator to introduce novice users, namely older adults, in the world of technology, using something that meets the real world day-by-day activities and that may turn their relation with technology more acceptable.

Among the different devices which could enable a NUI there is a growing market which uses touch input [Jan09, Col10]. There are already numerous devices supporting Multi-Touch technology. Multi-touch is a technology that recognizes many points of contact simultaneously – not just from one finger as with a typical touch-screen. More and more we face the release of novel devices in this area, e.g. smartphones, tablets, tabletops and so on.

Always focusing on older adults as end-users of our project, we selected tabletops due to their shape and size. As we mentioned before, a tabletop implements a NUI as "a revolutionary surface computing platform that responds to natural hand gestures and real world objects, helping customers interact with technology in a way that is simple and intuitive" [Cor08]. It has a large surface (approximately 100x60cm) that will overcome possible vision limitations in elderly people and that will provide the interaction by more than one person, providing social interaction. Tabletops run multi-touch technology allowing the collaborative interaction, becoming a multi-user experience that can be useful for collaborative games. It also can recognize real objects. Furthermore the tabletop has the peculiarity of having a shape that resembles a traditional table, being less intrusive than other devices for novice users.

2.3 Games

We identified in games the opportunity to meet our project goals – to design an usable game for older adults, in order to promote their well-being. When we were choosing our

technology device, the tabletop, we thought about what type of activity we could offer to elderly people with our goals in mind. This way, we introduce games as the opportunity to meet those goals.

A game is "a set of activities involving one or more players. It has goals, constraints, rewards and consequences. A game is rule-guided and artificial in some respects. Finally, a game involves some aspect of competition, even if that competition is with one-self." [Dem96]. A game may have different purposes according to the users or goals they are designed for. A game can be considered a break, a form of recreation or a replacement of physical and mental forces fatigued by work. It can also be considered as the expenditure of accumulated energy, by manifesting the unused power in the different forms of the game. Finally some authors view the game as a learning method [Gei03].

In our game, we should approach a description that allows us to develop a suitable activity for the elderly. Thus, the game should be presented to older adults as funny, offering leisure and meeting their needs and, in addition, it can be a well-being promoter, by training or stimulating their attributes. This way, considering the older adults as the end-user of our game and according to Pilar Point Geis [Gei03], we can consider the game as a mean to obtain:

- Leisure and entertainment;
- Energy release;
- Social interaction and relationships;
- Physical stimulation objectives;
- Psychomotor stimulation objectives;
- Intellectual stimulation objectives.

The items presented above, meet the user needs regarding the age-related changes they may suffer. The age-related changes may bring some problems that can be prevented by stimulation (see Section 2.1.2). Thus, "digital games hold a significant promise for enhancing the lives of seniors, potentially improving their mental and physical well-being, enhancing their social connectedness, and generally offering an enjoyable way of spending time" [INdKP07]. They can play a positive role in meeting the older adults' needs for fun and mental stimulation, while also heightening their self-esteem [Wei83].

We found with our review of the literature of digital games for older adults [INdKP07, MMSM10, GMS⁺09, ea09] that they may provide significant positive results in their lives, e.g. improving reaction times, self-esteem and sense of well-being, etc. However

these games have to be designed specifically with the older adult in mind, in order to become an easy and usable product, adapted to their characteristics.

Concluding our study of the advantages of using games with the older adults, we tried to find a specific typology or categorization that suits better their needs. No empirical data is available as to what kind of content the game should include. With this in mind, we followed the four design guidelines suggested by Ijsselsteijn et al. in [INdKP07]:

- Design for relaxation and entertainment;
- Design for socialization;
- Design for stimulate the mental and physical activities;
- Design ways of natural interaction.

In addition, we underline what it has been said with the words of Rita Teles in [Tel]: "the elderly games may be designed to stimulate the brain, the reasoning and the memory, promoting the physical involvement of the older adult in the task and the creativity. (...) All the games are designed aiming the entertainment and enjoyment while challenging the mind. (...) The games work on the cognitive, memory and concentration skills and promote the social interaction between the participants".

Chapter 3

Methodology

Nowadays, the digital games and other applications are growing larger through many different devices [JS08]. The older adults may take advantage from the use of this new technology. For that reason it was thought that they could use it, by offering them something they use in their routines – the games. This way, we thought of developing a game to be played by older adults in a tabletop. However, it was identified the lack of use of technology by this audience. The older adults have different needs than any other group of people and face barriers when trying to use new technology [Gre09]. And it does not happen because of lack of receptiveness of older adults. In some cases these barriers appear because the elderly people feel overwhelmed and frustrated by the use of some devices [Gre09]. Despite the receptiveness of the older adult, if he does not understand the benefits of using technology and if it does not meet his characteristics and needs, he will not use it. So, two things must be considered:

- The "need to use" – or rather the benefits of use – must be made clear before older adults will voluntarily adopt technology [FRC⁺09];
- It becomes necessary to adapt this technology to their needs, because age-related changes have implications for the design of the final product [CL07].

Considering the different needs of our audience, we assumed that if we want to offer them a final product that could be usable, we needed to center its design on the final user.

Human-computer interaction (HCI) is a relevant discipline surrounding this whole project, in order to offer the consumers something they like and to improve their acceptance of new products. HCI is the discipline that studies the quality of the relationship between the human and technology [Dix04]. Therefore, HCI is the way to design interactive computer systems to be effective, efficient, easy, and enjoyable to use, so that people

and society may realize the benefits of computational-based devices [Dix04].

During our work we adopted an HCI design methodology that poses the final user in the center of the whole design, in order to better meet the older adults' characteristics. In this chapter, we will describe the methodology we choose – User-Centered Design (UCD) – and the methods we used in each phase.

3.1 User-Centered Design

There are different approaches that involve real users and focus on their needs and goals [JPYRPHS02]. Among them, to guide our design with the involvement of end-users, we chose User-Centered Design (UCD) as a design methodology.

UCD is an HCI methodology that appeared in the eighties, introduced by Norman et al. [ND86]. UCD focuses on the needs and limitations of end-users. It focuses on their needs and limitations, but does not involve them directly in all stages of the development process as active members of the development and design team, because it may result in some unexpected problems. For example: users' thinking can be constrained by what they know and limit what designers could do; if users are too much involved they probably get bored and it may become counter-productive [JPYRPHS02]. However, this approach considers the end-users a central part of the process, but does not integrate them in the design team [JPYRPHS02].

According to Costabile (2000) [Cos00] this design methodology may be characterized by the following principles:

- analyze users and task;
- design and implement the system iteratively through prototypes of increasing complexity;
- evaluate design choices and prototypes with users.

There is a standardization, by the International Organization for Standardization (ISO), of Human-centered design processes for interactive systems: ISO 13407 [ISO99] (see Figure 3.1). "ISO 13407 can be regarded as an important supplement to the UCD literature". [JIMK03] It "provides guidance on achieving quality in use by incorporating user-centered design activities throughout the life cycle of interactive computer-based systems". [Usa06b].

After identifying need for human-centered design, this process runs in an iterative cycle composed by four phases, as it can be seen in Figure 3.1. Each of these phases is not detailed and therefore in this chapter we are going to explain what we did in each one, in order to develop our final product. At the beginning of our project, it was clear that the

aim of the use of User-Centered Design was defined by the final phase of this process – the system satisfies specified user and organizational requirements.

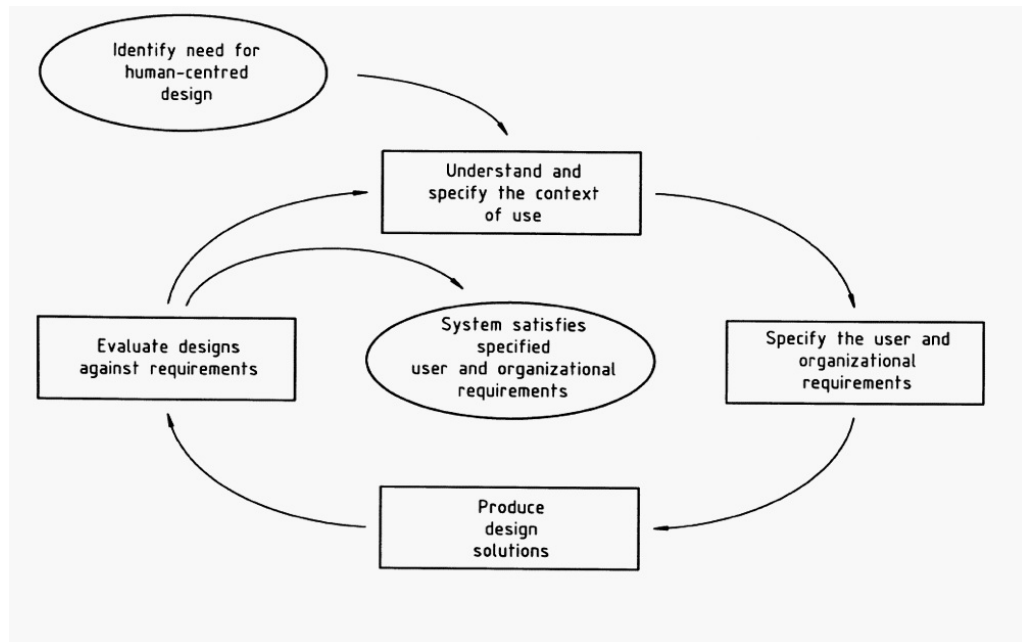


Figure 3.1: ISO 13407 [ISO99] – User-Centered Design

In the context of UCD, we used some different methods in each phase. Initially, in order to understand and specify the context of use by meeting the target audience, we used the User Research method. After that, using the results of the first phase, we used Informal Observation on older adults' environment (in the places where they socialize and in a Day Care Center) and informal interviews were conducted with some of them; this guided us to the establishment of the requirements that our game should include. Then, based on the established requirements and supported by Design Guidelines for Older Adults (see [Zaj06, Zaj04, FRC⁺09]), we developed Low-fidelity Prototypes for our game. The game's prototype has been iteratively redesigned using the feedback obtained with its evaluation with the users.

After explaining our methodology's life-cycle, we will subdivide it explaining each method that we refer.

3.1.1 Understand the user

In this phase, we used User Research. User Research is a process that "provides a consistent, rapid, controlled and thorough method of examining the users' perspective" [Kun03]. In this context, it allowed us to better understand our target audience, i.e. their characteristics, needs and behaviors [UXm09]. Thus, it guided our design process for the elderly

by having a clear understanding of what they could be familiar to. We based User Research on literature review and informal interviews with social educators of the Day Care Center and with the older adults themselves.

3.1.2 Specify the user requirements

After defining the end-user with User Research process, we needed to establish the requirements that our game would include in order to meet their needs. The requirements for our game were defined by literature review (see Section 2.3) and observing the older adults in their environment (the Day Care Center) playing games, performing their tasks and doing their usually daily activities – informal observation. To complement this observation, we also conducted informal interviews with them, in order to understand how their routines are, why they do the things they do and in what they put their daily interests. The addition of these two methods (informal observations and interviews) can be considered Field Studies [Ass10a]. Field studies are a general method for collecting data about users, user needs, and product requirements. Thus, this phase helped us define our game and the functionalities it could include.

3.1.3 Produce design solutions

Based on the understanding of our target audience and on the requirements obtained by the previous phases, we proceeded with the design of the game. To complement the requirements gathered, we studied design guidelines specific to older adults (see [Zaj06, Zaj04, FRC⁺09]). These guidelines for user interfaces design "summarize good practice and provide useful high and low level guidance on the design of usable interfaces" [Usa06a]. In this context we had an overview of the relevant guidelines. From this study plus the requirements defined, low-fidelity prototypes have been developed.

"A prototype allows stakeholders to interact with an envisioned product, to gain some experience of using it in a realistic setting, and to explore imagined uses" [JPYRPHS02]. It is "a limited representation of a system design that allows users to interact with it and to explore its suitability" [JPYRPHS02]. This way, prototyping is "an important technique to reduce the cost and risk involved in developing complex software systems", by providing the discussion of ideas between the designers and the stakeholders [RI94, JPYRPHS02].

There are two main types of prototyping that are related with the concept of fidelity: low-fidelity and high-fidelity prototypes. The low-fidelity ones are representations of the system differing on the final product in interaction design and vision appearance, such as sketches or paper models. The high-fidelity ones look much like the final product, including software prototyping [Car05].

Low-Fidelity prototyping methods are quick and cheap which encourage iterative design idea tryouts during usability tests. They allow designers and users to focus on high-level interaction design and information architecture, rather than on details or visual style, sacrificing some realism [Sny03].

High-fidelity prototypes have more realistic interactions than the previous ones. They have disadvantages like making the designers more reluctant to change designs and less likely to fully explore the design space. They are also more expensive and difficult to change [JPYRPHS02].

There is also an intermediate level of fidelity of prototypes that includes advantages from the two described above – the medium-fidelity prototypes.

In our design we used paper prototyping as low-fidelity prototypes and we also used the intermediate ones, in order to detail the scale and colors of the interfaces.

3.1.4 Evaluate designs

In order to test, evaluate and adapt our designs we prepared and made usability tests with the older adults, by using user-based evaluation techniques. In this context we used the card sorting and "wizard of Oz" methods.

Card sorting is a method that is used to assess how a group of people relates concepts together and organizes the information. It is appropriate when we have identified items that we need to categorize, and we need to have feedback from who will use it. It is particularly important to develop structures that maximize the probability of users being able to find the wanted items, such as options in menus or web site hierarchy [SW04, Gaf00, BSC08].

Wizard of Oz is another method for user-based evaluation of unimplemented technology. This technique consists in a simulation of the system by a human using natural language, while the user is performing tasks in the paper prototype of the system. This is used to test functionalities, user behavior and interfaces for systems which have not yet been fully implemented. In this context, it can provide valuable information on which to base future designs [DJA93, KSG⁺01, Ass10b].

Methodology

Chapter 4

The game design

After presenting the context of the project, the state of the art in the related areas and the methodology that we have adopted, in this chapter, we are going to present the results of our research and analysis, the iterative cycle of the design process and the evaluation methods for our game.

This section firstly presents the description of our defined game and only after there are presented the taken decisions and the adaptations that were done after the end-users' feedback.

4.1 Game description

4.1.1 Elements and rules

It is time to understand the content of the game for the older adults that we designed. This is a game in which one team is competing with another in order to finish the game first and to score more than the other. The game is composed by three main elements: the *images*, the *categories* and the *score*. An image is a picture/photo that is inserted in the system; a category is one word that classifies and aggregates a set of images that share one same subject, e.g. the category Animals has associated images with animals, like a cow, a dog, etc; the score is the mark that differentiates each team and that defines the winner of the game. This score is increased or decreased during the game, depending on the assertiveness of the team.

Initially the system gives to each team a name of one category. Each category has seven images associated and there are many different categories that can be part of the game.

The main goal of each team is to find and collect the images that correspond to the predefined category that the system gave, i.e. the team is responsible to aggregate images

that have the shared subject defined by the category. The game finishes when both teams have collected all the images from their predefined categories.

4.1.2 Game environment

As it was mentioned when we studied the User Interfaces that could support the use of older adults, on the Section 2.2.2.2, we found on multi-touch technology the opportunity to introduce them in our game that aims promoting their well-being. This way, the game that we defined was designed to be played on a MultiTouch Cell Advanced¹ (see its dimensions and shape on Figure 4.1) by this particular audience. The whole design of the game was based on this device's characteristics because that was the device that we had for testing with the users. In this section we are going to present the physical division of the device and its environment.

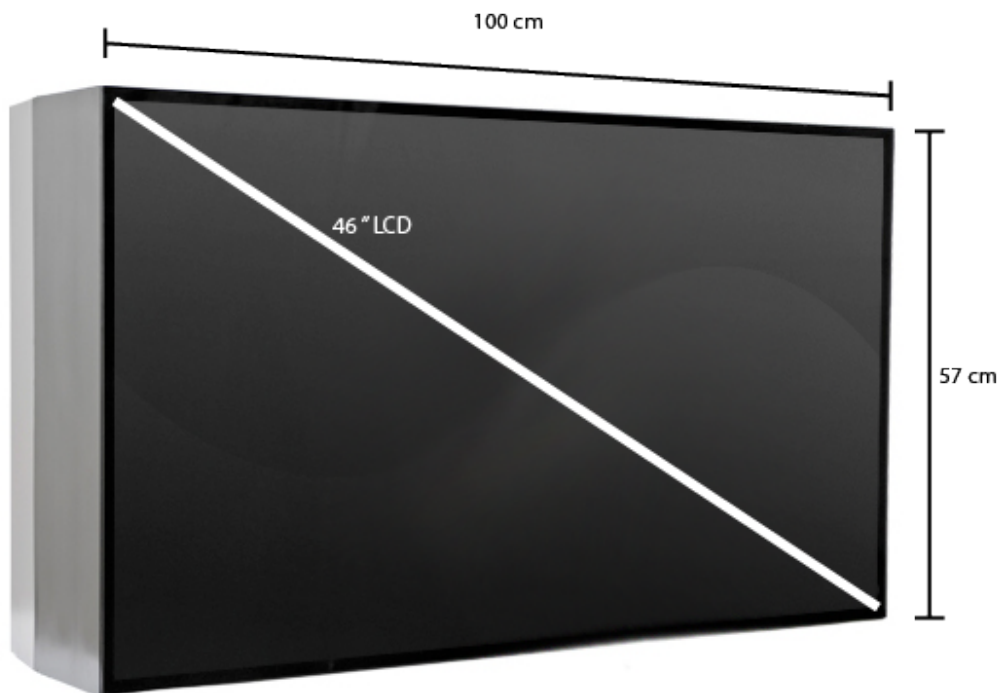


Figure 4.1: Tabletop dimensions

It is possible to be played individually or in team against another older adult or team (this way, it has three modes: one player versus one player or one player versus one team or one team versus one team) – from this point to forward we will call team even if it is composed by one player.

Each team is placed in the farthest opposite sides of the Tabletop. This way, while playing, each one has the possibility to interact with the table in two distinct areas – the

¹<http://multitouch.fi/products/celladvanced/>

The game design

Team Area (each team has its Team Area) and the Shared Area (see Figure 4.2). Into each Team Area there is a subdivision in two new areas that will be explained below – the Zooming Area and Album Area.

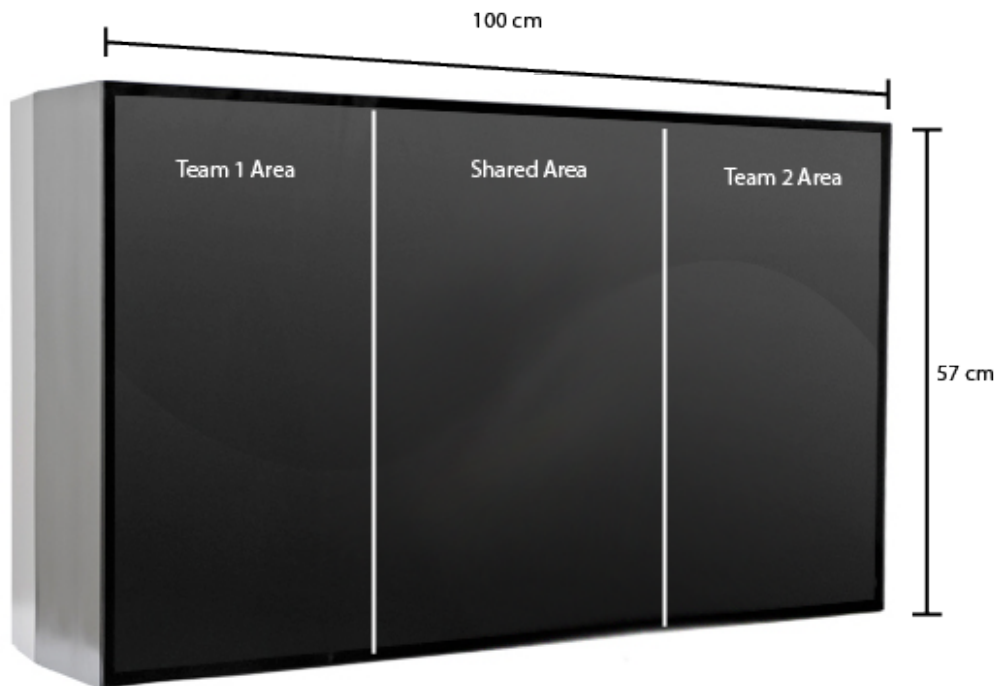


Figure 4.2: The three game areas

The images that each team has to find are laid-out in the Shared Area. In this Shared Area there are always twenty-one images laid-out, i.e. that correspond to three different categories (there is an extra category selected by the system, in addition to the two other that the teams are finding). To complete its goal, the team has to drag and drop the images from the Shared Area to the Album Area (see on Section 4.2 the definitions of these areas). If the player cannot see the image clearly he can, at anytime, zoom it in order to see it better. This process consists on scaling the image that the player cannot see. The game score assigned to each team depends, for example, on the errors that the team does on choosing incorrect images to the category that it is finding. The score is the comparing metric that will be explained below.

After explaining the rules and the course of the game, we are going to explain all the decisions and changes that have been done in the iterative process of design that brought us to this state of the game. Furthermore we will also present the established menus that the older adults have to complete in order to register themselves in the game, before playing. In addition it will be explained their iterative construction, by adapting it to meet the older adults' needs.

4.2 The iterative process of design

4.2.1 Specifying the context of use

As reported on Section 3, we used some methods to understand our target audience - the elderly. These methods were described in that chapter, such as User Research and Informal Interviews with their social educators and with the elderly themselves. In this context, some of the results obtained with the User Research were presented in Section 2.1. The age-related changes are one of the main things that change the way that people live. These changes are felt mainly at three levels:

- Physical;
- Cognitive;
- Psychosocial.

In this context, we found on the literature review that stimulating some parts of these human skills could result on benefits for the older adults' life, by delaying marked changes and promoting well-being [INdKP07, Zim00]. Wijnand IJsselsteijn et al. [INdKP07] also refers that digital games hold a significant promise in this sector. In addition, Pilar Pont Geis [Gei03] indicates the games as a mean to obtain leisure and entertainment, energy release, social relationships and physical, psychomotor and intellectual objectives (see 2.3).

On the other hand the Informal Interviews with the social educators of the Day Care Center allowed us to understand the importance of the games offering to older adults an important way of social interaction and an enjoyable way of spending time. In the Day Care Center, it is common to try to vary the games they play and the elderly sometimes ask for social educators' help when playing a new game. In the same way, we found that the older adults use the conversation about different subjects of their lives, as another way of leisure and spending time. Thus, we thought it was interesting to join the games with the things they like to remember, for example about the past vivid memories.

Finally, the Informal Interviews with the older adults allowed us to better understand which are their motivations to play games and to attend the Day Care Center (or a public place), besides playing or staying at home. The answers were unambiguous, they like to attend to social centers or another places to meet with people of their age group, in order to spend the time and not to be alone at home. The process of moving from their homes to the social center is also a motivation to "catch some air" and not to be closed all day. They play games to spend time and for pleasure. It was also found that the older adults are receptive to the new technologies if the provided advantages for using it are clearly understandable (for example, when we presented ourselves as Informatics Students, one older adult of the Day Care Center asked us to help him learning how to use computers;

another one told us that she had already no age to learn about it, but, when she realized that she could talk and see her daughter who lives far away, she became receptive).

In this context, we are going to try to take advantage from the dimensions of the testing MultiTouch Tabletop (referred above in Figure 4.1), in order to design a game to promote the well-being of the older adults.

4.2.2 Specifying requirements

When we adopt the UCD as design process, it became clear that to offer to older adults a game that could be usable and enjoyable we needed to establish clearly its requirements. To help this process, we had been involved in environments where some older adults frequently join the others – a Day Care Center and a public city garden in Porto. Furthermore, we conducted Informal Observations and Interviews to understand what are the different games and activities they usually do, why they are important and likely for them and the help they need when they are participating. It was also important to observe the different ways of interaction and to understand the things they like to remember and why they do. These methods and their results, in addition to the ones used on specifying the context of the game, guided the functionalities we include in our game, e.g. help in menus, game hints, zooming process, process to collect images, including images with things they could remember, having teams and scores, etc.

4.2.3 The game prototype and development

In this section, it will be presented the first version of the game and its continuous construction through the feedback received by the older adults. The game design process included the use of paper prototypes of the user interfaces (the game menus) and the board that simulates the surface of our tabletop (with approximately the same dimensions). These low-fidelity prototypes allowed us to project our ideas of design, discuss them and evaluate with the end-users. The whole section presents the comments for the user interfaces and functionalities of the game that have been emerged.

"No empirical data are available as to what a typology or categorization of senior gamers may look like and how this would map onto potential game content" [INdKP07]. This way, as it has been mentioned, we only had in mind to find a way to offer the older adults an enjoyable game that could at the same time stimulate the user at different levels. Initially, we designed the basic logic of the game and we observed the users playing it. The game prototype was designed to be played by four players placed in four distinct areas; there was a central area where the images that correspond to a determined category should be placed (see Figure 4.3).

The goal of each player was to aggregate the seven images that correspond to the category that we gave him. The used categories were Games (Jogos), Jobs (Profissões),

The game design

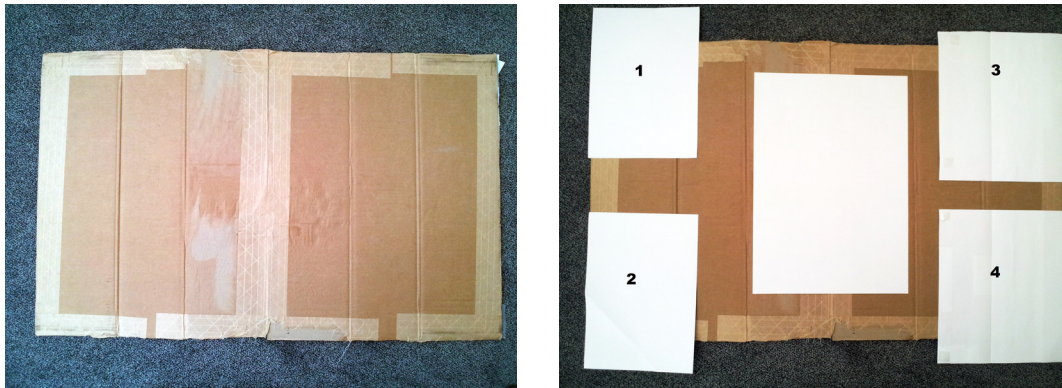


Figure 4.3: Prototype of the tabletop's surface and the gaming areas

Hygiene (Higiene) and Animals (Animais) (see Figure 4.4). The images that correspond to each category were selected randomly from a set of images available on each subject.



Figure 4.4: Game Categories

It was asked to players to collect the images from the shared area to their own game area (see Figure 4.5). The game finished when all the players had collected the respective seven images or if there were no more images in the shared area (it was possible for one player to miss some images if another player collected it by mistake).

The goal of our observation was to understand how they played this game in a group, with individual goals, to register the difficulties and to establish the requirements that the



Figure 4.5: Collecting a policeman that corresponds to the category Jobs (Profissões)

final game should include.

4.2.3.1 Results and opportunities

In this section we are going to explain the changes that the first prototype of the game has suffered, due to the feedback obtained by older adults and in order to meet their needs. It will be presented the division of the game in the following sections:

- The changing of areas;
- Introducing teams;
- Adaptation to vision impairments;
- Changing images;
- Introducing a validating system;
- Miscellaneous additions.

The changing of areas – The observation with the first prototype of the game showed that the dimensions of the board were not appropriate to be played with four distinct player areas. During the game some older adults were constantly colliding with others that were

placed next to them. In order to overcome this problem it was posed the hypothesis to divide the table in two player sections instead of four. At this point, to understand this problem an usability test was carried out (see Appendix A.2) that tried to define the average distance that the older adults can reach in the tabletop area. The task involved selecting fruits and vegetables from a paper laid-out upon the board. The facilitator asked randomly for the names of these fruits or vegetables and the older adult needed to select the respective item with his finger, effortlessly. Our test have shown that, in average, the sample of elderly we got reaches up to 49,4 cm upon the table. This dimension is approximately half of the length of the tabletop (length of the tabletop is 100cm, like it was mentioned before). Thus, we changed the way player areas were placed: now there are two player areas in the farthest sides of the table, instead of four. Thus, the players must access the images in the center of the table. This avoids the collisions between the players and the others' areas and, in addition, this is a way to train and stimulate their motor skills while they are interacting with a slightly distant location.

Introducing teams – Even with the game divided in only two player areas, we considered that maintaining more than two players would increase the challenge and the pleasure while playing. This was based on the observation: when a player found an image that did not correspond to his category, he made the effort to put this image near the player who is looking for it; on the other hand, the older adults who did not play directly had placed themselves near one of the game players, giving him hints in order to help finding new images. The cooperation was always present. With this in mind, the game has the possibility to be played in teams. The elements of each team need to cooperate in order to win the game against the other team. This promotes the social interaction between the elements of the team and even between opposite elements by comparing the assertiveness of each team and the scores obtained. The existence of teams will influence the user interfaces for menus: it is given to each team the possibility to choose its constitution, i.e. the players that it includes (see Section 4.2.4.3).

Adaptation to vision impairments – While playing the first game prototype, the senior citizens sometimes faced problems in seeing the images. They tried to pick up the images, in order to see them better. This problem arises from the age-related changes that can provoke impairments at vision level. In order to adapt the game to compensate these possible limitations, we introduced the possibility to zoom an image. This way, during the game, the players have the possibility to zoom an image when it is not well visible for them. This process was thought in two different possible ways:

- Dragging and dropping the image to a specific area (1);

The game design

- Putting a tangible object upon the image (2).

1 – Dragging and dropping the image to a specific area

This process consists on dragging the images to a specific area of the table. When the images are over this area they become larger. The "zooming" area is labeled with the text "Drag your image here to magnify it" (Arraste a imagem para esta zona para aumentar) and has associated a magnifying glass that is the object that we concluded that older adults associate better to this process (according to the tests performed and reported on Appendix A.1). The Zooming area is placed in the Player area (see Figure 4.6).

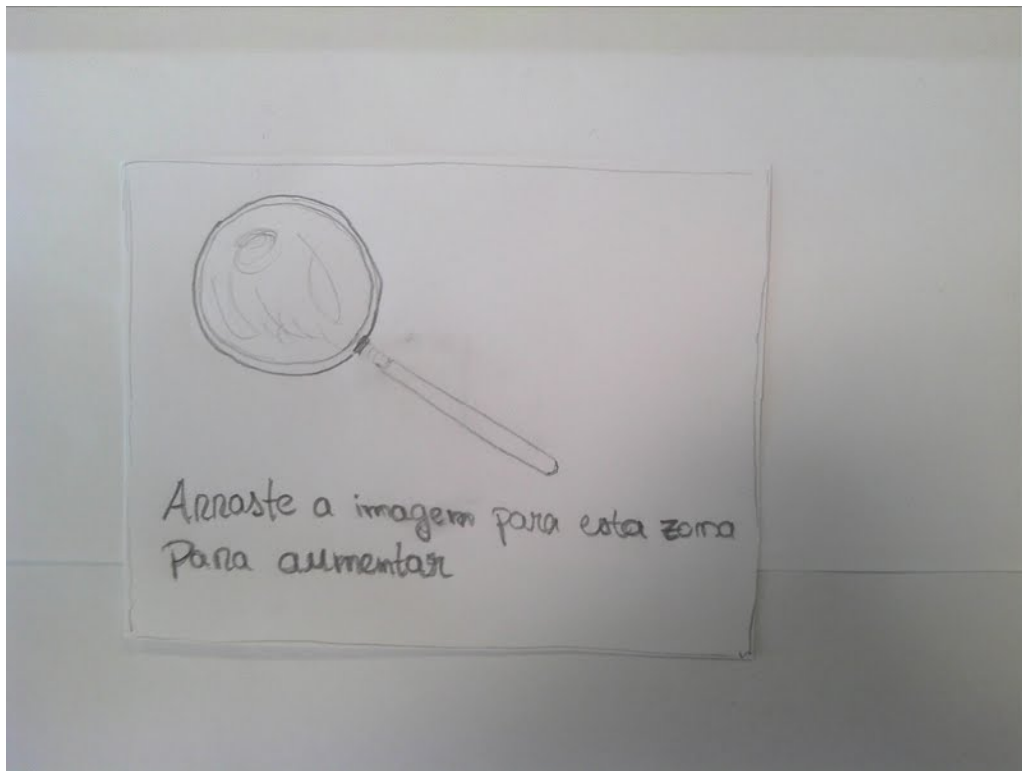


Figure 4.6: The Player Area containing the Zooming Area

2 – Zooming an image by the use of a tangible object – a magnifying glass

This process has the same objective of the previous, but it is applicable in other way. There is a tangible object that is recognized by the Tabletop, when it is placed upon one image. A tangible object is a physical object that allows the users to interact with digital applications. By means of physical and known objects, the user can interact with this type of technology in natural and intuitive digital interactions [Fit96, UI00]. The tangible object is shaped like a magnifying glass that, when is placed upon the selected image, transforms it, enlarging it (see Figure 4.7).



Figure 4.7: Zooming an image with a magnifying glass

The decision on this tangible object was also based on the results of the usability test (see Appendix A.1) that concludes that our test population associates the action of enlarging an image with a magnifying glass. This way, in our game, the users may also manipulate a magnifying glass, in order to enlarge the less viewable images.

The approach that will be tested with the final users on the tabletop is the last one, with a tangible object (see Chapter 5).

Changing images – Associated with the difficulty in understanding images by lack of something to enlarge them, it was also observed that the older adults did not identify some of the actions/objects that were represented in the images. With this in mind we found necessary to understand which images we should include in the game. Thus, from the informal interviews with the social educators and with the older adults, we identified some subjects that they regularly talk about or contact with. These are, for example, their past jobs (specifically farming, sewing), food (and kitchen), games, animals, music and

health care systems. This way, we prepared a game in which four participants played (see Appendix A.4). In this game we started by showing one word representative of one of the subjects referred above and we asked individually one related word to this subject. For example, we showed the word "Farming", we started by saying the related word "Hoe" and, individually the participants had started saying their related words. The game finished when nobody remembered more. With this game we obtained a list of words that guided us to the images to include in the game (this list can be consulted in Appendix A.4).

Introducing a validating system – Another thing observed was the older adults thinking aloud while choosing the images they want to collect and, sometimes, when they were not sure if they were collecting the correct image, they asked for confirmation: "Is this an image from my category?". Thus, we included in the system one area where they put their images and receive feedback about the assertiveness (correct/incorrect image). This area, named Album Area, has been placed near the "Zooming" Area, into each Player Area (see Figure 4.8). The name Album for this area was based on the object that the older adults use to store their life photos.

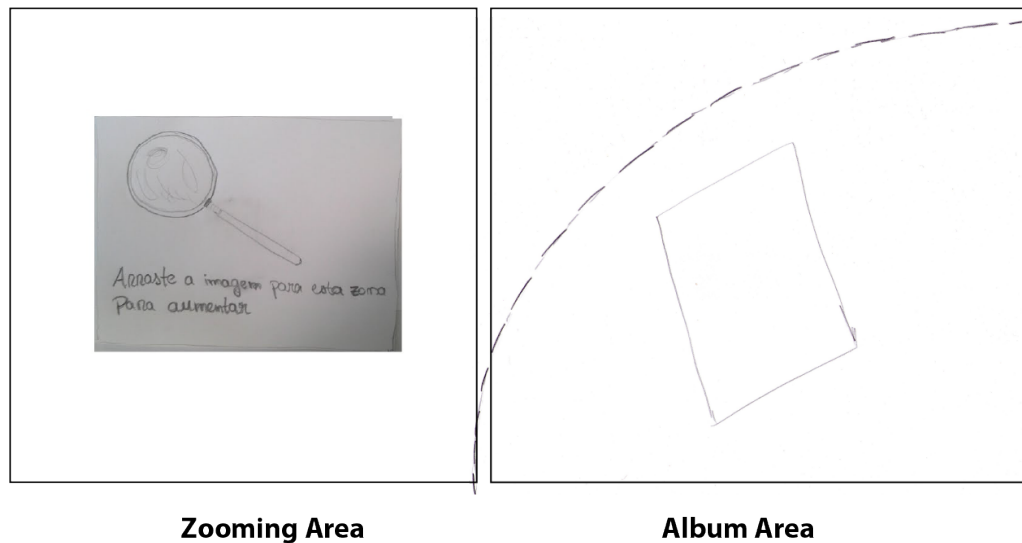


Figure 4.8: The Player Area

The main goal of the game is to find and aggregate all the images that match the categories the player is looking for. This way, this Album Area was identified as the place where the players may check his images.

Collecting an image is a functionality of the game that should be done by the participants while playing, in order to complete their goals. The process of collecting an image consists on choosing one image from the set of images laid-out in the center of the tabletop and dragging and dropping it into the defined area named "Album", in each

player area like we mentioned above. This process requires decision making inducing the players to decide on the images they want to collect.

When the image is dropped in the Album Area, two situations may occur

- The image is correct, because it matches the goal Category that the player is finding;
- The image is incorrect, because it is not part of that Category.

The system is responsible for giving feedback to the player's action. If the image is correct, the system accepts it and shows the message "Correct image" in message area; on the other hand, if the image is incorrect, the system shows the message "Wrong image", and additionally shakes it and returns it to the center of the table, below the other images (see processes [1] and [2], respectively, in Figure 4.9).

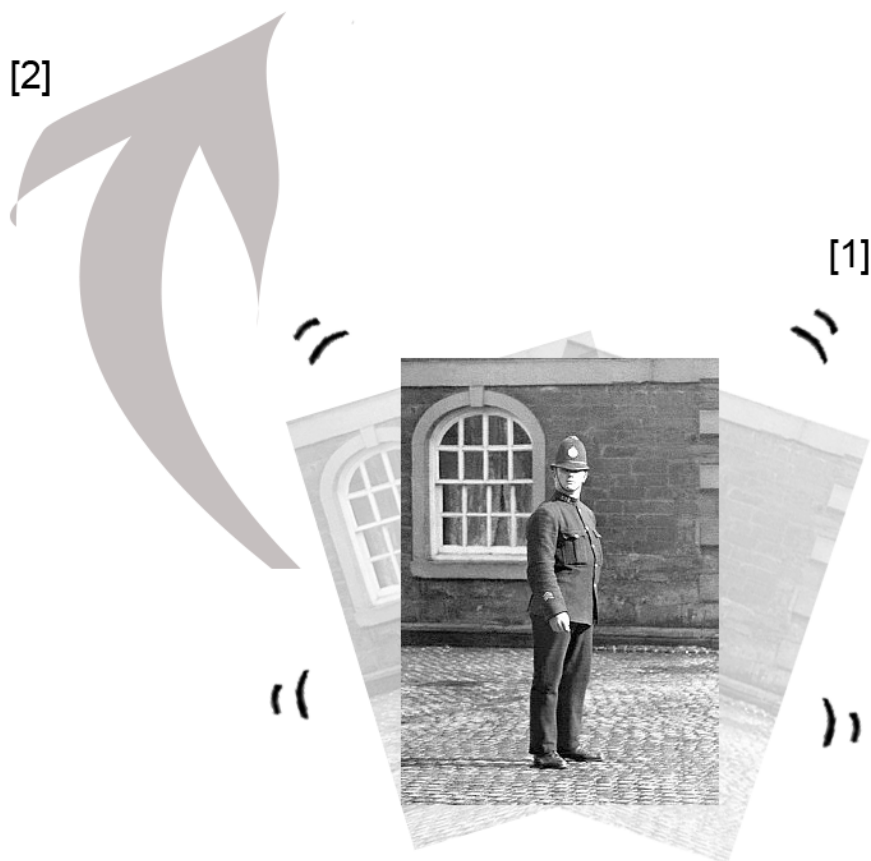


Figure 4.9: Wrong image

Even though the system gives the feedback to the user that he selects an incorrect image, it was defined that the process of returning the image to the center of the table

should be executed by the system, in order to avoid that the player keeps that image and does not allow the opposite team to complete his own goals. For example: Player_1 has the category Animals as goal and by error he finds and collects a Job image; the system gives feedback to Player_1 telling him that he misses and returns the Job image to the center, in order to avoid that the other team, which is finding Jobs, could not finish its goals because of the error of Player_1. This way, no player can be prevented from finishing the game because his opponent made an error (and did not recover from it by himself) that goes against his goals.

Therefore, the reason to exist a system that gives feedback to the player was based on these arguments:

- **Maintain the challenge of the game** – the player who misses the image may have another error with the same image and it can be used in the player's graphic of evolution (too much errors with an image);
- **Give feedback to the player** – the player observes that he misses or hits an image and that his score changes with it;
- **Do not prevent the other team to finish its goals** – the two teams have the possibility to complete their goals, independently from the opponent and each team has the same number of images to find.

When the participant collects an incorrect image, his score is decreased, and by noticing that, he will possibly try to make a better decision in next time. So, this functionality tries to avoid the continuous playing by trial and error, trying to force a better decision. This way, we placed the Album Area near the Zooming Area (see Figure 4.10).

Miscellaneous additions – From our observation we also concluded that the players were constantly counting the images that were collecting, and when they got seven images they asked the facilitator if they finished the game. With this in mind, it is possible to see in the Figure 4.10 that we designed an area where it is possible to see the number of images that the player already collected from the specific category. In addition, when the player hits all the images, he receives feedback saying if he won or lost the game.

There are also on the Figure 4.10 two fields that were not mentioned yet. These are the score and the assessable options during the game.

The assessable options during the game are three: one to exit the game, one that gives additional help to the game with its instructions and another where the players can request a game hint. If the players use the first one, a screen will open as pop-up asking the player if he is sure about exiting the game – this avoid the exit for error on clicking the button, asking for confirmation. The help button opens the instructions of the game. Lastly, the hint game button gives the player an instruction/goal to help him finding the missing

The game design

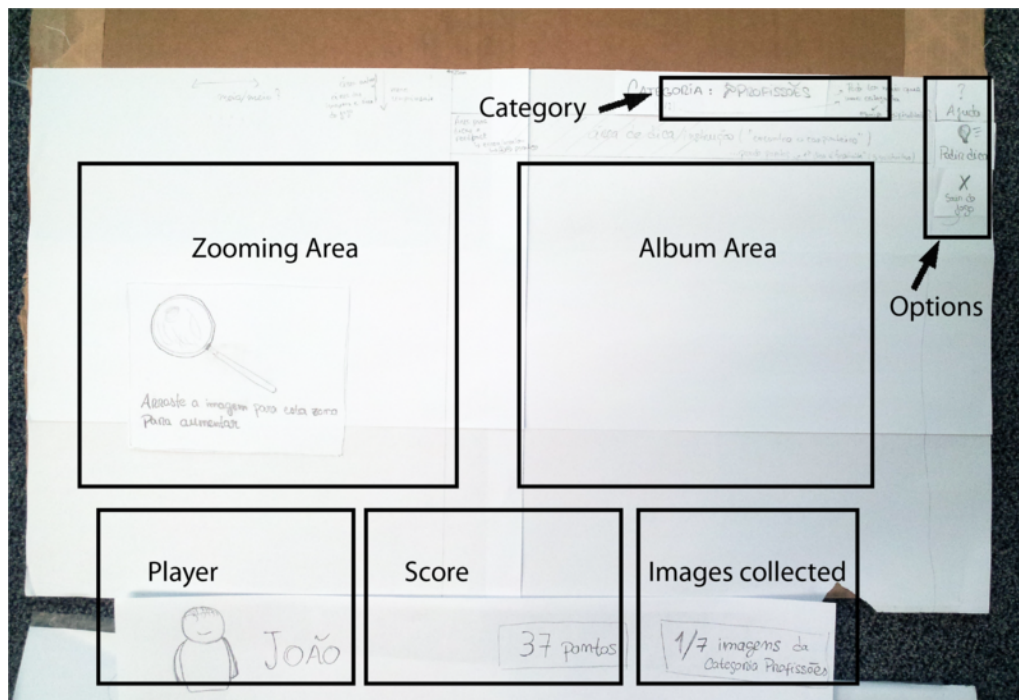


Figure 4.10: The player area: Zooming Area is placed near Album Area

images (for example, there is a missing image for the category animals and the player is not finding it: he requests an hint; the system responds him with "Try to find the Horse"); this instruction is written below the name of the category.

The score is a way to reward the players' actions. While playing each team has a game score associated. This score is displayed below the Album Area (as it is possible to see in Figure 4.10 and it is represented in Figure 4.11), next to the identification of who is playing. Thus, the player may always be aware of how is his score in the game and may have direct feedback about how it changes. The arrangement of this score display near to the Album Area is exactly to have the attention of the player focused in his actions. While he is collecting an image he can see the score associated with it.

The scoring system computes the current score of the team in the game. This calculation is based on five parameters:

- **Number of correct images** – during the game each team has to find images that correspond to the predefined category; this number counts the images that they collect and that belong to the category;
- **Number of incorrect images** – this number counts the images that the team tries to collect but are incorrect, i.e. do not belong to the category;
- **Number of combos²** – this number counts the sequences of three correct images;

²A combo (short for combination) is a term that designates a set of actions performed in sequence, usually with strict timing limitations, that yield a significant benefit or advantage [Wikib]

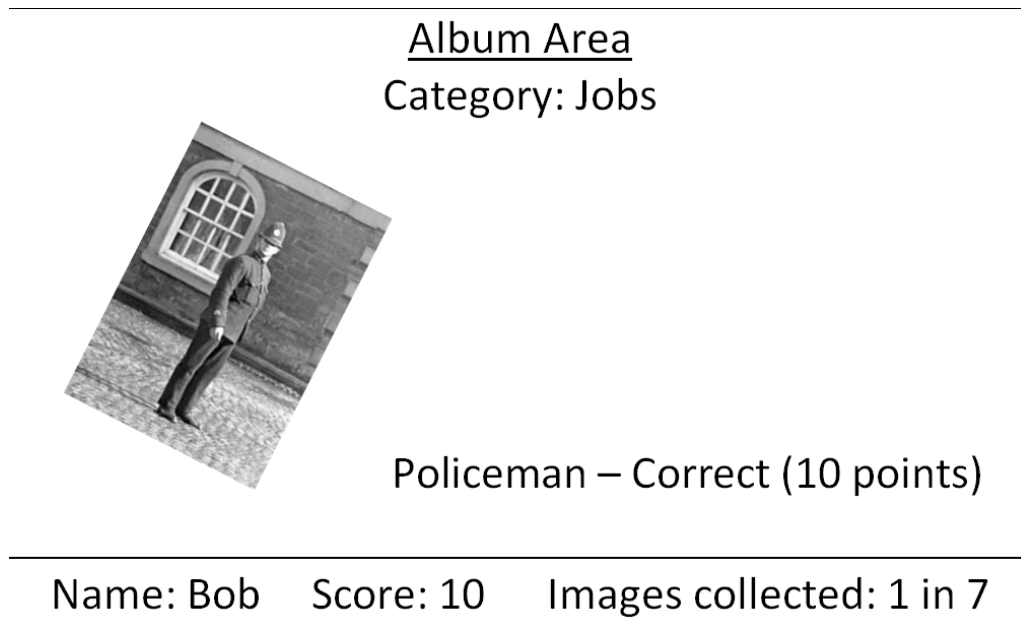


Figure 4.11: Album Area and Score

- **Number of game hints requested** – during the game, if the players are not able to find a missing image, they can ask for an hint; this number counts the number of hints requested during the game;
- **Time** – the time to finish the game influences the score of the team.

The game score calculation was based on our decision to value the correct tries and to prevent the wrong ones, when the players are choosing their images. This decision was supported by the study of previous games, designed for older adults, which had also an associated score to give them feedback of their current situation in the game and to give the opportunity of future discussion about player rankings, as a social interaction way [GMS⁺09]. The scoring rules we defined are represented on Table 4.1.

The time factor is defined in ranges, depending on the range of time the players finish the game (consult Table 4.2). These values have to be tested in the future in order to adapt to the average time that the players usually take to finish the game.

4.2.4 Menu interfaces

In this section we present the menus that give to the users the access to the game (see an overview of the flow in Figure 4.12 and, in large dimensions, in Appendix B). The user interfaces for these menus were thought to be based on the following considerations:

- To support the registration of the users in order to record their scores;
- To have an overview of the evolution of the players;

The game design

Action	Points	Notes
Selected a correct image	10	It was assigned by own decision.
Selected an incorrect image	- 4	It was decided to decrease score in minus than the middle from a correct image; the decreasing score tries to prevent trial and error when choosing images.
Selected consecutively three correct images	5	This bonus is higher than the decreasing score with incorrect collection, in order to encourage a better and thought decision when choosing an image.
Requests a game hint	- 2	It was decided that the first hint is offered to the player – we offer one hint in the game but we do not want a repeated request of hints, so we decrease the score after the first hint offered.
Game time	5 * time factor	It was decided to give bonus for the players who finish their goals earlier.

Table 4.1: The score attributes and its value in the calculation.

- To offer the players the instructions of the game before start playing.

Thus, three options arise in the first menu: "Start playing" (Começar a jogar), "See the instructions of the game" (Ver as instruções do jogo) and "See the best scores of the game" (Ver as melhores pontuações do jogo).

"Start playing" guides the user to the registration of the players, in which he can select the players of his team or create new players that will participate in the game.

"See the instructions of the game" is very important to help beforehand the users learning the rules of the game that will be played.

"See the best scores of the game" is also important to give the players an opportunity to compare their scores with the others. In addition they can have the perception of their evolution since the first game played.

4.2.4.1 Global considerations for the interfaces

Size of the text – As it was mentioned before, the older adults may suffer from vision impairments. Because of that, the text that is targeted for them must have large dimen-

Time to finish the game	Time factor
[0 to 1] minutes	[1 to 0.8]
[1 to 2] minutes	[0.8 to 0.6]
[2 to 3] minutes	[0.6 to 0.4]
[3 to 4] minutes	[0.4 to 0.2]
[4 to ...] minutes	[0.2 to 0]

Table 4.2: The time factor calculation.

sions. In our conditions, we wanted to know which was the minimum readable text, if we placed a word or sentence in the center of the Tabletop (the farthest place from where the older adults have to read because it is their menu limit). We decided to test different sizes in the center of the table with the users. Therefore, the usability test included one task that presented to an older adult a set of different words in different sizes (see Appendix A.3). These words were shown to the user that was sat near the table. Results showed that all the users were able to read, from the center of the table, at least in the 18pt text size. This way, we decided to present text at least with 20pt.

Icons – It was defined that, any option button of the menus should have associated the title of the button and a suitable icon. Icons will help illiterate users to complete the menus, because sometimes they are easier to distinguish than words [Nor91]. However, it can also ease the choosing of menus by any user, if the icon is suitable to the expression. This way, both the expression and the icon should make sense to the older adult. The older adult should be capable to choose one option by understanding its mean. Therefore, it was important to test several expressions and icons to make sense for older adults. Thus, we tested specific icons and expressions with the older adults during our design (see, for example, the usability test #1 in Appendix A.1).

4.2.4.2 Initial Menu

The Initial Menu is the main menu of the game (Figure 4.13). This is the first screen that appears when the user enters the game. It looks like a simple menu and this is our goal: to simplify things. However, this menu and the following ones have a shared property. They have been tested with a sample of end-users in order to adapt to their words. It is important to understand that to different backgrounds correspond different vocabularies. For this reason the Initial Menu was iterated in two usability tests (see Appendix A.8 and Appendix A.9). The issues studied in the usability tests included the names of the options and the posterior navigation test.

The options of the menu were defined earlier. Since this is the first menu of the game, the players must have the possibility to advance to the game, but also to view the instructions of the game if they did not play before or the to consult the previous scores

The game design

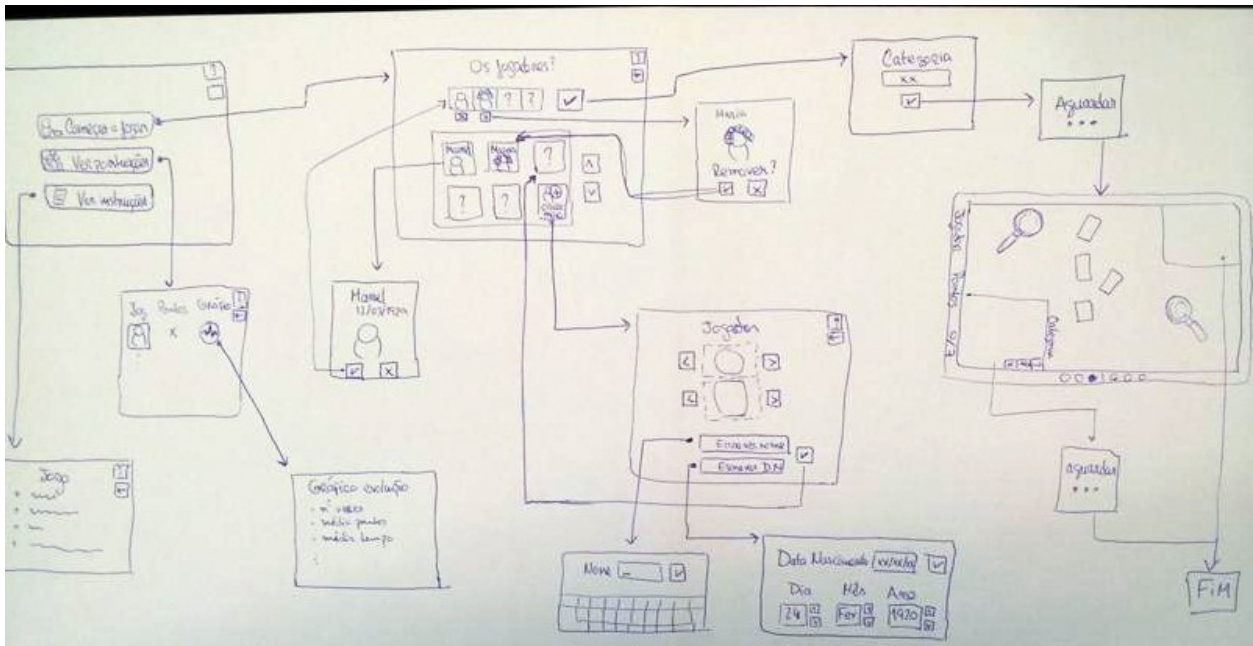


Figure 4.12: The flow of the menus' interfaces

in order to compare to their friends. Having the menu options defined, it was important to find the names for these functionalities that were the more meaningful possible to the older adults. Thus, we prepared usability tests in order to offer alternatives to our target audience, but also open to their suggestions. We prepared the eighth usability test (see Appendix A.8) to evaluate the suitable names for the options (see Table 4.3). The older adult was asked to imagine that he was starting to play a game. Then, it was explained each functionality of the menu and what it could enable in the game. The participants were shown different names for this functionality and asked to choose one or to suggest another. Results have shown that the functionalities were easily understood. These were simple options for the menus. The functionality "To play" was understood by all the participants. They associated the expression Start Playing (Começar a jogar) to this functionality. However, one participant also suggested Go to the Game (Ir para o jogo) as an option. The functionality "To see the scores" was understood after the facilitator tells that they would punctuate in the game. In this context, the option See Game Scores (Ver as pontuações do jogo) was chosen by most of the participants. The third functionality, "To see the instructions", was also understood by the participants. It was said that they did not know already how to play the game. It was their first time. Most of the participants chose the option See Game Instructions (Ver as instruções do jogo) as better expression to know how to play.

In the usability test described above, we defined the functionality names for the initial menu. However the whole menu (with the three functionalities together) has not been shown to the participants. In this context, we prepared another usability test (see Ap-

The game design

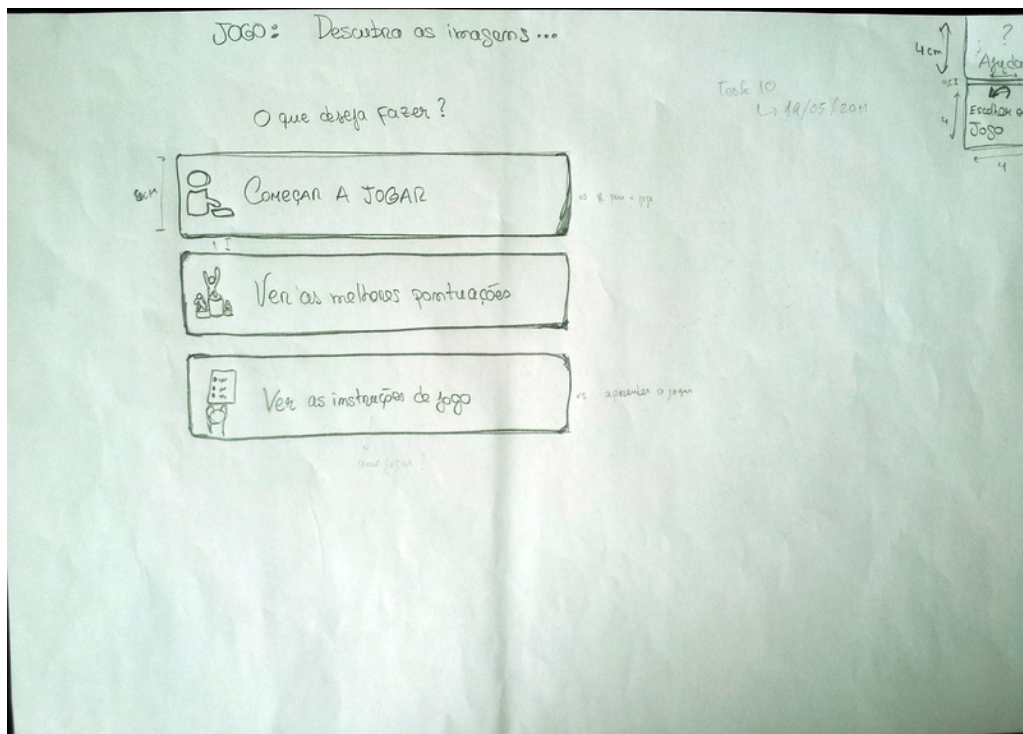


Figure 4.13: Initial Menu

pendix A.9) where we showed the Initial Menu with the three options to the participant. It was asked them to touch in a particular menu option and it were registered the errors on finding it. For example, the facilitator of the test asked the participant to choose the option that guided him to the game; thus, it was registered the number of times that the participant did not touch the option Start Playing. This test allowed us to conclude that the three options of the initial menu (that were obtained by the feedback of the end-users) were suitable to their words.

4.2.4.3 Choosing Players Menu

The Players Menu is the one that appears when the players choose the option "Start Playing" (see Figure 4.14). This is the menu where the users register themselves as players of the game. They have the possibility to play alone or to play as a team, by choosing one or more players from the list of players. The players selected to play will appear on the area "The players" represented on the Figure 4.14. If in the "The Players" area there is a player that will not play, the users can remove it by clicking the "Remove" button placed below the player info. After having the game players in that area, the users may confirm them and play by clicking the "Confirmation" button.

"The List of players" is always represented by six squares. This decision was based on the "The Magical Number Seven, Plus or Minus Two" model described in the section 2.1.1. The first five squares represent users that already played the game and the last

Functionality	Option 1	Option 2
To play	Começar a jogar	Jogar
To see the scores	Ver pontuações do jogo	Ver pontos dos jogadores
To see the instructions	Ver instruções do jogo	Aprender a jogar

Table 4.3: Options for the Initial Menu.

one is the option "Create New Player". The users may navigate in the "List of players" through the arrows placed next to that area. The users are alphabetically sorted. If the user is already registered, his information will appear in one of the first five squares. The user is responsible for choosing his player by clicking in his "Player register". In order to avoid errors in choosing players, after clicking in the "Player register", the user is asked if this is really his player (see Figure 4.15). After confirmation, he will join the list of game players represented by "The players" on the Figure 4.14. If the user did not play the game before, he will not have a "Player Register". In this case, the user may create his player register by choosing the option "Create New Player" (Criar Novo Jogador) that is shown in Figure 4.15 as "New Player" (see the Creating New Player Menu in Section 4.2.4.4).

4.2.4.4 Creating New Player Menu

In order to register himself in the game, the user must insert his data (name and birthday) to help him find his player in the next time he plays (see Figure 4.16). To make this process enjoyable, besides the introduction of player name and birthday, we also introduced the possibility to create an avatar (the avatar was tested on Appendix A.10, in order to evaluate if the older adults enjoy the idea of creating one; it was also our goal to understand if they prefer to create the whole avatar or to choose one from an existing list). Results have shown that the avatar could be an enjoyable option in the Player Registration. However, there was only one participant that would like to create his own avatar and three participants that would like to choose one pre-created. This way, we opted to have an avatar split between head and trunk (see Avatar on the Figure 4.16). Thus, the players can change their avatar by changing its head (Avatar's head on the Figure 4.16) or trunk (Avatar's trunk on the same figure) with the arrows placed near this area.

As it was mentioned before, the user may also insert his name and birthday, in order to create his player and recognize it in the second time he plays. With this in mind we created two options placed next to the avatar:

- To write my name (Escrever o meu nome);
- To write my birthdate (Escrever a minha data de nascimento).

These two functionalities were tested on UT6 and UT7 (see Appendix A.6 and Appendix A.7), respectively. Results shown that the proposed input methods for both data –

The game design

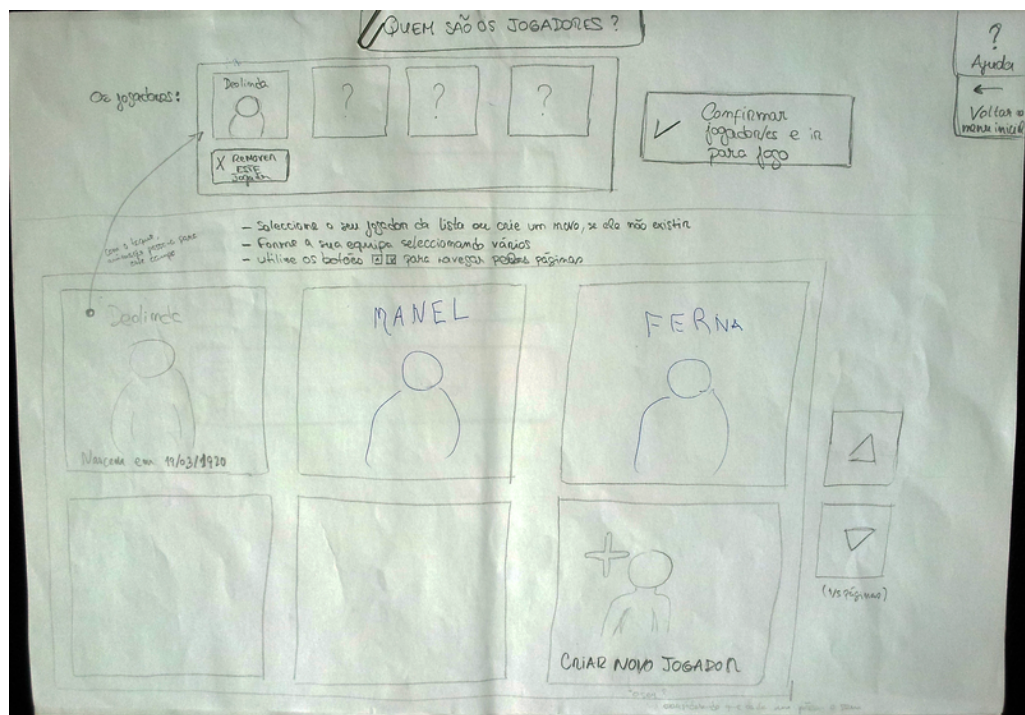


Figure 4.14: Players Menu

name and birthdate – were suitable for the older adults (see the prototype for input data on Figure 4.17).

Finishing the creation of the player, the user will be able to select the option Create Player (Criar Jogador) that will guide him to the Choosing Players Menu. His player becomes one of the game players in that menu.

4.2.4.5 Other menus

In addition to the menus explained above, there are others in the system that have the purpose of inform the user. The menus are presented depending on the options chosen by the players on the menus presented above. For example:

- Help Information Screen – when the player asks for help by clicking in the help button that have a question mark (see Appendix A.1), it appears a pop-up with the useful information in order to complete this menu;
- See the best game scores Information Screen – at the beginning of the game, the player may consult the best scores of the players that have already played the game. This screen is thought to have the position and the names of the players, their score and graphic information about the evolution of the player in the game; however we do not have yet a prototype of this menu (see the future work in Chapter 6);

The game design

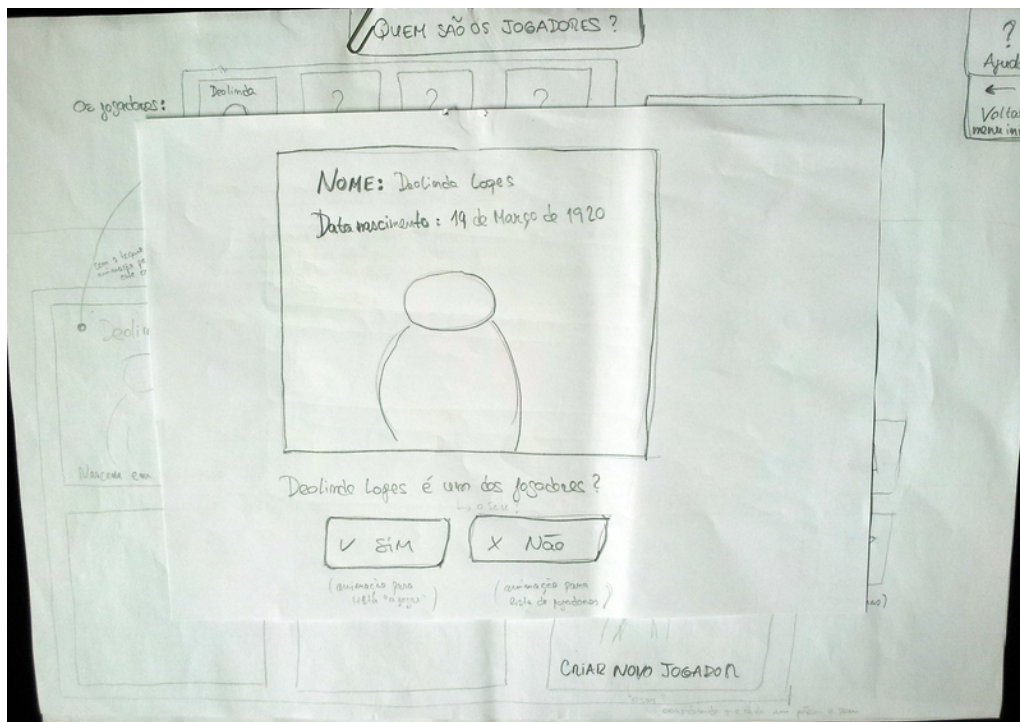


Figure 4.15: Player confirmation – it is asked to the user if this register matches his player.

- See the instructions of the game Information Screen – at the beginning of the game, the player may consult the instructions of the game in order to learn how to play it. He can do it by clicking in the instructions button (see Section 4.2.4.2) and it appears in a pop-up an information screen with the rules of the game;
- Category Information Screen – When the players, in the Choosing Players Menu (see Section 4.2.4.3), choose the option to advance to the game, it will appear an information that gives them the category that they have to search in the game;
- Wait Screen – If there are two players, when one of them completes all the menus, it will have to wait for the opponent to finish its menus; this way, this team will have a display that informs it that it should wait for the opponent.

4.2.5 Evaluation

The evaluation of our game and its menus was done through user-based evaluation. At the beginning of the project, when it was established the use of UCD as design methodology it was clear that the evaluation of design decisions and prototypes should be done with users (see Chapter 3). This section presents the recruitment issues and the test sample.

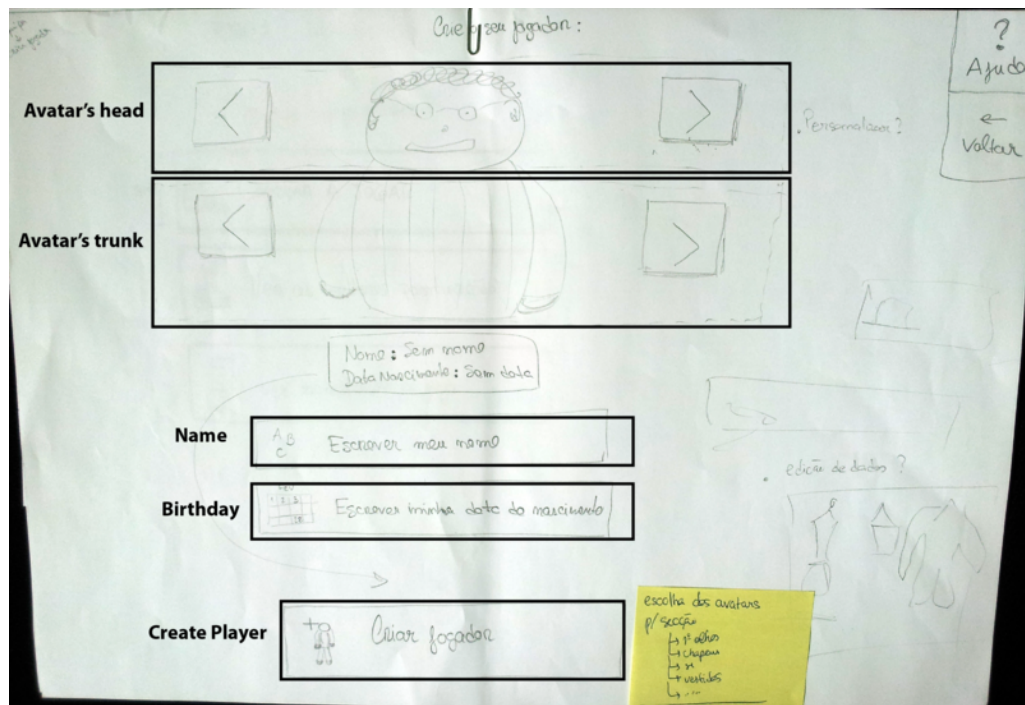


Figure 4.16: Creating new player Menu.

4.2.5.1 Recruitment issues

As stated earlier, the target audience of the project is the older adult. Given the clear differences between the persons, it became difficult to define what an older adult is (see Section 2.1). However, it was pointed that the retirement age could define the older adult. At this moment, it became necessary to define the participants to include in the tests. This way, the author considered to include a diverse sample of users.

The place chosen to recruit this sample of users was a day care center that usually supports people on that age range that constitute a varied sample. These institutions are places where the older adults come during the day and that promote social and individual activities and games. In addition, the senior citizens that resort to this place are still independent and maintain their active life.

All the usability tests were performed on one day care center in Porto with the collaboration of the social educators of this day center. Besides planning activities for the older adults, they were asked to manage the communication between the author and the centre. During the first tests they were also asked to help recruiting the users.

4.2.5.2 Sample description

The sample of the usability tests participants totals 12 older adults from the day care center. The average age is 76,8 years. The younger participant is 64 years old and the elder one is 84 years old. The level of education of these participants is not so diverse: no

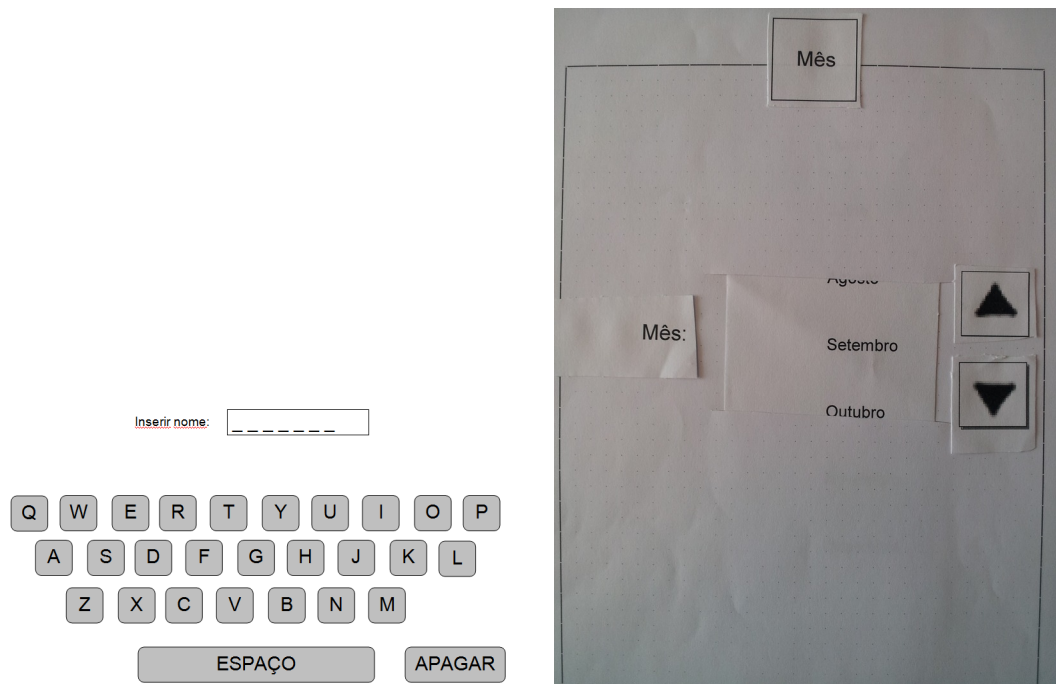


Figure 4.17: Keyboard input for Insert Name and Month input as an example of Birthdate input.

education (8%), primary school (75%) and high school (17%). Their background is very diverse with past professions like: office worker, seamstress, housemaid, farmer, factory manager, professor. Only two of the participants are male.

4.2.5.3 Test methodology

There were conducted ten usability tests, performed twice a week (see the Usability Tests on Appendix A). Because of the difficulties recruiting participants, the performed test with minimum participants was done with three and the maximum with eight.

Each usability test was prepared before the testing day. It was associated to a set of variables that the author wanted to measure in order to evaluate and improve the prototypes.

After a test was finished, the author has reflected on the results. This way, the requirements of the game and menus were adjusted to incorporate the results of the tests in a redesign of the interfaces.

4.3 Summary

It has been mentioned that we wanted to design a game that could promote the well-being of older adults. To do this by taking advantage of a large tabletop's surface, offering a more intuitive user interface. With this in mind, we wanted to align the goals of the game

with the goals of health, as Debra Lieberman suggests in her literature (see [Lie05]). Thus, some of the functionalities of the game were thought in order to stimulate certain attributes of older adults that change with the age or to avoid difficulties on using new technology because of age-related impairments. These functionalities were explained during the chapter and the main of them are going to be resumed in this section. The main opportunities we found to stimulate or to avoid problems when playing the game are:

- *To train motor skills* – The players have to collect images from an area that is not placed next to them and have to drag and drop these images in the closest area;
- *To adapt to vision impairments* – The players do not have to make effort if they cannot see clearly an image; they have the possibility to enlarge it using a magnifying glass. The text options and buttons of the game are large;
- *To stimulate recognition and semantic memory* – The images that the players are looking for were chosen considering things they remember or are likely to remember;
- *To encourage decision making* – The game score of one player is decreased if the player collects an incorrect image; it is given feedback of that situation in order to advise the player that he is losing points;
- *To train spatial vision and attention* – The large area that the players interact asks for his attention and spatial vision in order to find the images that he is looking for and also the incorrect images that the opponent tried to collect;
- *To promote cooperative game and social interaction* – Playing in groups and teams and the possibility to compare the game scores are a way to promote social interaction between the participants.

As a conclusion, we also want to underline the parameters that we had in mind and that we took advantage of while designing the game for older adults:

- Direct Input Device and Natural User Interface;
- Expandability;
- Goals;
- Feedback;
- Rewards;
- Social Interaction;
- Unique Interface Design.

The game design

Chapter 5

Results and discussion

The game designed during the iterative design process was defined and explained in the Chapter 4. However the final version was not tested. Thus, at the final of its definition, we tested it with the end-users. We found that it would be grateful and more reliable if we tested a final computer-based prototype, instead of giving back to the community only its study and definition.

Our project was developed in parallel and cooperation with another one named "Development platform for elderly-oriented tabletop games", developed in the scope of another Master's Thesis at the same institution. While the project presented here focused on the game design and the implementation details of its mechanics, the parallel project focused on the development of a basis framework for game development in tabletop devices. This development was carried out in cooperation with this thesis, so that functionalities indentified through the feedback obtained in the design cycle could be integrated in the framework. Thus, some of the menus and the functionalities of the game were iteratively implemented on the tabletop. This way, we prepared a final visit to the social center with an high-fidelity prototype of the game, on the tabletop. This final visit aimed the validation of the game itself by understanding the possible limitations that may have to change. At this time, the mechanics of the game were already implemented, but the menus were only partially implemented.

The tested menus included (see its definition on section 4.2.4):

- Initial Menu;
- Help Information Screen;
- See the instructions of the game Information Screen;
- Category Information Screen;

- Wait Screen.

The tabletop's implementation was based on the design that we presented on Chapter 4 and on the design of medium-fidelity prototypes with the scales that should be used, considering the dimensions of the tabletop. A mockup of the game was designed (see on the Figure 5.1).



Figure 5.1: The game mockup

It was defined a priori that we should follow a test protocol in order to guide the older adults during the first time dealing with the game. We only had to recruit some participants from their living room to ours and to explain that we were there to show the actual results of their participation. With the motivation the participants have integrated the game, we needed only to guide the options they could access during the game, and we took notes from what was happening.

The participants had sometimes problems while touching the interface objects, due to limitations of the tabletop dealing with the environment that had strong lights on the ceiling. Some adjustments were needed on the device. Apart from that, the users' interaction with the tabletop was done in acceptable conditions, mainly due to their motivation to play and to interact with the "unknown" device.

Initially the participants were presented with the menus of the game. The Initial Menu only had two options ("Start Playing" or "See the Instructions"). All the options were clearly read and after reading aloud and understanding the instructions of the game, the participants chose to play the game (see Figure 5.2). The help button on the upper right corner was considered small and not clearly visible; it would be necessary to increase its size or to correct the icon colors in order to give more contrast to the button. It would also be helpful if the button was not too distant from the player.



Figure 5.2: The participants interacting with the game menus

When entering the game, the system showed a message with the information of the category that each player should search for. The participants have read it clearly and memorized by saying it loud until the appearance of the interface of the game that had the name of the category written upon the Album Area.

During the game the participants have used the magnifying glass¹ few times, in order to enlarge the images. The images were mostly clear for them. On the other hand the visual representation of the magnifying glass on the system was not clearly understood. However when they used it, they became pleased for seeing it better (see on the Figure 5.4; one participant is interacting through the tangible object and the other through touch). To dissipate the confusion associated with the purpose of the object two approaches are proposed: to change the paper object for a real object with the shape of a magnifying glass, or to try the approach proposed on the Section 4.2.3.1 – Adaptation to vision impairments, *Dragging and dropping the image to a specific area*.

Regarding design aspects, there were some details that were thought and described during the design process (see Chapter 4) but that were not represented on the prototype used. The participants revealed the need of these details. For example, in this prototype, the images were accepted in the Album Area even if they were only half into the area; the participants kept arranging them to put the entire image in the area – the system should only accept an image if it is totally inside the area. The feedback messages were not represented upon the Album Area like it was defined in the design (see Section 4.2.3.1 – Introducing a validating system), they were represented in the Zooming Area where the participants laid-out their arms, and the participants rarely read them – the system should present these messages upon this area, or, as another possibility, they could be displayed upon the image itself by showing how much the image was worth in points. Another

¹The magnifying glass was created in a paper-based prototype (see Figure 5.3). It had a handle to ease its use and it had a magnifying glass printed in its top, in order to be identified.



Figure 5.3: The magnifying glass in a paper-based prototype

observation was that people positioned their arms in the corners of the table; thus, the score information may appear in the center of the player information (see Section 4.2.3.1 – Introducing a validating system) instead of appearing in the corner as it was implemented in the high-fidelity prototype. At the beginning of the game the player information about the number of images captured was not understood (i.e. with the "1/5 images" was not understood that are still four images to collect); over the course of the game it became understood, however we propose to change it to "There are still four images" information.



Figure 5.4: The participants interacting with the tabletop through different inputs: touch and tangible object.

The most rewarding aspect that was observed was related with the social interaction and mutual support that the older adults have shown during the game (see Figure 5.5). Even the older adults who were not playing were trying to help the participants collecting the images and explaining the game. When finishing the game, the players consulted the game scores and were discussing who had won. With this in mind we consider the multi-player game or group game as a viable option for social interaction stimulation.

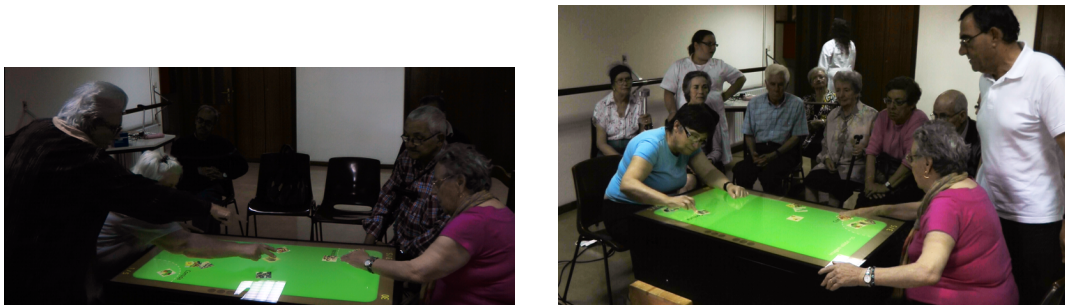


Figure 5.5: The participants, mutual support and social interaction.

As final issues, we underline that the players felt motivated to play the game and also the social educators have manifested the interest on the subject. The game concept raised challenges to the players and kept them involved in the game. After playing the game one of the participants that had become interested had the initiative to invite more people from the living room. The social educators have referred that the game is interesting and challenging and that the tabletop could be an enjoyable way to offer older adults more games and activities and keep them enthusiastic. Thus, with the suggested changes, we consider that the game is on the right track to success.

Results and discussion

Chapter 6

Conclusions and future work

The aging population phenomenon is well known. In the future, there will be even fewer young people supporting the aged population. The older adults have to maintain their activity in order to be independent and to maintain their quality of life.

New technologies are emerging and have been contributing to enhance people's health. This technology growth has not only been noted in the field of health but also improved the way that people interact with others by the growth of social networks, transports, etc. On the other hand, the games have been and are part of the older adults' life who use the games as a way of spending time with their friends or relatives.

Considering this, this dissertation joins the older adults with the technology by using games that stimulate their cognitive, physical and psychosocial functions in order to promote their well-being. Thus, it has one main objective: the analysis, design and evaluation of an elderly game on tabletop interfaces.

At the beginning of the project, it was known that designing for older adults would be a challenge. It is different from designing for any other age group. It is noted fewer use of technology by older adults than the younger adults. The older adults do not use technology if they not see benefits of using it. On the other hand, sometimes they do not use it because they are not able to; they face barriers in its use due to finding systems that do not suit their characteristics and needs.

Considering the difficulties found on designing for older adults, the methodology adopted at the beginning of the project was User-Centered Design, in order to put them at the center of the design process. Thus, the game design for tabletops has considered, since its beginning, the older adults, their characteristics and their needs. In this context, it was used user research, informal observations and interviews, low-fidelity prototypes and user-based evaluation as methods of the design process (see Chapter 3).

The investigation on older adults' specificities was documented on 2.1 and was based on the user research method. It was based on the review of the literature, mainly on the age-related changes as physical, cognitive and psychosocial changes.

There were conducted informal observations and interviews with elderly people and their social educators, in order to complement the investigation on older adults' specificities. It was done mainly to understand the older adults' daily activities and their importance, their needs and the subjects they like to remember (see Section 4.2.1 and 4.2.2).

Having an understanding of the target audience, was designed a low-fidelity prototype of the elderly game for tabletop interfaces. This design process was iterative and has changed with the feedback of user-based evaluation (see Section 4.2).

The process of design was iterative by presenting its parts to older adults and redesigning them according to the user-based evaluation. Thus, it was believed that these parts had been designed suitable to the end-users. However, it was the final visit to the day care center that validated the actual final product. It was conclude that it is on the right track to success (see Chapter 5).

The game was presented as a well-being promoter for older adults, by:

- *Training motor skills;*
- *Training spatial vision and attention;*
- *Avoiding vision impairments;*
- *Stimulating recognition and semantic memory;*
- *Stimulating decision making;*
- *Promoting cooperative gaming and social interaction.*

As future work related with the game, it is planned to design the backend of the game, i.e. a monitoring system that computes and generates a graphic with the evolution of the game players based on the score attributes: correct and incorrect images captured, game time, game hints, game combos. This system will generate a player evaluation graphic that will be able to consult on the Game Score Information Screen, which has also to be designed. It is also planned to support other categories in the game and to understand the possibility of personalize the game, in order to play with images of the participant's relatives and family. It would also be interesting to integrate a sound system instead of text system that gives feedback to the users when they are collecting correct/incorrect images; these sounds have to be tested with the end-users.

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Appendix A

Usability Tests

This appendix presents the usability tests and their results that helped guiding our design process. There are described ten usability tests.

A.1 Usability Test #1 – Zooming Images

In the first test, it have been already observed the game playing with the paper prototype (see 4.2.3). For this reason, it was important to evaluate the word and the icon more suitable to the functionality of zooming an image. Thus, it has been evaluated.

A.1.1 Test protocol

Hi, my name is Luís Ferreira and I am studying informatics engineering. I am finishing my Master and my final project is targeted to you, the older adults. I have to design a game that would be suitable to be played by you. Therefore, I need to design it considering your characteristics and your help will be very grateful. What I ask you is only need to participate in the games and activities that I bring for you and answer some few and small questions in order to help me clearing some doubts.

Thus, this week and in the following ones, I will make some activities with you that will not keep much of your time.

Now that I have explained the goal of my project and my dependence on your help, I would be very grateful to know if you are available to participate on some of the activities that I brought today. It is important to refer that this process is not a test or evaluation of your capabilities; it is only a way of understanding how the game should be designed in order to suits your characteristics or preferences.

Now that you have accepted to participate on the activities, I would like to know a little more about you and your background, because of statistics reasons. I ask you your name, age, your last profession, your level of studies and what type of glasses do you use.

A.1.1.1 1st Task – The word associated to the zooming functionality

For our first activity I will tape an image in the center of the table, where you probably will not see it clearly.

«An image of a policeman with small size is taped on the table.»

Yes, it is not clearly visible. Thus, I ask you to imagine that it is possible to see it better if you choose one of the following expressions. I ask you to choose one, and I will turn the image clearly visible. :M1

«The following expressions are taped on the table: Enlarge Image (Ampliar Imagem), Increase Image Size (Aumentar Imagem), Become Larger (Tornar Maior), See Better (Ver Melhor) and Stretch Image (Esticar Imagem).»

Excelent choice. Do you have any other suggestion for that expression? :M2

We have finished the first activity the results will help me defining the better expression for doing this functionality.

A.1.1.2 2st Task – The icon associated to the zooming functionality

Now we will start a relationed activity. If you have again an image in the center of the table that you do not see it clearly, but you cannot read the expression I have shown, I ask to choose not an expression but an icon that will turn the image clearly visible. :M3

«The following icons are taped on the table: Magnifying glass (Lupa), Glasses (Óculos), Stretching Image (Imagem a esticar) and Redimensionable Image (Imagem redimensionada) – see on the Table A.1!»

Excellent choice. Do you have any other suggestion for one object that remembers this functionality? **:M4**

We have finished the activities for today. Thank you very much for your participation. I will vere grateful if you continue collaborating with us.

A.1.1.3 Measured Variables

:M1 – The suitable expression for the zooming functionality.

:M2 – Suggestions for expressions for the zooming functionality.

:M3 – The suitable icon for the zooming functionality.

:M4 – Suggestions for objects for the zooming functionality.

A.1.2 Materials

In this subsection are presented the icons used on the 2nd taks of this Usability Test.

Qual o ícone que melhor se adequa à função de ver melhor uma imagem?

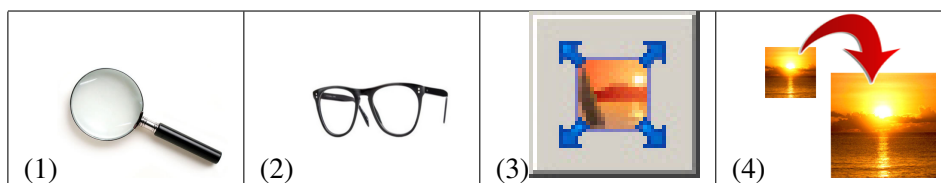


Table A.1: What is the icon that represents the zooming functionality? Magnifying glass (Lupa), Glasses (Óculos), Stretching Image (Imagem a esticar) and Redimensionable Image (Imagem redimensionada)

A.1.3 Results

In this section are presented the results gathered from the first Usability Test. The names of the participants are not refered in order to maintain their privacy.

For the expression, we opted for the Increase one and the magnifying glass is clearly the associated object.

Usability Tests

Name	Chosen Expression to see better the image	Suggestion for this expression	Chosen Icon to see better the image	Suggestion for this icon
ParticipantMS	Enlarge or Increase	-	Magnifying Glass	-
ParticipantFM	Enlarge	-	Magnifying Glass	-
ParticipantDC	Enlarge or Increase	-	Magnifying Glass	-
ParticipantBR	Become Larger	-	Magnifying Glass	-
ParticipantMF	See Better	-	Magnifying Glass	-
ParticipantC	See Better	-	Magnifying Glass	-
ParticipantAL	Enlarge	-	Magnifying Glass	-
ParticipantA	Enlarge	-	Magnifying Glass	-

Table A.2: Results of the two tasks of this Usability Test.

A.2 Usability Test #2 – Farthest reachable point on the tabletop's surface

The observation of the game allowed to understand that the dimensions of the tabletop could be inappropriate to have four player areas. Thus, this test allowed to understand the area that the older adults reach on the tabletop's surface, in order to adapt the interfaces.

A.2.1 Test protocol

Hi, my name is Luís Ferreira and I am studying informatics engineering. I am finishing my Master and my final project is targeted to you, the older adults. I have to design a game that would be suitable to be played by you. Therefore, I need to design it considering your characteristics and your help will be very grateful. What I ask you is only need to participate in the games and activities that I bring for you and answer some few and small questions in order to help me clearing some doubts.

Thus, we are going to continue making some activities that will not keep much of your time.

Now that I have explained the goal of my project and my dependence on your help, I would be very grateful to know if you are available to participate on some of the activities that I brought today. It is important to refer that this process is not a test or evaluation of your capabilities; it is only a way of understanding how the game should be designed in order to suits your characteristics or preferences.

Now that you have accepted to participate on the activities, I would like to know a little more about you and your background, because of statistics reasons. I ask you your name, age, your last profession, your level of studies and what type of glasses do you use.

A.2.1.1 Preparation

«To place a chair next to a table.» «To measure the height of the chair and the table.» **:M2**
«To laid-out a paperboard with some vegetables and fruits on the table.» «The paperboard have the following vegetables and fruits: Carrot (Cenoura) (at 10 cm), Lemon (Limão) (at 20 cm), Lettuce (Alface) (at 25 cm) , Corn (Milho) (at 35 cm) , Strawberry (Morango) (at 40 cm) , Pumpkin (Abóbora) (at 50 cm) and Tomato (Tomate) (at 60 cm) .

A.2.1.2 1st Task – The farthest point

In this activity I will ask you to sit in this chair and to be relax.

Then, I have a little game that consists in telling you some names of vegetables and fruits and you will have to search them on this paperboard, touching it with your finger. «Then, the vegetables and fruits were asked and it was registred the farthest one.» **:M1**

Very well.

We have finished our activity for today and the results will help me defining the distance were I have to put the elements of the game.

A.2.1.3 Measured Variables

:M1 – Measure the average reachable area.

Usability Tests

M2 – Measure the environment conditions: chair and table heights.

A.2.2 Materials

In this subsection is presented the paperboard used on this Usability Test A.1.

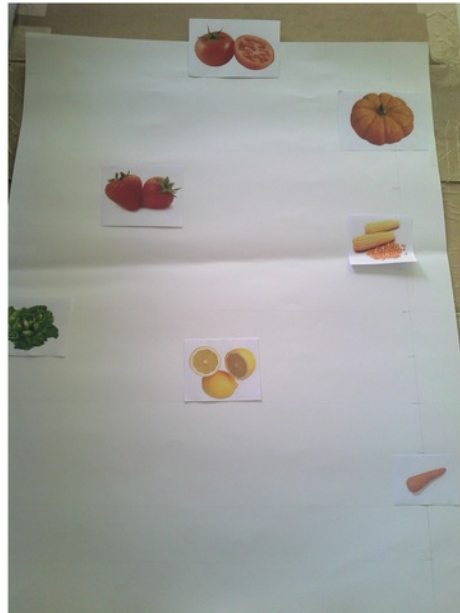


Figure A.1: The paperboard

A.2.3 Results

In this section are presented the results gathered A.3. The names of the participants are not referred in order to maintain their privacy.

Name	Farthest vegetable	Arm	Effort?	Notes
ParticipantMS	Tomato	Right	No	-
ParticipantFM	Strawberry	Left	No	-
ParticipantDC	Pumpkin	Right	Yes	have leaned on the table
ParticipantBR	Tomato	Right	Yes	have leaned on the table
ParticipantMF	Pumpkin	Right	Yes	have leaned on the table
ParticipantC	Pumpkin	Right	No	-
ParticipantAL	Tomato	Left	Yes	have leaned on the table
ParticipantA	Pumpkin	Right	Yes	have leaned on the table

Table A.3: Results of the Usability Test.

The tabletop's dimensions and the environment of the test are represented on the Figure ??.

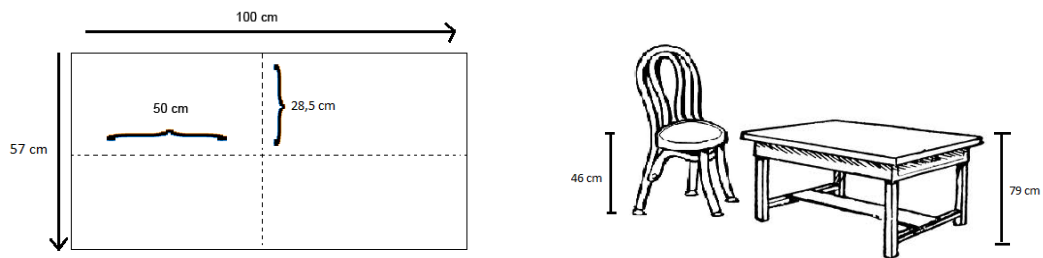


Figure A.2: Tabletop's dimensions and Test environment

Considering the results of the test, we have done an average of the farthest point achieved by the older adults and it resulted on 49,4 cm that is approximately half tabletop's dimension.

A.3 Usability Test #3 – Minimum readable text size

With this test we wanted to know what is the minimum readable text size that we could use in the farthest area for the participant – the center of the table.

A.3.1 Test protocol

Hi, my name is Luís Ferreira and I am studying informatics engineering. I am finishing my Master and my final project is targeted to you, the older adults. I have to design a game that would be suitable to be played by you. Therefore, I need to design it considering your characteristics and your help will be very grateful. What I ask you is only need to participate in the games and activities that I bring for you and answer some few and small questions in order to help me clearing some doubts.

Thus, this week and in the following ones, I will make some activities with you that will not keep much of your time.

Now that I have explained the goal of my project and my dependence on your help, I would be very grateful to know if you are available to participate on some of the activities that I brought today. It is important to refer that this process is not a test or evaluation of your capabilities; it is only a way of understanding how the game should be designed in order to suits your characteristics or preferences.

Now that you have accepted to participate on the activities, I would like to know a little more about you and your background, because of statistics reasons. I ask you your name, age, your last profession, your level of studies and what type of glasses do you use.

A.3.1.1 1st Task – The minimum readable text size

For our activity I will laid-out words in the center of the table (aproximately 50 cm) and you have to effortless read them.

«The words were laid-out on the center of the table, from the maximum text size to the minimum.» «Document the minimum readable text size» :M1

Very well.

We have finished this activity for today and the results will help me defining the minimum readable text size that I could use on the game.

A.3.1.2 Measured Variables

:M1 – The minimum readable text size.

A.3.2 Materials

The words and sizes that we used in this Usability Test were:

- Lettuce (Alface) – 30 pt
- Patato (Batata) – 28 pt
- Carrot (Cenoura) – 26 pt
- Tomato (Tomate) – 24 pt

- Pumpkin (Abóbora) – 22 pt
- Corn (Milho) – 20 pt
- Strawberries (Morangos) – 18 pt
- Manure (Estrume) – 16 pt
- Hoe (Enxada) – 14 pt
- Wheat (Trigo) – 12 pt
- Cabbage (Couve) – 10 pt

A.3.3 Results

In this section are presented the results gathered. The names of the participants are not referred in order to maintain their privacy.

Name	Last readable word	Notes
ParticipantMS	Wheat	-
ParticipantFM	Hoe	-
ParticipantDC	Cabbage	-
ParticipantBR	Strawberries	-
ParticipantMF	Strawberries	-
ParticipantC	Manure	-
ParticipantAL	Cabbage	-
ParticipantA	Wheat	-

Table A.4: Results of the Usability Test.

Every participants read at least till the word Strawberries. The words that have small size than that have not been clearly read. Thus, we assume 18pt as minimum readable text size. All the sizes larger than that are with high probability readable.

A.4 Usability Test #4 – Categories' content

From this test we obtained some objects that could integrate the categories defined.

A.4.1 Test protocol

Hi, my name is Luís Ferreira and I am studying informatics engineering. I am finishing my Master and my final project is targeted to you, the older adults. I have to design a game that would be suitable to be played by you. Therefore, I need to design it considering your characteristics and your help will be very grateful. What I ask you is only need to participate in the games and activities that I bring for you and answer some few and small questions in order to help me clearing some doubts.

Thus, this week and in the following ones, I will make some activities with you that will not keep much of your time.

Now that I have explained the goal of my project and my dependence on your help, I would be very grateful to know if you are available to participate on some of the activities that I brought today. It is important to refer that this process is not a test or evaluation of your capabilities; it is only a way of understanding how the game should be designed in order to suits your characteristics or preferences.

Now that you have accepted to participate on the activities, I would like to know a little more about you and your background, because of statistics reasons. I ask you your name, age, your last profession, your level of studies and what type of glasses do you use.

A.4.1.1 1st Task – Words that are suitable to each category

«The facilitator of the test invited four participants.»

Today we are going to play a little game. I will tell you one word and, individually, each one have to say a relationed word. The game finishes when nobody remember more words. :M1

«The words that represented categories were laid-out individually on the table. The second word only was laid-out when the game for the first one have finished.»

Very well. Thank you.

We have finished this game and its results will help me defining the set of images I will integrate on each category of the game.

A.4.1.2 Measured Variables

:M1 – The different words that the older adults remember for each category.

A.4.2 Materials

The categories used in this Usability Test were:

- Agriculture (Agricultura)
- Sewing (Costura)
- Professions (Profissões)
- Games (Jogos)

- Animal (Animais)
- Music (Música)
- Health (Saúde)
- Food (Comida)
- Kitchen (Cozinha)

A.4.3 Results

The main results obtained for each category were:

- Agriculture (Agricultura) – foice, sulfatador, serra, carrela, prensa, ancinho, mangueira, serrote, sachola, sachinho, picão, enxada, tesoura, tractor, estufa, enxertar, regador;
- Sewing (Costura) – Tesoura, maq. Costura, giz, couro, linhas, caixa para linhas, fita métrica, feixos, Agulhas, pano ou ceda, manequim, colchete, dedal, alfinete, almofada para alfinetes, botão, elástico para calças;
- Professions (Profissões) – professor, engenheiro, serralheiro, padeiro, motorista es-tivador, advogado, picheleiro, varredor, cabeleireiro, tipógrafo, cirurgião, merceiro, varina, costureira, agricultor, costureira, topografia, médico, polícia, jardineiro;
- Games (Jogos) – futebol, volley, quatro em linha, bilhar, cartas, basquete, sopa de letras, damas, rãguebi, dominó, ténis, andebol, xadrez;
- Animal (Animais) – cão, vaca, anaconda, tigre, golfinho, toupeira, urso, porco, leão, canguru, galinha, gato, javali, macaco, leopardo, coelho, rato, cobra, panda, raposa, pinguim, caracol;
- Music (Música) – trombone, flauta, cavaquinho, acordeão, reco-reco, auscultadores, violino, gaita de foles, microfone, guitarra, piano, saxofone, órgão, violoncelo, pan-deireta bateria xilofone;
- Health (Saúde) – injeção, estetoscópio, ecografia, endoscopia, radiografia, TAC, bata, operação, comprimido, espátula;
- Food (Comida) – polvo, coelho assado, pizza, bife, bacalhau com natas, leitão, coelho estufado, camarões, anho, bacalhau espanhola, bacalhau assado na brasa, bifana, arroz de feijão, batatas fritas, picanha, tripas, francesinha, feijoadada, arroz de lampreia, lulas;
- Kitchen (Cozinha) – fogão, armário, microondas, chávenas, bandeja pratos, tijelas, ferveedores, talheres, cafeteiras, guardanapo, frigorífico.

A.5 Usability Test #5 – The Help Icon

At the beginning, we found necessary to have help menus during the game. For this reason, it was important to evaluate the icon more suitable to the functionality of ask for help. Thus, it has been evaluated.

A.5.1 Test protocol

Hi, my name is Luís Ferreira and I am studying informatics engineering. I am finishing my Master and my final project is targeted to you, the older adults. I have to design a game that would be suitable to be played by you. Therefore, I need to design it considering your characteristics and your help will be very grateful. What I ask you is only need to participate in the games and activities that I bring for you and answer some few and small questions in order to help me clearing some doubts.

Thus, this week and in the following ones, I will make some activities with you that will not keep much of your time.

Now that I have explained the goal of my project and my dependence on your help, I would be very grateful to know if you are available to participate on some of the activities that I brought today. It is important to refer that this process is not a test or evaluation of your capabilities; it is only a way of understanding how the game should be designed in order to suits your characteristics or preferences.

Now that you have accepted to participate on the activities, I would like to know a little more about you and your background, because of statistics reasons. I ask you your name, age, your last profession, your level of studies and what type of glasses do you use.

A.5.1.1 1st Task – The help icon

For our today's activity I ask you what object do you associate with the functionality of asking for help. :M1

«The available options for the icons were: a lifebuoy, a question mark or an information icon.»

Lifebuoy

Excellent choice! Then, there are two different representations of a lifebuoy, which one do you prefer? :M2

«There were presented two representations of a lifebuoy.»

Question mark

Excellent choice! Then, there are two different representations of a question mark, which one do you prefer? :M2

«There were presented two representations of a question mark.»

Information icon

Excellent choice! Then, there are two different representations of an information icon, which one do you prefer? :M2

«There were presented two representations of a information icon.»

A.5.1.2 Measured Variables

:M1 – The suitable icon for the helping functionality.

:M2 – The understandable icon.

A.5.2 Materials

In this subsection are presented the icons used in this Usability Test.

Qual o ícone que melhor se adequa à função de pedir ajuda?

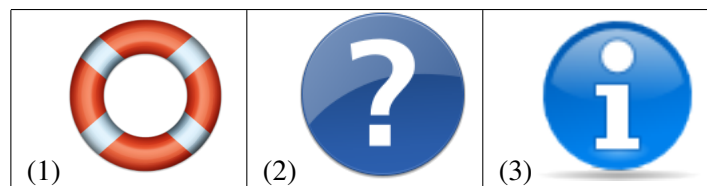


Table A.5: What is the icon that better represents the functionality of asking for help? Lifebuoy (Bóia de Salvamento), Question mark (Ponto de Interrogação), Information icon (Ícone de Informação)

Then are presented the options for the three icons.

Qual a bóia mais perceptível?

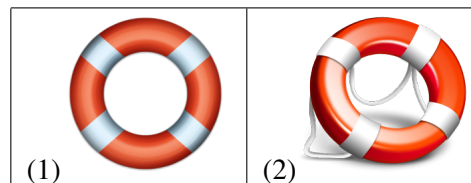


Table A.6: What is the most understandable Lifebuoy?

Qual o ponto de interrogação mais perceptível?

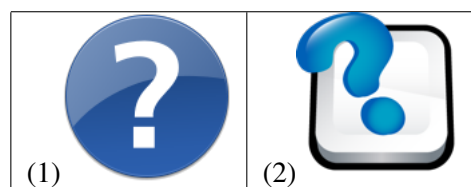


Table A.7: What is the most understandable Question Mark?

Qual o ícone de informação mais perceptível?

Usability Tests

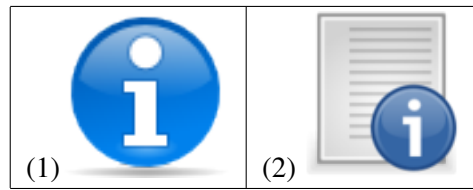


Table A.8: What is the most understandable Information icon?

A.5.3 Results

In this section are presented the results gathered. The names of the participants are not referred in order to maintain their privacy.

Name	Lifebuoy	Question Mark	Information Icon	Notes
ParticipantDC	2nd Option	-	-	Because it has ropes
ParticipantFM	-	2nd Option	-	-
ParticipantI	-	2nd Option	-	-
ParticipantAL	-	1st Option	-	-
ParticipantJ	-	-	1st Option	-
ParticipantC	-	1st Option	-	-

Table A.9: Results of the two tasks of this Usability Test.

We opted for a question mark to the help icon. However we do not conclude any majority for one of the question mark icons. Thus, we opted for the first.

A.6 Usability Test #6 – Using the keyboard

This usability test allowed us to understand if the use of a keyboard with the older adults was acceptable and the differences in using an alphabetical keyboard or a qwerty keyboard.

A.6.1 Test protocol

Hi, my name is Luís Ferreira and I am studying informatics engineering. I am finishing my Master and my final project is targeted to you, the older adults. I have to design a game that would be suitable to be played by you. Therefore, I need to design it considering your characteristics and your help will be very grateful. What I ask you is only need to participate in the games and activities that I bring for you and answer some few and small questions in order to help me clearing some doubts.

Thus, this week and in the following ones, I will make some activities with you that will not keep much of your time.

Now that I have explained the goal of my project and my dependence on your help, I would be very grateful to know if you are available to participate on some of the activities that I brought today. It is important to refer that this process is not a test or evaluation of your capabilities; it is only a way of understanding how the game should be designed in order to suits your characteristics or preferences.

A.6.1.1 1st Task – Finding a letter on the keyboard

«This task was duplicated to the different keyboards and was conducted in order to prepare the participants to the next task.»

For this activity I ask you to find characters in two different keyboards.

I ask you to find and touch the X letter in the keyboard.

«It was registred the time to perform the activity.»

I ask you to find and touch the E letter in the keyboard.

«It was registred the time to perform the activity.»

«The same for the other keyboard.»

A.6.1.2 2nd Task – Writing a word on the keyboard

«One question for a game card was done. The answer was "Pescada".»

«This task was duplicated to the different keyboards.»

For this activity I ask you to write the word "Pescada" in two different keyboards. **:M1**

«The word emerged as the participants was writing on the keyboard.»

«It was registred the time to perform the activity.»

«The same for the other keyboard.»

A.6.1.3 Measured Variables

:M1 – The time expended on using the keyboard.

A.6.2 Materials

In this section are presented the game card and the keyboards.

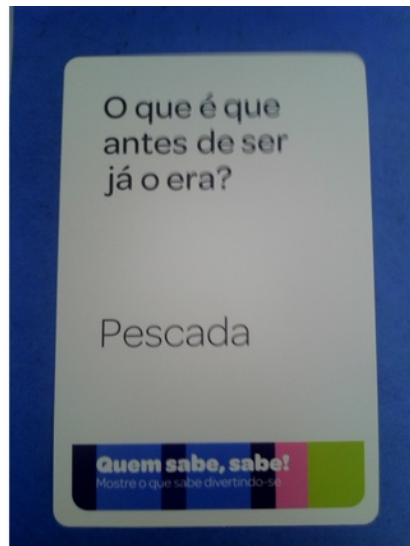


Figure A.3: The question for a game card.

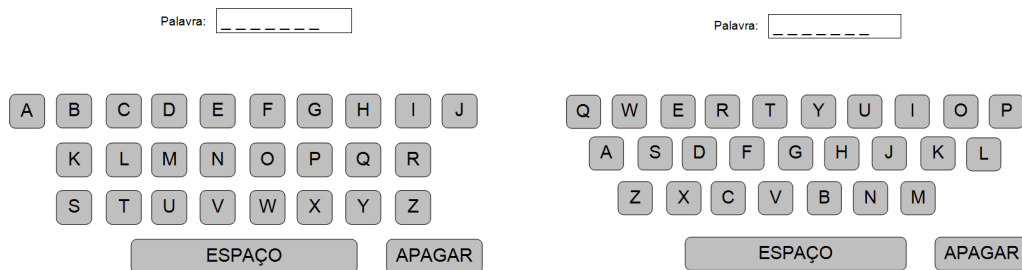


Figure A.4: The different keyboards.

A.6.3 Results

From these results we understood that using a keyboard is not a barrier for older adults, even if they spend more time on doing it. The average of the results for Alphabetical or Qwerty keyboards did not disperse to much. However in average the Qwerty took few time for the participants. We opted for using it.

Usability Tests

Name	Alphabetical Keyboard (seconds)			Qwerty Keyboard (seconds)		
	Letter X	Letter E	Pescada	Letter X	Letter E	Pescada
ParticipantL	2.10	1.11	17.25	1.97	4.18	20.83
ParticipantFM	4.17	7.44	35.55	3.41	2.63	22.98
ParticipantB	7.56	2.89	32.78	3.43	3.61	25.91

Figure A.5: Table with the results for the two tasks of this Usability Test.

A.7 Usability Test #7 – Using the birthdate input

This usability test allowed us to understand if the birthdate input was suitable for older adults.

A.7.1 Test protocol

Hi, my name is Luís Ferreira and I am studying informatics engineering. I am finishing my Master and my final project is targeted to you, the older adults. I have to design a game that would be suitable to be played by you. Therefore, I need to design it considering your characteristics and your help will be very grateful. What I ask you is only need to participate in the games and activities that I bring for you and answer some few and small questions in order to help me clearing some doubts.

Thus, this week and in the following ones, I will make some activities with you that will not keep much of your time.

Now that I have explained the goal of my project and my dependence on your help, I would be very grateful to know if you are available to participate on some of the activities that I brought today. It is important to refer that this process is not a test or evaluation of your capabilities; it is only a way of understanding how the game should be designed in order to suits your characteristics or preferences.

A.7.1.1 1st Task – The birthdate input

First, I ask you your birthdate.

Then, I show you three papers where you have to select your birthdate – day, month and year. You have to use the arows for up and down to adapt to your date.

«Regist if the buttons suits their actions.» :M1

«Regist if they select the correct date.» :M2

A.7.1.2 Measured Variables

:M1 – The order of the data.

:M2 – The facility of using the input.

A.7.2 Materials

In this section is presented the input for the month A.6.

There were also prototypes for the day and year inputs.

A.7.3 Results

The results showed that the three participants inserted the right birthdate. However, one problem was observed and corrected: the up arrow have to change the data for an upper value, e.g. if the participant use the up arrow for the month input and it is on Setember, it should change to October and not to August.

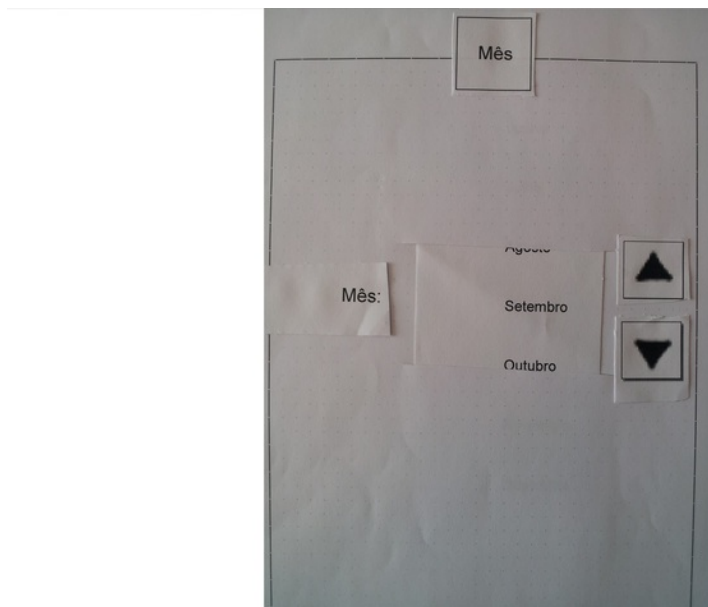


Figure A.6: The month input.

A.8 Usability Test #8 – Options for the Initial Menu

This usability test allowed us to understand the names for the options for the Initial Menu.

A.8.1 Test protocol

Hi, my name is Luís Ferreira and I am studying informatics engineering. I am finishing my Master and my final project is targeted to you, the older adults. I have to design a game that would be suitable to be played by you. Therefore, I need to design it considering your characteristics and your help will be very grateful. What I ask you is only need to participate in the games and activities that I bring for you and answer some few and small questions in order to help me clearing some doubts.

Thus, this week and in the following ones, I will make some activities with you that will not keep much of your time.

Now that I have explained the goal of my project and my dependence on your help, I would be very grateful to know if you are available to participate on some of the activities that I brought today. It is important to refer that this process is not a test or evaluation of your capabilities; it is only a way of understanding how the game should be designed in order to suits your characteristics or preferences.

A.8.1.1 1st Task – See Instructions

If you wanted to know how to play the game, which would you choose?

«"See the instructions of the game" (Ver as instruções do jogo) or "Learn how to play" (Aprender a jogar).»

A.8.1.2 2nd Task – Start Playing

If you wanted to know go to the game, which would you choose?

«"To play" (Jogar) or Start playing (Começar a jogar).»

A.8.1.3 3rd Task – See Score

If you wanted to know how many points did you have in a game, which you would choose?

«"To see the game scores" (Ver pontuações do jogo) or "To see points of players (Ver pontos dos jogadores).»

A.8.2 Results

Usability Tests

Nome	1st Task	2nd Task	3rd Task
ParticipantFM	See the instructions of the game	Start playing	To see the game scores
ParticipantL	See the instructions of the game	Start playing	To see points of players
ParticipantM	See the instructions of the game	Start playing	To see the game scores
ParticipantC	Learn how to play	To play	To see the game scores

Table A.10: Results of the three tasks of this Usability Test.

A.9 Usability Test #9 – Navigation in the Initial Menu

This usability test allowed us to understand if the options on the Initial Menu were understandable.

A.9.1 Test protocol

Hi, my name is Luís Ferreira and I am studying informatics engineering. I am finishing my Master and my final project is targeted to you, the older adults. I have to design a game that would be suitable to be played by you. Therefore, I need to design it considering your characteristics and your help will be very grateful. What I ask you is only need to participate in the games and activities that I bring for you and answer some few and small questions in order to help me clearing some doubts.

Thus, this week and in the following ones, I will make some activities with you that will not keep much of your time.

Now that I have explained the goal of my project and my dependence on your help, I would be very grateful to know if you are available to participate on some of the activities that I brought today. It is important to refer that this process is not a test or evaluation of your capabilities; it is only a way of understanding how the game should be designed in order to suits your characteristics or preferences.

A.9.1.1 Preparation

« A screen with the Initial Menu is displayed.»

A.9.1.2 1st Task – See Instructions

Before playing a game that you never played before, you have to learn how to play it. I ask you to select the option that guide you to learn how to play. **:M1**

«Regist the errors that the player makes before choosing "See the instructions of the game" (Ver as instruções do jogo).»

A.9.1.3 2nd Task – Start Playing

Now I ask you to imagine that you already know these instructions and then you want to play the game. Please select the option that guides you to the game. **:M1**

«Regist the errors that the player makes before choosing "Start playing" (Começar a jogar).»

Ok, thanks.

A.9.1.4 3rd Task – See Score

Now please imagine that you have finished a game and you would like to consult the points you have made. Please select the option that could give you this screen. **:M1**

«Regist the errors that the player makes before choosing "See the scores of the game" (Ver as pontuações do jogo).»

Ok, thanks.

A.9.1.5 Measured Variables

:M1 – Errors choosing options, because of lack of comprehension.

A.9.2 Materials

In this section is presented the Initial Menu A.7.

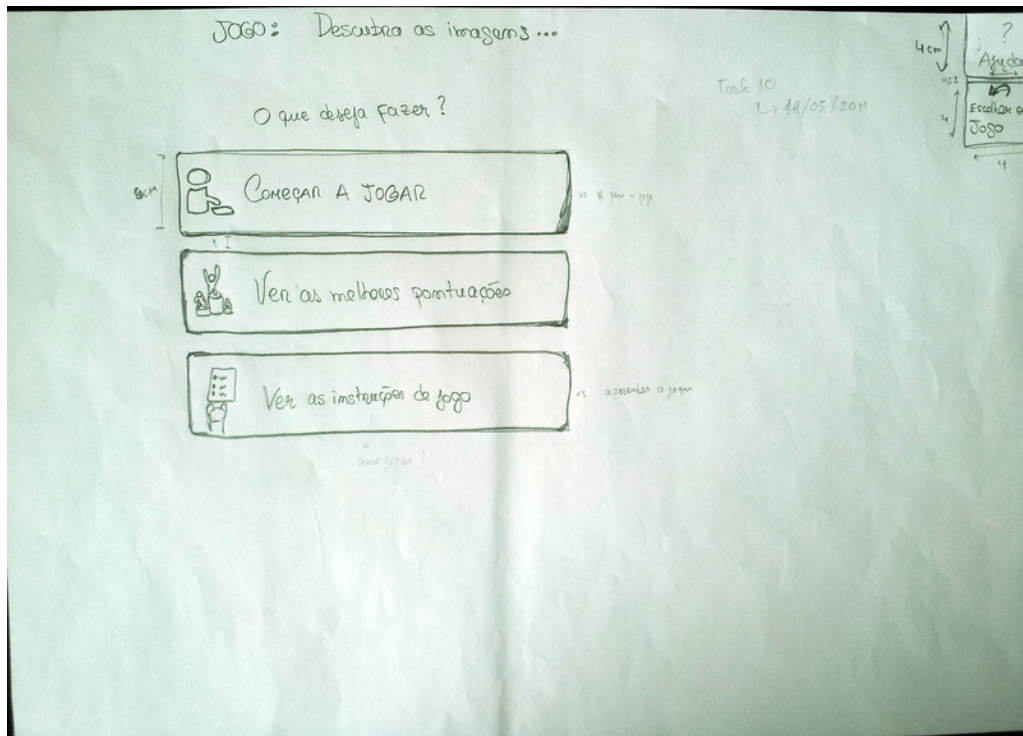


Figure A.7: Initial Menu.

A.9.3 Results

Nome	Começar a jogar (errors)	Ver as melhores pontuações (errors)	Ver as instruções do jogo (errors)
ParticipantFM	0	0	1
ParticipantL	0	0	0
ParticipantM	1	0	1
ParticipantC	0	0	0

Table A.11: Results of the three tasks of this Usability Test.

A.10 Usability Test #10 – Navigation in Choosing Players Menu and Creating an Avatar

This usability test allowed us to understand if viability of using an avatar for creating a player.

A.10.1 Test protocol

Hi, my name is Luís Ferreira and I am studying informatics engineering. I am finishing my Master and my final project is targeted to you, the older adults. I have to design a game that would be suitable to be played by you. Therefore, I need to design it considering your characteristics and your help will be very grateful. What I ask you is only need to participate in the games and activities that I bring for you and answer some few and small questions in order to help me clearing some doubts.

Thus, this week and in the following ones, I will make some activities with you that will not keep much of your time.

Now that I have explained the goal of my project and my dependence on your help, I would be very grateful to know if you are available to participate on some of the activities that I brought today. It is important to refer that this process is not a test or evaluation of your capabilities; it is only a way of understanding how the game should be designed in order to suits your characteristics or preferences.

A.10.1.1 Preparation

« A screen with the Choosing Players Menu is displayed.»

A.10.1.2 1st Task – Remove a player

In this screen you may see the players that will play our game (Os jogadores). The player Deolinda is on that list, but you are not Deolinda. If I ask you to remove Deolinda for that list, where would you touch? :M1

«Regist the errors that the player makes before choosing "Remove this player" (Remover este jogador).»

A.10.1.3 2nd Task – Where to create a new player?

Now you if you wanted to create your own player, where would you click? :M2

«Regist the errors that the player makes before choosing "Create New Player" (Criar novo jogador).»

Ok, thanks.

A.10.1.4 3rd Task – Creating an Avatar

«A body of an avatar and a set of accessories to dress it were presented.»

I ask you to use these accessories in order to create your avatar. It is a game object that will allow you to play again with the same player.

«Regist the number of accessories used.» :M3

Usability Tests

Finally, I ask you if you have liked to create your own avatar or if you would like to choose one from a set of created avatars. **:M4**

«Regist the preferences.»

A.10.1.5 Measured Variables

:M1 – Difficulties on finding the remove player button.

:M2 – Difficulties on finding the create new player button.

:M3 – The enjoy level on creating an avatar.

:M4 – The preference for creating a player.

A.10.2 Materials

In this section is presented the Choosing Players Menu A.8 and the body used for the avatar and some accessories A.9.

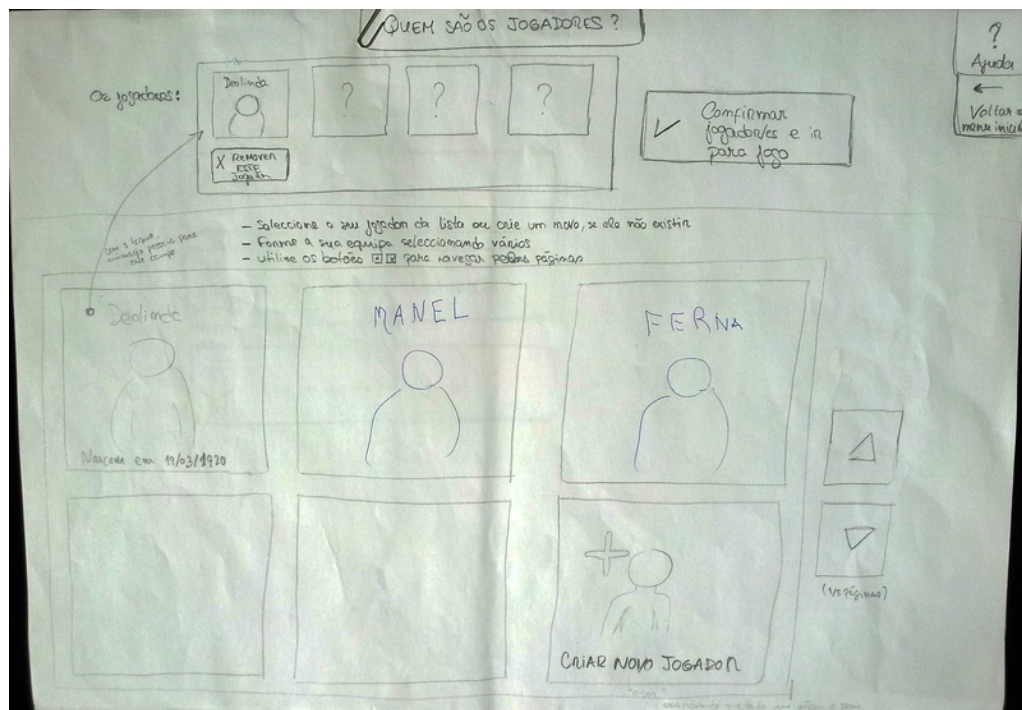


Figure A.8: Choosing Players Menu.

A.10.3 Results

The results obtained with the four tasks of this Usability Test are represented on Figure A.10.

From the results, we concluded that the functionalities Remove Player and Create New Player were understood and easy to find. Regarding the avatar, we observed that it could



Figure A.9: Avatar and some accessories

be an enjoyable way of registering the participants, because they manifested satisfaction on creating it. However, from the results comparing the Creation or Choosing the avatar, we opted for mix both approaches and we make a division in avatar's head and avatar's body. Thus, the participants may choose their avatar by using the arrows next to this area (see Figure A.11). By clicking the arrow, the avatar changes randomly its parts and accessories.

Usability Tests

Name	Remove Player		Create New Player	Avatar	
	Errors	Notes	Errors	Accessories	To Create or To Choose
ParticipantFM	0		0	5	To choose ("do not have ability to create")
ParticipantL	0		0	5	To create
ParticipantM	1	Clicked on the image	0 (Spent more time)	3	To choose
ParticipantC	0		0	6	To choose

Figure A.10: Table with the results for the four tasks of this Usability Test.

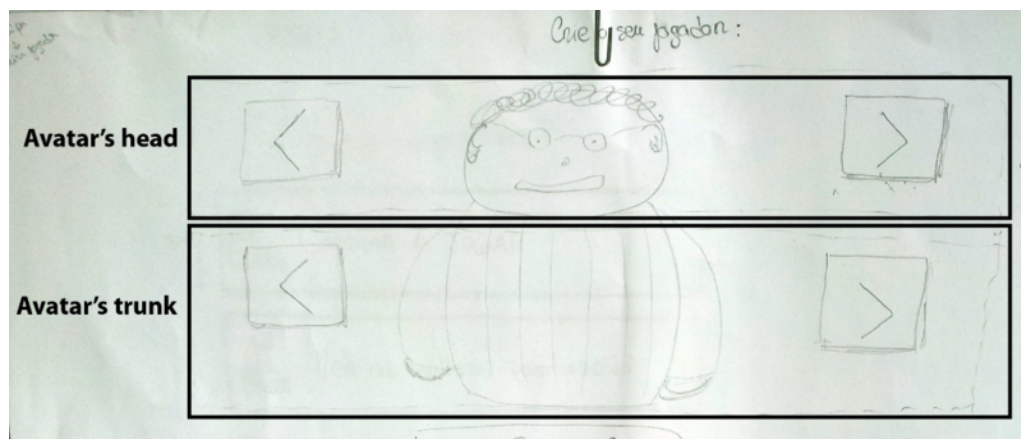


Figure A.11: Creating the avatar – paper prototype.

A.11 Usability Test #11 – The final Usability Test

The last usability test allowed us to evaluate those most functionalities of the designed game – it was registered with video camera.

A.11.1 Test protocol

1. Two older adults are invited to join the game: each one is disposed in the opposite sides of the table;

2. Mini-interview

Name

Age

Read/write?

Job

Happiness (evaluation)

Muito contente/contente/normal/triste/muito triste

Physic situation (evaluation)

Cheia de genica/com alguma energia/normal/cansada/muito cansada

Notes

3. Facilitator of the test – Now we are going to play a game that we developed especially for you. Initially, I want you to understand that the game will be played touching in this surface; you are going to see its display here and you will be able to play by touching it. Ok? Please ask me for help if you have any doubt during the game. Ok... let's play. «The game is started, showing the first menu to each player»
4. Facilitator of the test – This is a menu where you can choose two options that are written there (“Start Playing or See Instructions”). You can also ask for help if you don't know what option to choose. Yet you do not know how to play this game. I ask you to see the instructions of the game. Click there, please (you can ask for help if you don't know where to click). «They will click on “See Instructions”. Register the errors and the notes (for example recovering for error by clicking “Return to the previous menu”»
5. Facilitator of the test – Here you can read the instructions of the game. Please read it. No problem if you do not understand anything, I will help you during the game. Ok, are you ready? Go forward to the game. «They will click on “Next”. Register problems»
6. Facilitator of the test to each player individually – this is the category. In the game you will need to find images that correspond to that category. For example: Horse, if the category is Animals. Ok, you are ready, click on “play” and wait for your opponent. «Register the notes for the waiting time and the click on “Play”» «Both “play”... the game»

7. Facilitator of the test to each player individually – There is your score during the game (0 at this moment). In the final you can compare it with your opponent. There is the number of images that you have already collected to complete your goal (0 at this moment). You have this area to put the images that you are certain that are yours. And there is a magnifying glass to enlarge the images you can't see well. Ok, you can now start searching you images. «Observe and register the game playing: n° magnifying glass, n° incorrect, n° combo,...»
8. How many points did you have? And you? So, who won? «Register»
9. Ask again:
 - Happiness (evaluation)
 - Muito contente/contente/normal/triste/muito triste
 - Physic situation (evaluation)
 - Cheia de genica/com alguma energia/normal/cansada/muito cansada «Do the survey»
10. Do you want to play again? I will invite more two older adults and now you are going to play in team: one for each team. «Do the mini interview with the new users»
11. You two are playing in a team versus these two that are another team. Now there is the initial menu. These two have already played and will help you initializing the game. If you already know how to play you can already go to the game. Where do you click? «They will click in “Start Playing”. Register errors.»
12. There is the category that you will need to find images for. I ask the ones that have already played to explain softly what you have to do in the game. «Register the difficulties in explaining and notes»
13. Ok, let's play. «Register the cooperation in the game and the explanation of the rules...»
14. Compare your scores. «Do the survey with the other two older adults»
15. Ask again to all:
 - Happiness (evaluation)
 - Muito contente/contente/normal/triste/muito triste
 - Physic situation (evaluation)
 - Cheia de genica/com alguma energia/normal/cansada/muito cansada

The main observed results were registered in the Results and Discussion on Chapter 5.

Usability Tests

Appendix B

The game flow

This appendix presents the game flow representation, through a draft of its menus.

The game flow

