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MentalSense
A ludic and didactic game for people with dementia

MASTER DISSERTATION

Maria João Pereira Gouveia da Conceição
INTERNATIONAL MASTER OF INTERACTIVE MEDIA DESIGN

UNIVERSIDADE da MADEIRA
A Nossa Universidade
www.uma.pt

September | 2023

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SUPERVISION
Mónica da Silva Cameirão

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Acknowledgment

I would like to thank Professor Mónica Cameirão for all the support and guidance she provided during the development of my dissertation, which I believe would not have been possible without her support because even with all the obstacles, she always had a positive word.

To the director of the Interactive Media Design course, Professor Sergi Bermúdez, who was always present and supported us during the master's degree.

To Garouta do Calhau, for having received me at the Day Center "Lugar de Memórias"; to Drª. Patrícia Castro, director of the space; Psychologist Gonçalo Fernandes who supported the first tests, as well as the case study; Psychometrician Benjiliani Teixeira who was always present and answered all questions; and all technicians at Lugar de Memórias I and II.

To Casa de Saúde São João de Deus, for volunteering to participate in the first tests of the application; to Psychologist Susana Jardim, for having supported the dissemination of tests within the institution; and to Técnica Raquel Gomes, for all the support provided.

To the Alzheimer's Unit of Ribeira Brava, in the voice of Psychologist Madalena Abreu, for accepting participating in the first tests.

To Alzheimer Portugal, namely to Psychologist Lucília Nobrega, for all the information and support provided.

Finally, I thank all participants in the study, my family, my mother, and my partner, who supported and contributed to the realization of this dissertation.

I dedicate this dissertation to my grandmother, who lived the last years of her life in a Dementia State, being the main motivation for the project.

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Resumo

Com o envelhecimento da população, é cada vez mais comum encontrar pessoas com demência. A demência é caracterizada pela perda de habilidades emocionais e cognitivas. Nesta dissertação, propomos um novo sistema para estimulação cognitiva através de jogos, o MentalSense, onde pessoas em estado demencial podem realizar alguns exercícios cognitivos para cuidar de um animal de estimação, trabalhando no mínimo cinco domínios cognitivos: atenção, memória episódica, raciocínio lógico, pensamento abstrato e funções executivas. O jogo está implementado em tablet para poder ser usado em diversos lugares e situações. Foram realizados diversos estudos, desde questionários online e entrevistas a cuidadores formais e informais, e seguiu-se um design participativo com psicólogo e psicomotricista, onde obtivemos informação sobre as necessidades desta população e de quem presta cuidados a estes. Realizámos um estudo piloto, o qual culminou em sugestões para o melhoramento da aplicação final. O protótipo final foi testado através de um estudo de caso com dois participantes acompanhados por um psicólogo, que realizaram várias sessões com o MentalSense, com resultados positivos.

Palavras-chave: Tecnologia, Estimulação Cognitiva, Demência, Jogo, Aplicação de Tablet

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Abstract

As the population ages, it is increasingly common to find people with dementia. Dementia is characterized by the loss of emotional and cognitive abilities. In this dissertation, we propose a new system for cognitive stimulation through games, MentalSense, where people with dementia can perform some cognitive exercises to take care of a pet, working on at least five cognitive domains: attention, episodic memory, logical reasoning, abstract thinking and executive functions. The game is implemented on a tablet so it can be used in different places and situations. Several studies were carried out, from online questionnaires and interviews with formal and informal caregivers, and a participatory design with a psychologist and psychometrician was followed, where we obtained information about the needs of this population and those who provide care to them. We carried out a pilot study, which culminated in suggestions for improving the final application. The final prototype was tested through a case study with two participants accompanied by a psychologist, who carried out several sessions with MentalSense, with positive results.

Keywords: Technology, Cognitive Stimulation, Dementia, Game, Tablet Application

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1. Introduction

Dementia is characterized by the loss of emotional and cognitive abilities. According to the World Health Organization (WHO), more than 55 million people worldwide suffer from dementia, with more than 10 million cases appearing every year [1]. Nevertheless, this number is believed to be underestimated because several patients may not have been diagnosed due to various factors [2]. Organic dementia is caused by physical changes or damage to the brain. Different types of organic dementia are Alzheimer's disease, vascular dementia, Lewy body dementia, frontotemporal dementia, non-fluent progressive aphasia, and semantic dementia [3], [4]. Dementia is the seventh leading cause of death, as well as a major cause of dependence and disability [1]. Although the disease is not yet fully understood [5], non-organic dementia, also known as functional or reversible dementia, is different in that it is not primarily associated with physical brain damage. Instead, it may be caused by factors that are treatable or reversible, such as: age (over 65 years old); hypertension; diabetes; being overweight or obese; smoking; alcoholism; sedentarism; social isolation; and depression. Typical symptoms of dementia are mood disorders, agitation, apathy, aggression, psychosis, hallucinations, and delusions [3]. Some of the early symptoms are forgetting recent events, misplacing things, getting lost, being confused, losing track of time, difficulty in doing simple things or solving problems, and difficulty in making decisions [1].

We first heard about the disease in 1906-07 through Alois Alzheimer, a doctor, and scientist that dedicated his career to the study of dementia. Alois Alzheimer made this disease known and characterized it as an incurable disease that just elderly people could have, but as average life expectancy was reduced, it was rare to see someone with the disease [6]. As a neuropathologist, Alzheimer said that dementia is an irreversible and neurodegenerative progressive disease that it is marked by the gradual progression of the deficit in one or more cognitive domains [7]. Neuropathologically, it is characterized by neural death in several brain areas, as well as by the appearance of senile plaques and fibrillar plaits that lead to difficulty in communication between nerve cells [8]. What is still unknown are the causes that lead people without any kind of familiar bridge with the disease to develop it, and several factors are being studied such as environmental

factors, biochemical disturbances, and immune processes [9]. Nevertheless, an early diagnosis is essential in this disease, leading to better control of the individual's entire cognitive behavior [3], [4].

Currently, an early diagnosis of the disease can be performed with great accuracy, triangulating different sources of data such as the clinical history, a physical examination, and a neurological examination [10]. Dementia can be divided into three phases: initial, advanced, and terminal. In the initial phase, it is possible to observe a marked loss of memory. At this stage, all memory deficits are more evident, as well as difficulties in basic orientation in space and time. There are also difficulties in verbal communication, attention, coordination, and concentration. At this stage, we can also observe changes in the personality of the individual, who can display, for instance, a less inhibited behavior with strangers [11], [12]. The advanced phase is when the individual loses part of his autonomy and has strong limitations in the recognition of places, everyday objects, faces, smells, and sounds [12]. Poor hygiene habits and behavioral changes such as agitation, aggressiveness, delusions, and hallucinations are constant and frequent. In the terminal phase, the one that is considered more complicated for the family is when the individual shows substantial deterioration of long-term memory and communication as well as is totally dependent. Many individuals in this phase are bedridden and apathetic [13]–[15].

Dementia has a large impact on the performance of activities of daily living, as it continually interferes in all occupational and social activities of the individual [16]. Hence, there should always be a monitoring of the individual's state, the stage of the disease in which he/she is in, as well as his/her cognitive abilities and the capacity to perform common tasks [11], [13], [16], [17].

1.1 Motivation

With the aging of the population, it is becoming more common to find people suffering from dementia [18]. In fact, the main motivation to start working on this topic arose from a personal experience. My maternal grandmother was diagnosed with dementia after the age of 80. At the time, we, as informal caregivers, found it very challenging to obtain

support and information to help sustaining the cognitive status of my grandmother, which declined very rapidly. Hence, more work is needed on the provision of strategies for cognitive stimulation for individuals with dementia. Particularly, solutions that can be used remotely by patients at the comfort of their homes. This became more evident after the COVID-19 pandemic. From interviews with formal and informal caregivers, we found that after the first confinement, people with dementia who returned to the health centers, day centers and others, showed a huge decline in their cognitive abilities, even the ones who could still perform difficult exercises and maintain a coherent conversation. A number of factors have been identified by formal caregivers (from *Lugar de Memórias* and *Alzheimer Portugal*) as potential contributors for this situation: 1) little interest from the family; 2) cognitive exercises done on paper; 3) no time to support the person with dementia at home; 4) cognitive exercises presented is an unappealing way; and 5) doing the exercises at home is sometimes seen as an obligation and the person with dementia feels that the family is in command.

In this context, we present MentalSense, a ludic and didactic cognitive game for people with dementia. MentalSense is a system for cognitive stimulation that was designed and developed through participatory design methods with psychologists, psychometricians, and formal and informal caregivers. The system is implemented on a mobile device, a tablet, and includes cognitive stimulation exercises to work different cognitive domains.

1.2 Research Questions and Objectives

MentalSense aims at providing cognitive stimulation activities for individuals with dementia with the support of formal and/or informal caregivers. Our main research questions (RQ) are:

RQ1: Can a ludic and didactic cognitive game, used in a tablet, be useful in the stimulation of people with dementia?

RQ2: Can such a system increase positive emotions in the person with dementia?

To address the above RQs, the objective of this project is the creation of a game for

cognitive stimulation with playful and didactic aspects. This application is to be used by formal caregivers, such as psychometricians or neuropsychologists in nursing homes, day care centers, hospitals, health homes, among others, and also by informal caregivers. The game is to be used on a tablet for easy transportation and use in any setting and in any situation. For example, it could be used in a possible lockdown as it happened during the SARS-COV-2 epidemic, when individuals are confined to their homes without any support and training, what can worsen their state if continuing cognitive stimulation is lacking. Moreover, with the increased use of technology by the younger population, an application like MentalSense could promote an increased positive interaction between the elderly with dementia and younger members of its family. Finally, this is an affordable technology with the potential to reach more people, particularly those that do not have access to any type of intervention.

1.3 Thesis contribution

With the development of MentalSense, this project makes the following contributions:

1. **Tablet-based ludic and didactic game for cognitive stimulation**

   This solution was created during a participatory design with psychometricians and neuropsychologists, for promoting the cognitive stimulation of individuals with dementia.

2. **Portable game with cognitive exercises**

   It is important that people with dementia can train the cognitive exercises anytime and anywhere. A tablet-based solution provides portability and ease of access.

3. **User-centered design**

   The design follows rules based on the specific profiles of people with dementia. Aspects like color and the amount of visual stimulation were carefully considered.

2. Related Work

Studies about dementia have been reported in different areas since many years ago. In this section, we review previous studies in several areas related to dementia such as technology, games, music, software, diagnosis, anxiety, Virtual Reality (VR), augmented reality, storytelling, arts, mixed-reality, robot, and animal-assisted. The following databases were used for the search: ResearchGate, Wiley, Sage Pub, ACM Library, NCBI, Cochrane Library, Science Direct, Oxford Academic, Springer, and Google Scholar.

The incorporation of design and technology in dementia research is a fascinating topic and a promising opportunity. It has the potential to bring significant changes in society and affect the lives of many. Regarding technology, Ancient *et al.* said that older people are interested in utilizing technology, particularly when it is considered beneficial [19]. Rosenberg *et al.* underline that people with dementia can utilize well-known technologies at a competent level [19]. However, technology and its use can be influenced by the gender of the person with dementia and by caregivers [20]. Another important aspect is that technology should ideally be used pervasively, in the place where the person with dementia is. At the time that the individual enters a hospitalization circuit, it could be too late [21].

In this section, we will discuss assistive technology that enhances the quality of life of both, users, and caregivers. There are various Assistive Technologies (AT) available to aid daily activities, such as safer walking devices, telecare, and reminders. It is important to consider the context in which these technologies will be used, including who will be using them and when to ensure they are effective in improving daily care activities [22]. When it comes to cognitive stimulation technologies, there is a growing range of resources available to individuals grappling with dementia. The progress made in technology development has yielded positive results. Nevertheless, it is imperative to stress that technology cannot replace the compassion and assistance offered by both, formal and informal caregivers. Moreover, when designing for dementia, it is crucial to prioritize accessibility, usability, and user experience. This is especially important when

designing for elderly individuals with dementia. Personalization and user acceptance should also be taken into consideration [23], [24].

AT has the potential to increase the level of independence of individuals in three ways, specifically by 1) ensuring that the individual performs the activity safely, 2) compensating for some losses in terms of behavior, and 3) monitoring and evaluating the cognitive performance of those using it [25]. Overall, we can say AT is safe because it helps people with dementia without any risk for them; it helps in the improvement and stagnation of the disease and is enhancing because it helps in the improvement of the quality life of these people [26]. As an interesting example, we have a device called SenseCam, which has been shown positive results such as the reduction of feelings of depression [27]. The SenseCam (Figure 2 – 1) is a mini camera that the individual puts on the neck, which captures several images of the individual's daily life, allowing the individual with dementia to later review his/her day-to-day activities, providing memories and well-being. This camera can also be an asset for family members, as they get to know how their loved one's day-to-day life is going [26].

Figure 2 - 1 SenseCam - Microsoft Research.

2.1 Cognitive stimulation in dementia

It is well-established that early cognitive stimulation can be highly beneficial in delaying the onset of dementia. It is also widely accepted that there are distinct cognitive differences between younger and older individuals. When discussing individuals with dementia, these differences are especially pronounced [4]. The process of cognitive stimulation includes encouraging people to participate in activities and exercises that are

specifically created to boost their cognitive abilities, improve their memory, and maintain their overall brain health [28]. To maintain brain function for an extended period, it is essential to provide significant stimulation to the brain. Cognition is basically "a mental process, related to thinking, through which the individual acquires knowledge, carries out plans, and solves problems" [29].

In recent years, there has been a significant focus on cognitive development due to advancements in technology and science [30]. It can be observed that a 70-year-old individual today possesses cognitive abilities equivalent to that of a 65-year-old person from three decades ago. This can be attributed to various factors such as culture, financial status, education, health, and more [4], [31]. Hence, to effectively stimulate cognition (Figure 2 -2), a combination of strategies and exercises is necessary. This should involve cooperation between the caregiver and the patient with dementia. It is important to focus on functions such as memory, logical reasoning, problem-solving, and executive functions to ensure they are being compensated for [32]. To improve memory, we can engage in activities that require us to recall and remember information. These may include reminiscence therapy, memory games, and memory exercises. There are various ways to improve attention and concentration. One effective method is to assign tasks that require individuals to focus on specific stimuli or activities such as puzzles, reading, and guided exercises. To enhance language and communication skills, activities like storytelling, conversations, word games, and naming objects are beneficial. For improving executive functioning, exercises targeting planning, decision-making, problem-solving, and organization skills can be helpful. Additionally, activities that involve visual processing and spatial skills, such as jigsaw puzzles, matching games, and drawing, are effective in enhancing visual perception and spatial awareness [28], [33].

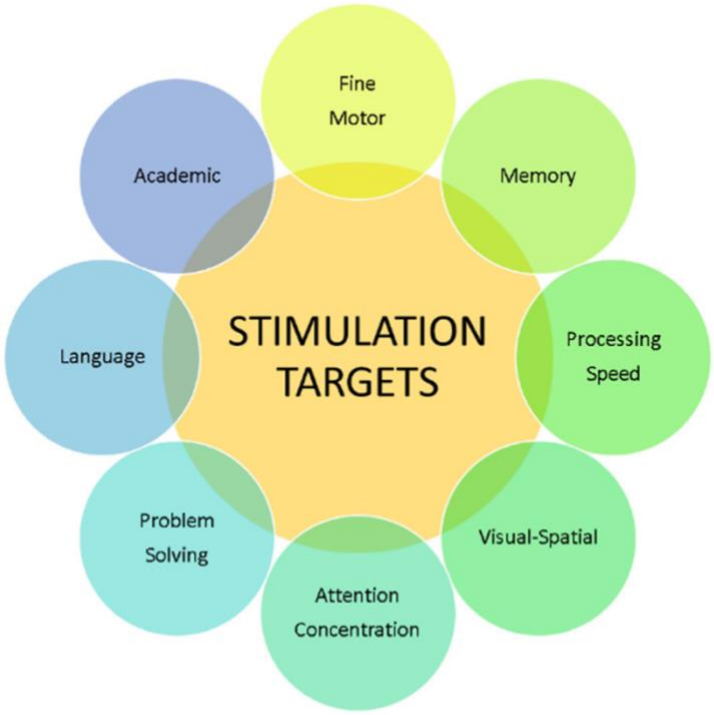


Figure 2 - 2 Stimulation targets.

2.2 Barriers and facilitators when living with dementia.

Dementia can create many challenges that hinder the well-being of individuals. These difficulties can affect not only those who suffer from the disease but also their loved ones and caregivers [34]. Caregivers often find it difficult to take care of themselves as they face physical and mental exhaustion, including problems with osteoporosis, spine, lumbar, insomnia, depression, insecurities, and fears. Communication difficulties can also arise depending on the stage of the disease, making it hard for the caregiver to understand what the individual is feeling. Additionally, housing conditions can create further barriers, as many homes are not equipped to handle Alzheimer's patients with mobility issues. Simple tasks like showering, using the toilet, and brushing one's teeth can become challenging, and falling or getting lost can be a real concern. The lack of support for this illness can also create barriers [20], [26], [35]. On September 6, 2019, a new statute declaring the Informal Caregiver was published in the Diário da República, to acknowledge this role and allow for supports such as the right to rest, psychosocial

support, integration measures in the labor market, and monetary allowances for caregivers [36], [37].

Dealing with challenges in life can have a negative impact on a person's overall well-being, which can also affect their relationships with others. When someone is suffering from an illness, it can create communication barriers with their caregivers or those they live with. These difficulties can escalate and lead to disruptions in daily routines as new needs arise that must be addressed[38], [39]. In recent years, there has been a surge in the availability of facilities that cater to individuals with illnesses. These facilities range from day centers to specialized homes and provide a much-needed respite for caregivers who may be overwhelmed by the demands of caring for their loved ones. Moreover, these facilities offer individuals the opportunity to explore new talents and resources that they may not have had access to before, due to their previous work and family commitments. In essence, facilities like these have become an essential component of care for those with illnesses, providing them with a safe and supportive environment where they can receive the attention and care they need to thrive.

Caregivers are often faced with a sense of isolation and exclusion from society. To address this, support groups have been established as a means of assisting caregivers in coping with the challenges that come with their role. These groups offer a wide range of counselling services, providing a safe space for caregivers to express their emotions and avoid mental exhaustion. It is worth noting that the support groups are run by trained professionals who possess the necessary expertise to help caregivers navigate the challenges they face. Additionally, these groups offer an opportunity for social interaction, which can be a source of relief for those feeling overwhelmed. Overall, support groups are an invaluable resource for caregivers, and they have helped many individuals cope with the demands of caregiving [40].

2.3 Formal and informal caregivers

A caregiver is someone who provides care, support, and assistance to an individual with a physical or mental disability. Often, caregivers do not have their own source of income

and may need to work full-time to cover daily expenses. In many cases, caregivers are family members or close friends who have an emotional connection to the individual they are caring for. Caring for a loved one in need can be an incredibly demanding and stressful experience for informal caregivers. The responsibility of being available around the clock can have a significant impact on their mental and physical health, as well as their financial stability. Essentially, these caregivers are working a full-time job without any real time off, which can quickly take a toll on their overall well-being. It is important that we recognize and support the valuable contributions of these caregivers, and work to alleviate some of the burdens they face daily. It is highly recommended for those with dementia to maintain regular communication with their healthcare professionals to receive the most appropriate care. In some cases, those with dementia may find it difficult to recognize or cooperate with their caregiver, leading to added stress for both parties. The caregiver plays a crucial role in assisting with daily tasks and providing essential care. Establishing a harmonious and empathetic relationship between the individual under care and their caregiver is of paramount importance in promoting an atmosphere of tranquillity and equanimity for all parties involved. It is imperative to prioritize the cultivation of a compassionate and amicable bond to ensure a positive care experience for everyone. Informal caregivers often perform tasks such as cleaning, feeding, assisting with dressing, promoting socialization, providing affection, and supporting medication management [41], [42].

Caregivers are often without a steady source of income and must work full-time to meet daily expenses. Caregivers can be family members such as children, spouses, siblings, or close friends who have a deep emotional connection with the person they are caring for.

It is indisputable that informal caregivers who are tasked with caring for individuals with dementia face a multitude of challenges that can be both psychological and physical in nature. These challenges can also be compounded by financial difficulties, making the role of caregiver a truly demanding one. It is therefore imperative that caregivers maintain regular communication with health professionals to ensure that the patient receives the best possible care. This is because patients with dementia may not always recognize their caregivers, and may even resist cooperation, which can exacerbate the

stress and exhaustion felt by the caregiver. By staying in close contact with health professionals, caregivers can ensure that the patient's needs are being met as effectively as possible and that their own well-being is being properly addressed as well. Those who suffer from dementia often require the aid of informal caregivers to carry out essential daily activities. For the well-being of both the individual and caregiver, it is essential that a harmonious and compassionate connection is established between the two parties. This allows for a peaceful and tranquil atmosphere, which can have a positive impact on the overall quality of life for both the individual and caregiver[4], [43].

2.4 Games for dementia

Participating in games has proven to be a highly advantageous activity for individuals affected by dementia. Not only it aids in the enhancement of cognitive function, but it also promotes social interaction and contributes to overall well-being [44]. The enjoyable experiences instilled by these engaging activities can foster social connections and improve mood. In the realm of dementia care, games are utilized in various ways, including but not limited to reminiscing activities, sensory games, mental stimulation games, and physical exercise games. These activities are designed to cater to the different needs and preferences of individuals affected by dementia, ensuring a fulfilling and engaging experience [23], [45].

Cognitive stimulation games are designed to challenge and stimulate various cognitive abilities, including memory, attention, and problem-solving skills. These games can be played on tablets, computers, or through traditional board games. For example, puzzle games, trivia games, and memory-matching games can help exercise cognitive function. Studies have shown that cognitive stimulation through games can have positive effects on cognitive performance in individuals with dementia [32].

We can have different types of games targeted at dementia. For example, reminiscence games focus on evoking memories and promoting conversation. They often involve looking at pictures, listening to music, or engaging in activities related to past experiences. These games can be played in group settings or one-on-one with a

caregiver. They provide opportunities for individuals with dementia to share stories, reminisce, and maintain a sense of identity [46]. As another example, games that incorporate physical activity, such as modified versions of bowling, golf, or Virtual Reality games, can provide exercise opportunities for individuals with dementia. Physical activity has been shown to have positive effects on cognition and overall well-being in this population [47], [48]. Finally, games that encourage social interaction can help combat social isolation and improve mood in individuals with dementia. Group activities such as card games, board games, or interactive video games can provide opportunities for social engagement and foster connections with others [49].

When selecting games for individuals with dementia, it is of utmost importance to carefully consider the abilities, preferences, and stages of dementia [50]. To ensure that the games are both appropriate and enjoyable, it is highly recommended that caregivers and healthcare professionals provide guidance and support throughout the process. This personalized approach will prove to be invaluable in enhancing the overall gaming experience for those with dementia.

2.5 Technology for dementia

The utilization of technology has become crucial in the care and treatment of dementia [51]. Various types of technology are available to aid in the diagnosis, treatment, and assistance of individuals with dementia and their caregivers. Detecting early signs of dementia can be aided by technology. Mobile apps and tests can be utilized to evaluate cognitive function and identify slight decreases in memory and focus. Wearable devices such as smartwatches have proven to be valuable tools in monitoring the health and well-being of individuals with dementia. These devices are equipped with advanced sensors that can track physical activity, sleep patterns, and heart rate, providing valuable data for healthcare providers. Additionally, these devices can alert caregivers or emergency services in case of an emergency, ensuring that individuals with dementia receive prompt and appropriate care. The use of wearable devices in dementia care represents a significant step forward in the management of this challenging condition and can greatly improve the quality of life of those affected. Individuals with dementia can benefit from a variety of apps and computer programs designed to enhance their

cognition and memory. These tools may include interactive exercises, puzzles, and memory games. For individuals with dementia, technology can aid in the simplification of daily tasks. Electronic devices with programmed reminders and alarms can assist in recalling when to take medication, complete household chores, or attend medical appointments. Communication can become more difficult as dementia progresses. However, there are technologies available to assist with communication, such as computer-assisted communication apps, voice-activated devices, and social robots. These tools can help individuals with dementia communicate and engage socially [51]–[53]. However, it is crucial to emphasize that introducing technology in dementia care requires careful consideration of each person's individual needs. It is important to have the support and guidance of caregivers and healthcare professionals to ensure the proper and safe use of technology [52].

Novel technologies are a breakthrough in supporting diseases such as dementia, enabling greater comfort for caregivers, whether informal or formal caregivers, thus creating a reduction in burden for them [54]. These technologies should be included from an early stage of dementia, to maximize and promote the independence and quality of life of the population in question [54], [55]. There are several types of systems, which are an added value for this population, such as night monitoring, which reduces the risk of falls, GPS systems, which make this population in the early stages of the disease more independent [54], [56].

There are now increasing resources available for individuals with dementia, specifically in terms of cognitive stimulation technologies. Nevertheless, when caring for someone with dementia, it is crucial to utilize various tools and techniques to gradually advance their exercises. This is essential for enhancing their cognitive abilities, memory retention, and overall well-being. By gradually increasing the difficulty level of exercises, we can guarantee that the person we are caring for continues to progress and attain their maximum potential. With regular practice and unwavering support, we can help our loved ones maintain their mental abilities and provide them with a sense of purpose and achievement.

Before providing care for someone with dementia, it is important to conduct a thorough assessment of their individual needs and challenges. This assessment should consider their age, any vision, hearing, or mobility issues they may have, as well as any additional health conditions or phobias they may be dealing with. It is also important to consider their personal preferences and gender when providing care [50]. It is particularly crucial to consider the social and cultural context in which technologies will be utilized [57]. This includes understanding whether the technology will be used at home, outdoors, in a day center, and who will be the primary caregiver. Failure to consider these factors can result in suboptimal outcomes for those in need of assistance.

Nowadays, there are numerous applications for smartphones or tablets that we can use free of charge through the APP STORE (IOS) and PLAY STORE (Android), which can be used by patients with dementia to help in their care, to promote the practice of physical activity and good nutrition, and to support the management of medication [58].
Here we show examples of applications from PLAY STORE:

1. **Yo te cuido Alzheimer:** with a rate of 4.9 out of 5 and with great comments, this is an application dedicated to solving doubts and questions that arise in caregivers and people with Alzheimer's in everyday life. The application was developed by Lapisoft in collaboration with the Association of Families of Alzheimer's Patients of A Coruña (AFACO)(Figure 2 – 3).

Figure 2 - 3 App "Yo te Cuido".

2. **Memory Exercise for Alzheimer's:** with a rating of 4.8 out of 5, this is an application for working and developing memory. The application was developed by Furkan Torun in Istanbul, Türkiye (Figure 2 – 4).

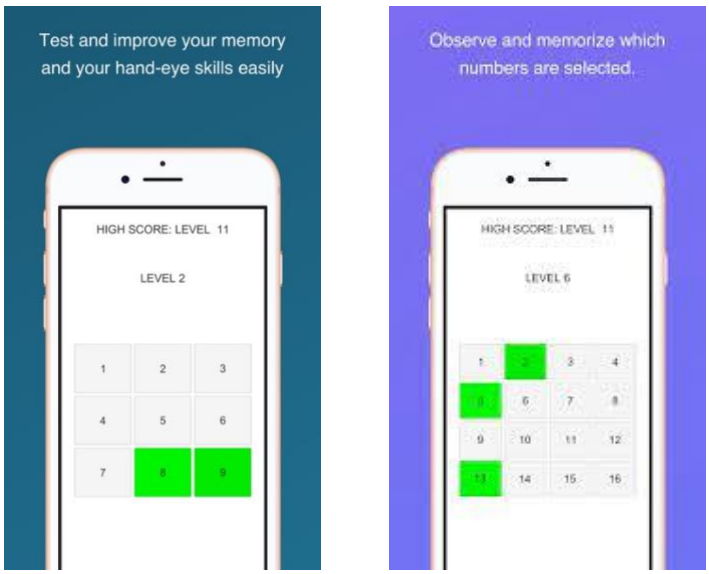


Figure 2 - 4 App "Memory Exercises for Alzheimer".

3. **Amyloids:** An Arcade game that features a rate of 4.8 out of 5. The game is named after a toxic protein that is created in the brain during Alzheimer's, and the game was created in a way that researchers can get more concrete data for their studies. The application was developed by a group of UK researchers called Alzheimer's Research UK (Figure 2 – 5).

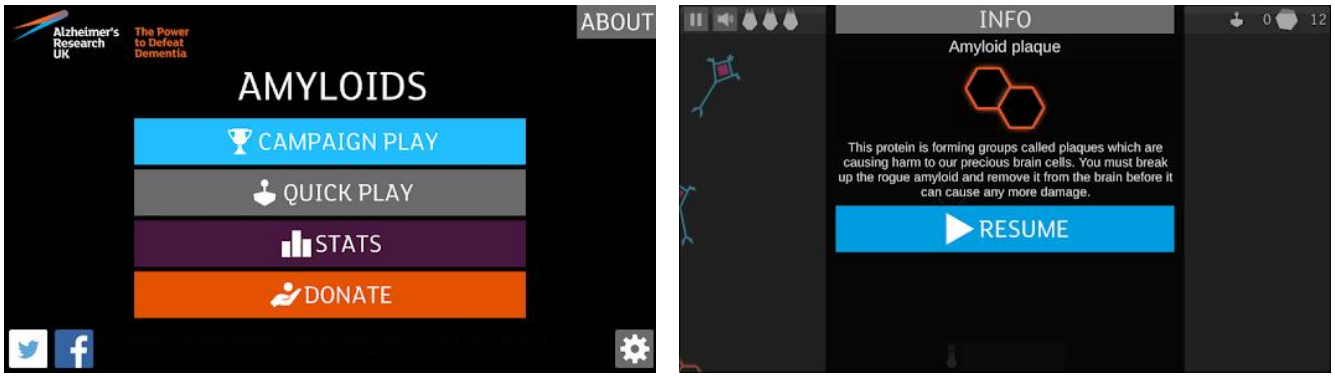


Figure 2 - 5 Arcade Game "Amyloids".

We can also mention other types of technologies that support the day-to-day life not only of the individual with dementia but also the informal caregiver. From these, we highlight motion sensors for when the individual still has motor flexibility and can walk normally around the house, helping to understand where in the house the individual is; articulated beds that support the bed and rise of the same; and location through GPS [59].

2.6. The use of tablets in Dementia Disease

The use of tablets has shown promise in supporting individuals with dementia. Tablets can provide a user-friendly interface and a range of applications that can enhance cognitive function, facilitate communication, and provide entertainment for people with dementia [60]. Tablets offer various cognitive stimulation apps and games that can engage individuals with dementia. These apps often target memory, attention, problem-solving, and language skills. They can be customized to suit the individual's abilities and preferences, providing interactive and engaging activities to stimulate cognitive function [61].

Tablets are suitable as adjuvants in different therapies. For example, reminiscence therapy is commonly used in dementia care to evoke memories and promote conversation. Tablets can be loaded with photos, videos, and music from the individual's past, allowing them to reminisce and engage in meaningful discussions. This can help improve mood, communication, and overall well-being [62]. Regarding communication, dementia can affect an individual's ability to communicate verbally. Tablets can be equipped with communication apps that use pictures, symbols, or text-to-speech capabilities to facilitate communication. They can also provide access to video chat applications, enabling individuals with dementia to connect with their loved ones, reducing feelings of social isolation [52], [60]. Tablets can also be used as a visual reminder system for medication management. Apps can be set up to send reminders for taking medications, displaying pictures or textual prompts to guide the individual through the process. This can help improve medication adherence and reduce the risk of missed doses. Finally, Virtual Reality (VR) applications on tablets can provide immersive experiences that engage the senses and stimulate cognitive function. VR can

recreate familiar environments, offer relaxing nature scenes, or provide interactive games. These experiences can promote relaxation, reduce anxiety, and provide sensory stimulation for individuals with dementia [63].

In order to ensure optimal usage of tablets in dementia care, it is imperative to personalize the experience based on the individual's unique capabilities and preferences. Ongoing support from caregivers or healthcare professionals may also be necessary to facilitate the process. Additionally, further research is necessary to fully understand the long-term benefits and potential drawbacks of tablet usage in the context of dementia care [64]–[66].

3. Understanding the problem and gathering requirements

3.1 Online Questionnaire to Informal and Formal Caregivers

To carry out this research project, we started by developing questionnaires that were disseminated through various communication channels to both formal and informal caregivers. This dissemination of questionnaires aimed to understand who these informal caregivers were, what the relationship between them and the person they cared for and, above all, what their need was, what they most needed. As for the formal caregivers, we were interested in knowing what their professions are, where they mostly work, as well as their needs in order to meet common needs between them. Furthermore, we conducted interviews with both categories of caregivers, with the intention of knowing more about each one, as each caregiver is different, from the personality to the person they care for, as well as their specific needs.

During February 2020, an online questionnaire was conducted to gather information from informal caregivers. The following questions were included: 1) What is your age?; 2) What is your relationship with the person with Dementia Disease; 3) Since when are you an informal caregiver?; 4) What is the stage of the disease of this person?; 5) What is the age of this person?; 6) What were the changes in your day after becoming an informal caregiver?; 7) Being an informal caregiver had any impact on your social life?; 8) How do you describe your physical condition after becoming an informal caregiver?; 9) How much time a week do you dedicate to yourself? Why?; 10) Could you describe any situation you went through after being an informal caregiver?; 11) If you could choose any type of assistive technology, which one would you choose?; 12) With the new situation of social distancing due to COVID-19, have you been experiencing more difficulties in being a caregiver for a patient in a dementia state?; 13) If you would like to be included in a future part of this study, you can leave your contact details in this field. This survey was carried out using Google Forms and was disseminated by various groups on Facebook related to the topic in question in order to reach more people.

The survey received a total of 75 responses. From these 75 answers, we could conclude that the age of informal caregivers ranged between 20 and 85 years old, with a mean

age of 48.9±12.6 years. Regarding the relationship with the person with dementia, most of the informal caregivers were sons/daughters (68%), husband/wife (9%), informal caregivers hired (9%), grandchildren (5%), and brothers (3%). It is an established truth that women are primarily responsible for caregiving duties and are more frequently recipients of care. This phenomenon can be attributed to the fact that women tend to have a longer average lifespan than men [43]. Asking since when these person were informal caregiver we noticed that the most usual time of being an informal caregiver is 2 years (15%), 8 years (12%), 3 years (11%), 10 and 4 years (9%), 15 and 7 years (7%), 6 and 5 years (5%), 18 years (4%), 14 and 11 years (3%), 40, 12 and 9 years (1%). Regarding the stage of the disease, we had answers for initial (23%), intermediate (28%) and advanced (39%). When we ask about the age of the person with dementia disease, we get the most different answers as 73 years old (9%), 88 years old (7%), 82 and 87 years old (5%), 76, 90, 80, 68, 83, 89 and 70 years old (4%), 78, 69, 72, 84, 85, 76, 91, 79 and 100 years old (3%) and with 1% of the answers 96, 56, 86, 75, 81, 63, 77 and 93 years old. When we ask more personal questions like "What has changed in your life after being an informal caregiver", we can get the most diverse answers as follows for example: “Everything”, “Time became very short”, “Although it hasn't changed much, because my mother's type of dementia only affects the dialogue part, I started to contact my mother many more times a day, either in person or by phone.”, “Completely changed mine and my family's household because we decided to move to my father's residence to provide him with maximum support and support because he lived alone.”, “I no longer have time to take care of my health, my family, the stress and it increased due to the lack of attention in hospitals and social security”, “It completely changed my life because I am limited to being 24 hours dependent on my brother's situation because we live in the same house alone.”, “Absolutely everything! I chose not to have a professional or social life in favor of having a life dedicated to the person most important to me”, “My whole life has changed...my routine is to care 24 hours a day...I don't have time for anything other than care...”, “Routines / sensitivity / increased concern / I can no longer go out to be with my mother / more careful eating.”, “I can't be away from home for a

long time, I don't have holidays and my whole life is conditioned by my mother", "Namely, greater social isolation and greater distance in the relationship I had/have with my brothers", "Yes, I stopped having a personal life, making friends, being able to go to a café", "The routine, everything changed... It was an adaptation of new schedules, tasks", between others, basically all caregivers complain about a life of greater social isolation, or even of no longer having a life, of going out, of socializing.

When we asked these informal caregivers about their physical condition, we received answers such as "worn out", "exhausted", "tired", "very depressed", "I stopped exercising", "huge blood vessels burst in my legs", "back discomfort", "body pain, especially shoulders, knees and back", "I lost a lot of weight", with these responses, we see a caregiver who wears himself out, who is mostly tired. When we asked how much time these caregivers dedicate to themselves, the answers were little or no time, as they have no one to leave the people they care for, they do not have a space to rest or relax. We asked these caregivers to describe any situation they have experienced after being informal caregivers. We obtained the following answers as an example "After being an informal caregiver, and appreciating art, I started to value all of my mother's behaviors without getting into confrontation and laughing with her. Creativity is our best ally for the situation in context. We are all artists. And when I'm with her, I'm an actor because I enter her world, I put myself in her place.", "Sometimes the user does not understand what situation they are in, and they think they are capable of carrying out tasks that were once simple and are now complicated. This causes the person in question to have depressive cycles or aggressive moments, which makes it difficult to treat the person.", "Having to go to the hospital urgently and not having anyone to stay with my grandmother as the group of people around is scarce, however, I managed to get help from a neighbor for this specific situation", "It has happened several times, when I'm with my mother, and we meet someone I know, that I have to be the one to give meaning to the conversations because they lack the words.", "Regular absences from work, need to be medicated for anxiety attacks and depressive symptoms, crying spells with the desire to leave home altogether", "So many horrible and incredible things, but what shocks me the most is society's lack of understanding of a problem they are fortunate enough not to know about.", "At first my mother disappeared from the hairdresser without realizing it, it was a big shock, my mother often doesn't know who I

am", "My mother doesn't recognize me or wakes me up at dawn saying I got home at that time, etc.", "In times of crisis I was often attacked. You must take it daily said strong medication".

Later the same year, in November 2020, we conducted a second online survey. The main goal of this second survey was to see if during the time people were at home because COVID-19, the pattern of informal caregivers changed, as well as to obtain new information with different question as 1) Gender; 2) What stage of Dementia disease does the person fall into? 3) What is the age range of people with dementia? 4) What is your relationship with the person with Dementia disease? 5) If your answer was "FORMAL CAREGIVER", what is your area of work? 6) If your answer was "INFORMAL CAREGIVER", what is your relationship with the person with dementia? 7) The person with Dementia disease in question usually: 8) In your opinion, what are the needs of people with Dementia disease? 9) In your opinion, what are the goals for people with Dementia disease? 10) Does the person with dementia with whom you have contact usually use assistive technologies in their daily lives? 11) If you answered "YES" to the question above, what are they? 12) Do you usually play memory games with the person with Dementia Disease? 13) If you answered "YES", what genre of games do you use? 14) Do you think that a person with Dementia Disease would adapt well to an activity that involves interaction with some technology? 14) Do you think that virtual activities will help improve the day-to-day life and the memory capacity of people with Dementia Disease? 15) Do you think music would help people with Dementia disease improve? 16) Do you think that dancing would help in the motor performance of people with Dementia disease?.

From this questionnaire, we collected 58 answers from informal and formal caregivers.

Regarding the sex of the caregivers 77.6% were female and 22.4% male. Concerning the age of the person with dementia the respondents were caregiving, it ranged from 50 to 100 years old (Figure 3 – 1).

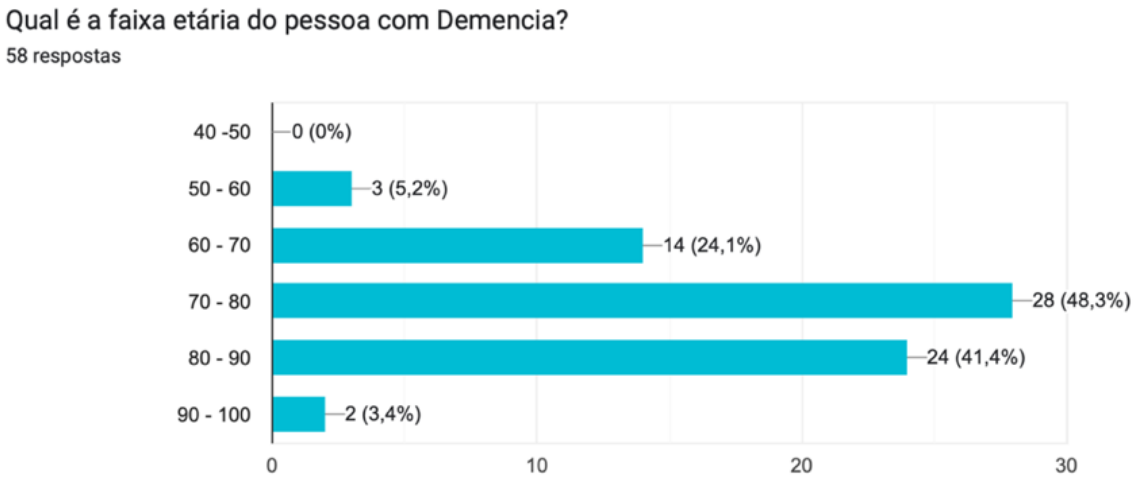


Figure 3 – 1 Answer from the questionnaire to caregivers of people with dementia, Question 3) What is the age range of people with dementia?

In this new questionnaire, we had a more specific question about the relationship with the person with dementia and we observed that 64.4% of the persons were sons/daughters (Figure 3 – 2).

Figure 3 - 2 Answer from the questionnaire to caregivers of people with Dementia, Quention 6) If your answer was "INFORMAL CAREGIVER", what is your relationship with the person with dementia?

Concerning the use of technology, when asking if the person with dementia disease had contact with technology in daily life, we had 44.8% of the answers with “yes” and 53.4% with “no” (Figure 3 - 3).

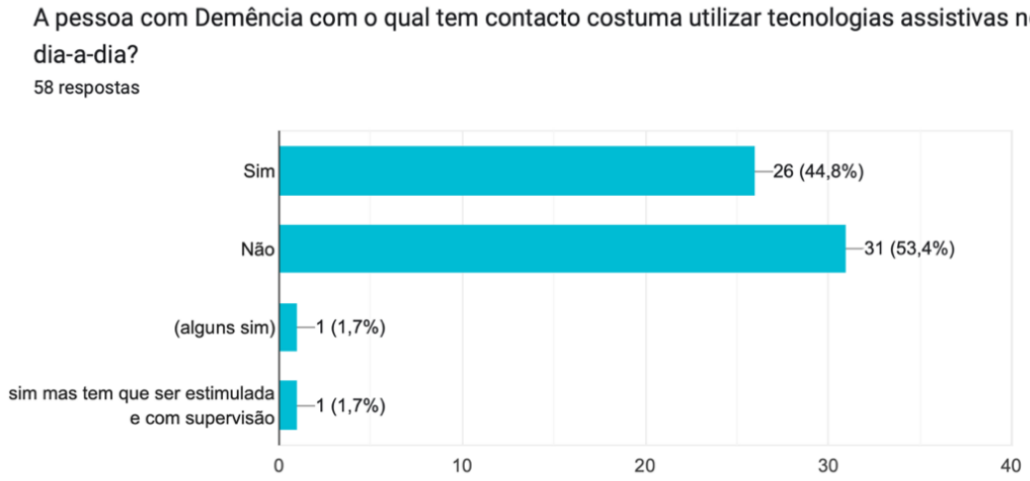


Figure 3 – 3 Answer from the questionnaire to caregivers of people with Dementia, Quention 10) Does the person with dementia with whom you have contact usually use assistive technologies in their daily lives?

When asked if they could adapt well to an activity that involves technology, on a response scale from 1 - Would not adapt to 5 - It would adapt very well, we had 44.8% that answered “Yes” and 53.4% that answered “No”, 1.7% that answered, “some yes”, and 1.7% that answered, “yes but with stimulation and supervision”. This questionnaire was open to formal and informal caregivers, so we obtained responses from both, with 72.4% of responses coming from informal caregivers and 27.6% from formal caregivers. From the formal caregivers, the major of answers was from the technicians (music therapy, psychometrician, Snoezelen) with 31,3%. When we ask what the person with dementia usually does during the day, we get answers such as spending the day in a Day Center (24.1%), Staying at home with the Informal Caregiver (56.9%), Living in a Nursing Home /Home for the elderly (13.8%). When we asked about their opinion, what are the needs of people with Dementia, we obtained answers such as Medical Care (53.4%), a better physical quality (51.7%), A good quality of social and emotional life (79.3%), Access to support services (55.2%), Support from a formal/informal caregiver (58.6%). When asked what the objectives of formal/informal caregivers are for people with dementia, they respond: Being active and doing things you like (72.4%), achieving an improvement in aspects related to the disease (51, 7%), Enable them to be independent in some day-to-day tasks (70.7%).

These surveys helped us to understand from a more realistic point of view who the informal/formal caregivers were in that period, it also helped us to think in a more cohesive way about the focus we wanted to direct when carrying out the application.

3.2. Interviews with Formal and Informal Caregivers

We conducted several interviews with informal caregivers, neuropsychologists, and psychometricians with the goal understand what the needs of this population are. We had several meetings with informal and formal caregivers as “NA”, an informal caregiver and one of the members of ANCI; with the neuropsychologists “GF” and “LN” from Alzheimer Portugal, where we had an impressive conversation about the disease and about the Alzheimer Portugal; with Drª. “PC”, psychometrician “BT” and Music Therapist “PJ” from Lugar de Memórias, where we could discuss ideas and have more information. Additionally, we had a meeting with “MA”, a psychologist from the Unidade de Alzheimer da Ribeira Brava, where we could understand the differences between the population and others.

During an interview with “BT” a psychometrician from Lugar de Memórias, we delved into the topic of creating cognitive games specifically tailored for elderly individuals who suffer from dementia. It quickly became evident that these games are not only beneficial for those who suffer from the condition but also for anyone who is in the process of aging. The importance of such games cannot be overstated, as they play a crucial role in maintaining cognitive function and overall mental acuity. It is of utmost importance to ensure that individuals who are suffering from dementia receive adequate stimulation, as a lack of such stimulation can have a profound impact on their physical and cognitive health. It is crucial to provide them with activities and experiences that will engage their senses and keep their mind active, thereby reducing the risk of further deterioration and promoting a sense of well-being.

Determining the ideal time to engage in cognitive games varies depending on the individual. However, “BT” suggests that people are more inclined to participate in such activities during the morning hours as happens in Lugar de Memórias. By contrast,

undertaking cognitive games in the afternoon may prove less effective since individuals tend to feel more fatigued and disoriented at that time.

As part of the activity plan for users in nursing homes, health homes, and day centers, cognitive stimulation exercises are consistently included from their admission until their discharge. These activities can be done individually or in a group, depending on the person's personality and the stage of their illness. Engaging in these types of activities can greatly enhance an individual's cognitive abilities. These activities focus on a range of cognitive skills, such as concentration, numerical processing, retention of information, communication, motor skills, higher-level thinking, and many others. These are activities that require understanding the association of words to images, colors, everyday objects in daily life activities, musical instruments, overhead projector, sticks, bows, buttons, small colored balls, books sensory, adapted bingos, mimicry, mandalas, letter soups, works manuals, sentence construction, mathematical calculations, beads.

In the Lugar de Memórias, a Day Center for people with Dementia Disease, users participate in sessions individually or in groups. Group cognitive stimulation sessions are mostly performed by the Psychologist; however, all technicians perform group and individual sessions with users. In the area of music therapy and occupational therapy individual and group, sessions have a duration of one hour. In Psychomotricity, individual sessions vary between 30 to 45 minutes and group sessions vary between one hour and one hour and a half.

“BT”, refers that technologies are an interesting and useful tool for populations with dementia, as they are visually appealing, allow to increase the user’s self-esteem, since most of them are not familiar with the use of these instruments, and still allow anyone and everyone, even without literacy, to manage to perform the proposed tasks.

We asked about the usability of a tablet in Lugar de Memórias, and it was answered that they already use the tablet and with success. Everyone can perform activities effectively on them. It was added that any user with dementia can use the tablet if the activities meet the preferences.

The psychometrician “BT” still referred that all exercises are important, however, those that involve everyday objects are fundamental for every user with dementia. The approaches used are those of naming, categorizing, associating, and identification of the different types of therapy available at Lugar de Memórias.

During the interview, we spoke about reminiscence and highlighted that it is important and inevitable in the exercise’s cognitive performance. In the area of Psychomotricity, is often resort to images from the old days and compare them with recent images, with respect to means of transport, kitchen objects, toilet, television, telephone, gardening utensils, public figures, clothing, professions, music, culinary recipes or photographs of users and their families.

With the confinement in the pandemic situation because of the SARS-COV-2, we listen to cases of people with Dementia Disease that regressed at a cognitive level, in this day center, all users without exception lost some skills at both the motor and cognitive levels. After the reassessment of users in June 2020, when the center reopened, all suffered a reduction in the quotations of the applied scales. It is suspected that such is due to the lack of stimulation and the absence of the routines that they had when they went to the Day Center.

We spoke about the idea of this project is to bring to the home of people with the disease, and with the help of the family, a cognitive game, where they can play, and train the cognitive sense without knowing that they are training, to what the psychometrician answer would be very useful, as their work in the day center would be more complete if all family members performed some of their proposed tasks in, they reach the house.
And even for the family members themselves, it would be beneficial, since the user would end up being less time stopped and in turn calmer and busier.

Interviews are truly an asset, as they help us understand each service, person and situation in greater detail. Since we denote the differences between informal caregivers and services that provide care by formal caregivers.

3.2.1. Interviews with dementia population

During interviews with the dementia population, it is often more effective to use closed questions that can be answered with "yes" or "no" for several reasons. Individuals who have dementia often experience a range of cognitive impairments that can make it difficult for them to understand and respond to open-ended questions that require a more complex or detailed response. Closed questions, on the other hand, simplify the cognitive demands of the interaction and provide a more structured and manageable format for individuals with dementia to respond to. Open questions can sometimes lead to confusion or anxiety in individuals with dementia because they may struggle to find the right words or context for their responses. Closed questions reduce this cognitive burden and help individuals feel more at ease. Using closed-ended questions when communicating with someone who has dementia can be highly beneficial. By phrasing questions in a clear and specific manner, individuals with dementia are better able to comprehend and process the information being conveyed. This approach can ultimately result in more precise and significant responses. Nevertheless, while closed-ended questions can be advantageous, it is important to maintain a balance. Open-ended questions can also be valuable in specific circumstances. For instance, they can foster dialogue, prompt individuals to share personal anecdotes, or provide an opportunity for them to articulate their sentiments and viewpoints.

3.3. Observation with Informal Caregivers

We performed observation in two different private homes. In the first observation session we addressed the case of C1, an 85-year-old lady with a dementia state in the initial phase. This lady was still showing a good degree of autonomy with her daily tasks. The observation took 4 hours (in her house and the café). We observed a calm personality with some punctual changes when frustrated or when the daughter told her to do something; a lady that still cooked and cleaned, with a good cognitive and motor functionality, but that when tired or performing the same task for a long period, got easily lost. This family lost a member two weeks before the observation. In an initial conversation with C1, she referred that event, but in the middle of the observation

session, she started asking about the time the deceased person would arrive. She did not remember about his death.

In the second session, we observed C2, a 93-year-old lady that was completely dependent on her daughter. The husband of C2 was 96 years old and could not provide extended support to his wife because of his age. Hence, the daughter moved to their house and was responsible for most of the tasks. C2 had dementia disease in an advanced stage, could not talk and eat properly (she had a nasogastric tube to eat, where the daughter gives the food with a syringe) and could not walk. It was a 2 and half hours observation session, where were never saw the informal caregiver take a rest.

It was very important to have this opportunity to observe and spend a little time with informal caregivers, often with the feeling that they were left abandoned, tired and exhausted from caring for someone with Dementia every day. What we realized is that there is a gap, perhaps in terms of resources, where information does not reach everyone. When we spoke to these informal caregivers, they mentioned their difficulties, from not having time to take care of themselves or even their homes as a whole, as the people they care for are not alone, to having to resolve issues outside of their homes and they had to take them too, they had no way of entertaining them in a way that would leave them relaxed and at ease. These caregivers were looking for something that could be used as a form of entertainment for these people, that would be an asset on a physical and mental level, and that would be easy to transport.

3.4 Participatory Design

We did a participatory design study (Figure 3 – 4) that was accomplished with the psychometrician “BT” and the neuropsychologist “LN”, from where we could take valuable insights. The objective of carrying out a Participatory Design with formal caregivers, in this case neuropsychologists and psychometrician, was to understand how at a visual level we should create our application, in order to follow the needs and parameters relating to people in this population. This small study was carried out in two

individual sessions with the formal caregivers in question, where we discussed ideas and exercises examples.

The cognitive stimulation of a person with Dementia Disease must be the most worked because it is the area that is more damaged. After the lockdown, they noticed that the people with dementia disease that stayed at home lost a part of their cognitive skills, because of the little interest from the familiars, maybe because of the way that the cognitive exercises were given.

For a tablet application, we should have in mind the use of solid colors and not too dark, light, and clean backgrounds. It is not nice for people with dementia to have many visual stimulations, as they start to stay confused, restless, and anxious. Not often able to work the cognitive part. The images on the screen should be realistic and have a measure of at least 8x6 centimeters. Sometimes, and depending always on the person and the stage of the disease, if the image is not realistic, they cannot understand what it is. For the buttons of the cognitive game, we should use a diameter of 3 centimeters for circles and 3x3 centimeters for squares. About the words to apply during the game, we should not use formal words, as they cannot understand them.

The cognitive exercises that we can add can be associated with words and images, for instance, we can put an image of the sun, and the words wind, rain, and sun, and the people with dementia have to say which one it is. We can use the hangman game, putting the letters of the beginning, middle, and final. As well use exercises that they can train the house divisions, the flowers, types of food, countries, the seasons of the year, types of clothes, the family members (degrees of kinship), the body parts, the vegetables, fruit, and festive seasons.

If we want to add music, we must go back to their Epoque and check first in general which type of music they like the most, for instance, the singers Amália Rodrigues, Zeca Afonso, Carlos Paião, Paulo de Carvalho. We can create cognitive exercises by adding the lyrics with some missing words where they must choose the right one or as well play the music and they must discover what the singer is.

About festive seasons, we can create exercises with recipes, images of the seasons, and proverbs that they must complete it or discover the word that is missing.
If we want to add mathematics, we can use exercises where they can add or subtract money, for the ones who are still independent in this part and still use money. And complex accounts that for them are, for instance, 25+75=99/121+69=190 or 7x7=49/9x8=72.

We should not use any punctuation, time, or add any pressure so that they cannot be frustrated or comparisons during group sessions. We should always give rewards with sounds like claps and fireworks, and use sentences such as “Great, you did it! Or “Amazing, you are the best!” if they managed to solve all the exercises, or “Wow, you've made it this far. Let's try again” and “You are the greatest! We were able to solve a lot of exercises. Let's try again?” for when people with Dementia Disease are unable to solve the exercises.

The participatory design with both formal caregivers was very important to understand the real needs of a person with dementia. The truth is that even if caregivers monitor the entire use of the application, it becomes difficult when it is not well received by our target audience, whether because of very small images, very complex questions, sounds that create frustration, among other points that make these users lose all interest in the application.
From this point onwards, whole visual research began, as well as sketches of what was intended, where we began to shape our application. In the image below (Figure 3 - 4), we can visualize a summary of what was extracted from the entire participatory design, which was divided into four key points, namely Technology, Design, Game Features.

Design Toolbox	
Technology	- Tablet application - Portable - Usable everywhere - No need for print if send it to home - Usable because elder people are not used to it - Create a connection between the younger and elder people - Database where we can check the evolution from each user. - As future work, the updates will be done directly in the application
Design	- Real images - Images with 8 cm x 6 cm - Buttons with 3 cm x 3cm or 3 cm of diameter - Light background - Light color (soft/pastel colors) - Easy sentences - Screen composition without too many visual stimulations, because causes stress
Game	- Ludic and didactic - Easy to understand - Give a challenge in a certain way - Funny and motivational - Use of hints during the game to help the user
Features	**Cognitive exercises:** - Words and images association - Hangman Game using almost all the letters of the word (i.e., B_N_A) - Inverted cards - Not too much information - Themes: House divisions, Flowers, Food, Seasons, Countries, Clothes, Family kinship, Body parts, vegetables, Fruit, Festive days - Music (instrumental, vocal) - Festive Seasons (music, recipes, images) - Count of vowels in a word - Complex and simple accounts (i.e., 24+27= / 121+69)

Figure 3 - 4 Design Toolbox created with formal caregivers.

3.5 Personas

Personas are fictional characters or representations that are created to embody specific user types or audience segments. They are widely used in various fields, to better understand and address the needs, goals, behaviours, and preferences of different groups of people. Personas help teams and individuals develop a deeper empathy for their target users, allowing them to design products, services, or experiences that are more relevant and user centric. We developed two personas that represent potential typical users of our application.

Figure 3 – 5 Persona 1, Lícia Pereira.

Dr. Marco Marques

Neuropsychologist

Age	:	40
Occupation	:	Neuropsychologyst
Locations	:	Funchal

Personality Traits

Analytical, compassionate, innovative, detail-oriented, dedicated to research-driven care.

Bio

Dr. Marco Marques is a 40-year-old neuropsychologist with a specialization in geriatric care. He works at a leading research hospital and is dedicated to improving the cognitive health and quality of life of older adults, particularly those with dementia. Dr. Marco is involved in clinical research and the development of cognitive stimulation interventions.

Goals

1) Develop evidence-based cognitive stimulation programs tailored to the unique needs of dementia patients.
2) Stay updated with the latest research and developments in the field of cognitive interventions.
3) Collaborate with interdisciplinary teams to provide comprehensive care for dementia patients.
4) Advocate for the integration of cognitive stimulation into standard dementia care protocols.
5) Contribute to the training and education of fellow healthcare professionals.

Challenges

1) Balancing her clinical practice, research, and administrative responsibilities is demanding.
2) Navigating ethical considerations when working with vulnerable dementia patients and their families.
3) Ensuring that cognitive stimulation interventions are culturally sensitive and accessible to diverse populations.

Key Needs

1) Access to the latest research findings, clinical studies, and best practices in cognitive stimulation.
2) Tools and technologies for designing and monitoring personalized cognitive stimulation programs.
3) Collaboration platforms to coordinate efforts with other healthcare professionals and researchers.
4) Opportunities for professional development and presenting her work at conferences.

Figure 3 – 6 Persona 2, Dr. Marco Marques.

Creating personas for healthcare professionals is typically defined with specific goals because these professionals need clear guidance and training in providing consistent and effective care. Healthcare professionals, including doctors, nurses, psychologists, neuropsychologists, and caregivers, benefit from clear personas because it helps them understand their roles, responsibilities, and the specific needs of the patients they are caring for. These personas guide professionals in delivering standardized care protocols. In a healthcare setting, consistency in care is crucial to ensure patient safety and quality of care. Standardized personas for healthcare professionals help in achieving this consistency. In contrast, creating personas for patients is a more nuanced process. Each person with dementia is unique, and their needs, preferences, and experiences can vary greatly. When providing care for dementia patients, it is essential to take an individualized approach. Dementia patients come from diverse backgrounds, have different life experiences, and may have varying levels of cognitive ability. Creating a one-size-fits-all persona for them is not practical.

In the context of our application, we found it imperative to focus on creating personas for formal caregivers rather than for individuals with dementia. This approach allowed us to gain a better understanding of the needs, preferences, and challenges faced by the caregivers who are responsible for providing care and support to people with dementia. By creating detailed personas for formal caregivers, we can develop tailored solutions that consider their unique circumstances and improve the overall quality of care provided to individuals with dementia.

4 Development of MentalSense: A Ludic and Didactic Game for people with Dementia

The implementation of the solution in this project is a result of thorough research, incorporating state-of-the-art techniques, interviews, observations, questionnaires, and participatory design studies. The collective input from these efforts has been instrumental in developing a comprehensive and effective solution.

When designing for individuals with cognitive limitations, such as dementia, it is imperative to take into account their deficits in attention, perception, memory, and problem-solving, as these can significantly impact their interaction with technology. It is crucial to consider these limitations when designing technology that will be used by this population, as it can greatly improve their ability to use and benefit from the technology. Therefore, it is essential to incorporate design features that are tailored to the specific needs of this population, such as simplifying interfaces, reducing cognitive load, and providing clear and concise instructions. By doing so, we can ensure that technology is accessible and usable by all individuals, regardless of their cognitive abilities[67]. Hence, the following elements should be considered: 1) Eliminating what causes stress and frustration, creating a simple design, and reducing the complexity of the software; 2) All the tools needed on the screen, without having the need to investigate the application; 3) Use of large icons, buttons, and images; 4) Familiar names and simple sentences; 5) Use of descriptive texts to help the way they use the application; 6) Use of appropriate graphics; and 7) Use of light and soft colors [68].

4.1 Brainstorming Process

Brainstorming is a widely recognized technique that is employed to generate creative solutions to problems. This involves the generation of a large number of ideas within a short period of time, which allows for the exploration of various perspectives and potential solutions. The main objective of brainstorming is to encourage free thinking and suspend judgment during the idea-generation phase, thereby allowing participants to come up with innovative and unique solutions. By setting aside criticism and allowing

ideas to flow freely, a range of diverse ideas can be generated, which can then be evaluated and refined to select the best solution. Brainstorming is, therefore, an effective means of generating a variety of ideas that can be assessed, resulting in the selection of the most suitable solution. Nine brainstorming (figure 4 – 4) sessions were held, some of the sessions using research at the time and others with the support of formal and informal caregivers. Some of the ideas that emerged were:

1. Using a bracelet (an element that is not very evasive to the patient) with sensors, which would be connected to an application and which, through graphics, would show the level of colors and waves as the Dementia Patient is (anxious, afraid, happy, sad...).
2. Also with the bracelet, the patient, depending on his emotional state, would listen to music that would provide calmness and serenity. In order to help the informal caregiver to modify the emotional state of the patient.
3. Using a tracking system. This need was referred by “NA”, an informal caregiver and member from ANCI – Associação Nacional de Cuidadores Informais. She told us that this solution is needed in Portugal.
4. The need of memorandos. Placement of a device with reminders in the homes of people with Dementia, activated with sensors and connected to an application controlled by the informal caregiver, who, when passing by, would refer to their name, such as: "Hello Ana.", with information regarding the calendar and what the person should do that day.
5. The use of Playtronica device which is a creative platform that combines music and technology to create interactive experiences. It allows people to explore music and sound in a hands-on and playful way. Playtronica offers various interactive devices and tools that enable users to turn everyday objects into musical instruments or create music through physical interaction. Playtron (Figure 4 – 1), which is a device that we can connect to 16 objects with alligator clips, picking different sounds for each (Figure 4 – 2; Figure 4 – 3).

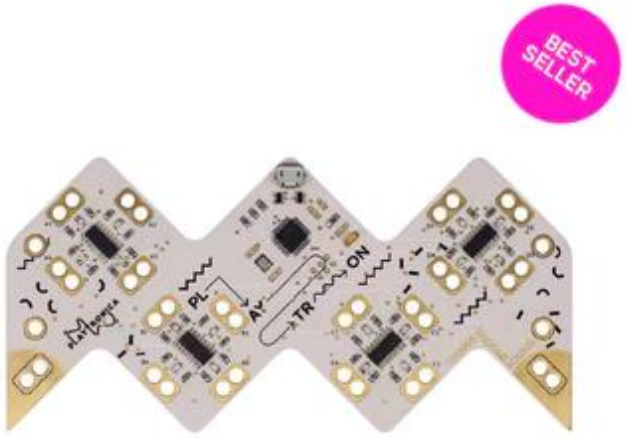


Figure 4 - 1 Playtron Device.

A key goal of the therapeutic approach is to help people and groups who are impacted by Dementia Disease to produce sound using everyday objects within a calm and peaceful setting. Additionally, the approach aims to incorporate a tactile element to further enhance the sensory experience. By providing a variety of objects and materials that can be touched and manipulated, individuals with Dementia can engage in a stimulating and rewarding activity that promotes relaxation, creativity, and social interaction. The use of sound and tactile sensations has been shown to have a positive impact on those with Dementia, as it can improve their mood, reduce agitation, and enhance their overall sense of well-being.

Figure 4 – 2 /3 Setup for the Playtron experience.

When we reached out to Playtronica with the idea for our study, they were quick to offer their Playtron device for us to use. The device proved to be an integral component in our

research, allowing us to understand what we were looking for. We are grateful for Playtronica's prompt response and willingness to support our work with their technology. Since after a more in-depth study of the subject and a meeting with the music therapist from “Lugar de Memórias”, and after her and the director of the space tried the Playtron, we reached the conclusion that the idea would not be the best due to the loss of interest of the users. The sounds created were not captivating and the objects used, or that could be used, were not of interest to all users, due to the different and special needs of each one.

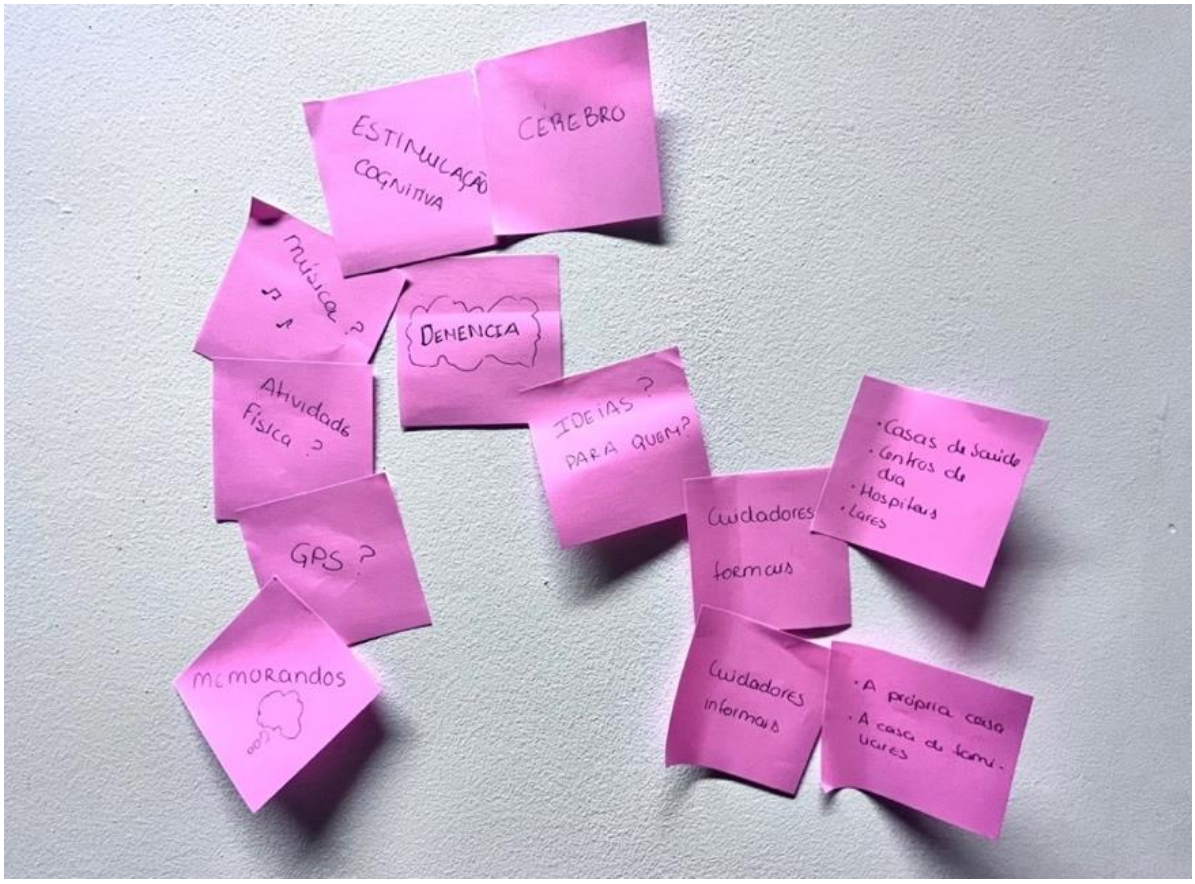


Figure 4 – 4 Brainstorming.

4.2 Moodboard

A moodboard is a visual tool used to capture and convey the overall mood, atmosphere, and aesthetic of a concept, project, or design. It is a collage or collection of images, textures, colors, patterns, and typography that represents the desired look and feel of the subject matter.

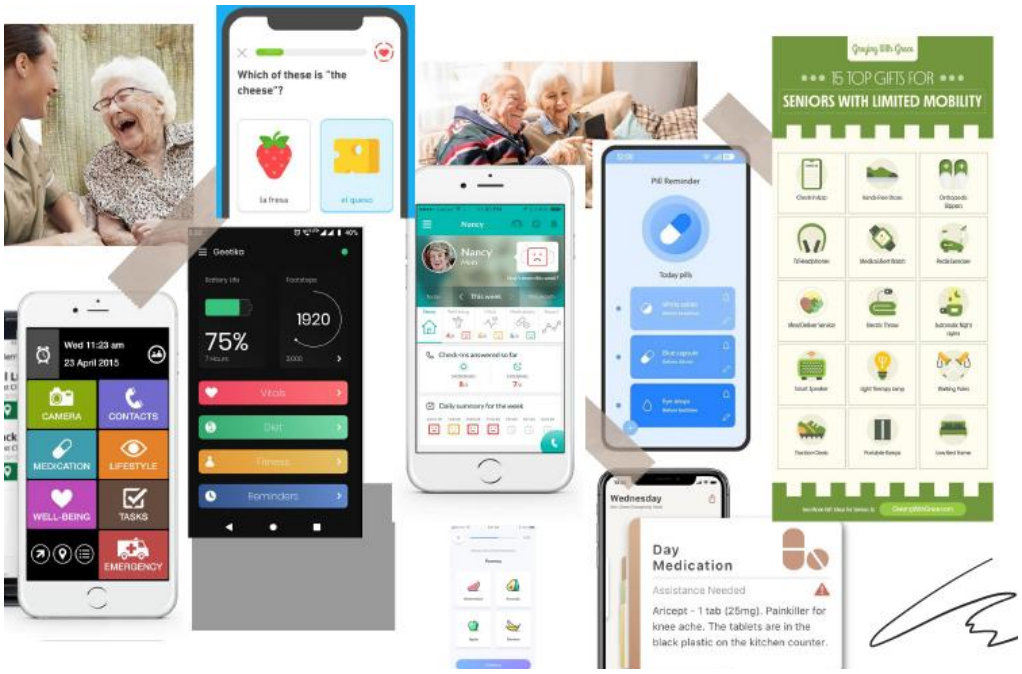


Figure 4 - 5 Moodboard for MentalSense design

Moodboards are commonly used in various creative fields such as graphic design, fashion design, interior design, advertising, and marketing. They serve as a source of inspiration and a visual reference for designers, clients, or collaborators to ensure a shared understanding of the desired visual direction.

The moodboard (Figure 4 – 5) was created at an early stage of the project, where images were chosen that inspired us to start the entire design of the project, this being a visual basis for the project.

4.3 Color Study

It is important to take into account the specific needs and sensitivities of individuals with dementia when choosing colors for their environment or designs [69]. It is crucial to understand that each individual with dementia can have different color preferences and responses. Therefore, it's necessary to observe and assess the specific needs and reactions of the individuals in question [50]. Consulting with healthcare professionals or specialists in dementia care can provide further guidance tailored to the specific needs of the individuals we are working with.

As mentioned by the psychometrician in the participatory design and following the state-of-the-art, we should use solid colors and not too dark, light, and soft ones. Taking that as a base, for the application we used the colors shown in Figure 4 – 6.

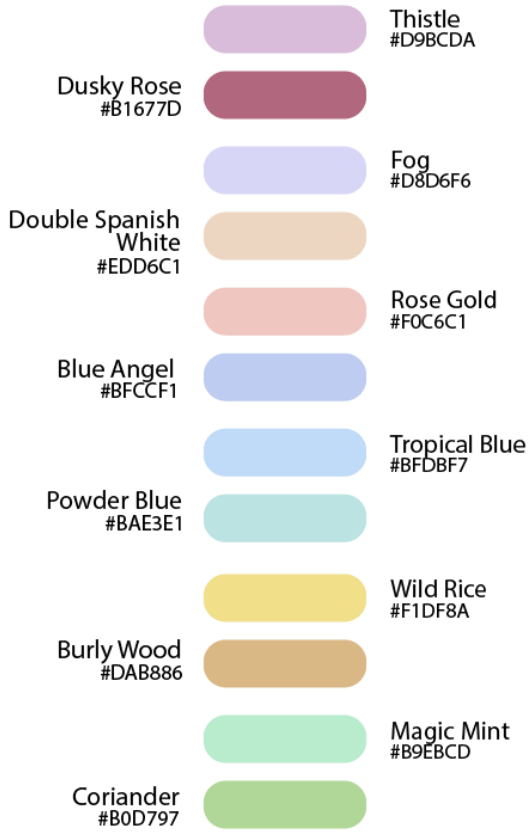


Figure 4 – 6 Colors used in the application.

4.4 Typeface

Quicksand is a popular sans-serif font that is known for its clean, modern, and versatile design (Figure 4 – 7). It was created by Andrew Paglinawan and is often used in various design projects, including websites, print materials, user interfaces, and more. Quicksand's characteristics make it a popular choice for conveying a sense of simplicity, elegance, and readability. Quicksand has a minimalistic and straightforward style, making it suitable for both headings and body text. It comes in multiple weights (Light, Regular, Medium, Bold) and italics, allowing for flexibility in design. The font's clean lines and open letterforms contribute to its high legibility, even at smaller sizes. Quicksand is

available as an open-source font, which means you can use it freely for personal and commercial projects without purchasing a license. We can find and download the Quicksand font from various online font repositories such as Google Fonts, Font Squirrel, or GitHub.

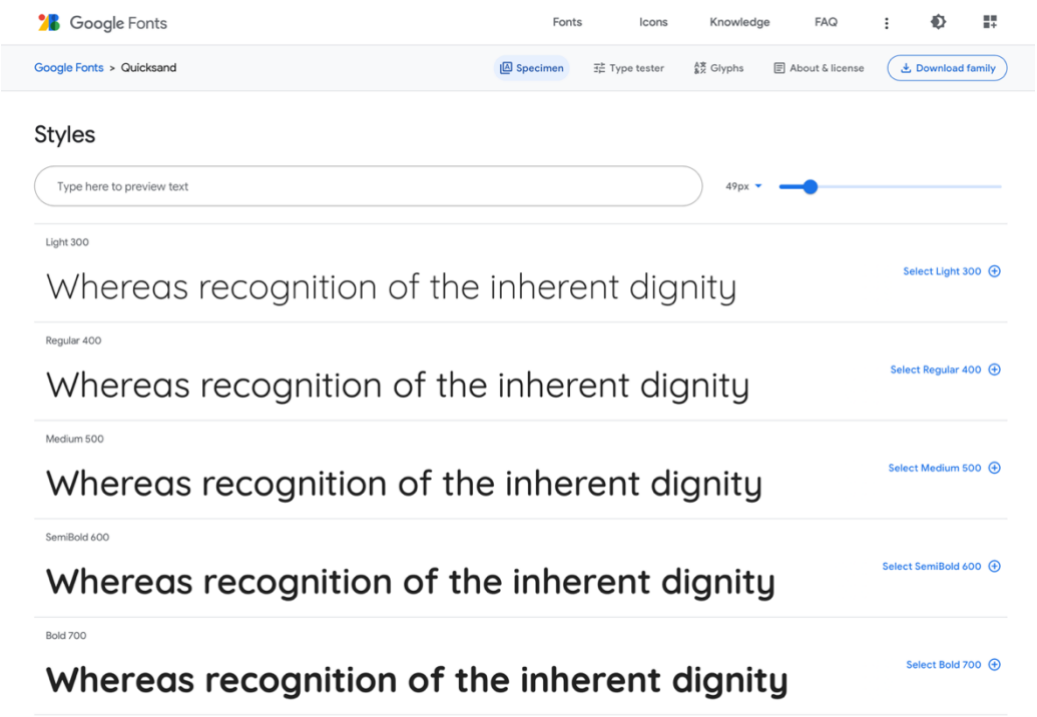


Figure 4 – 7 Quicksand family font.

4.5 Story of the game

Storytelling in games is a dynamic and immersive way to engage players. It combines traditional narrative elements with interactivity, allowing gamers to become active participants in the story. Through character development and decision-making, games can evoke strong emotional responses from players, creating a more profound connection to the narrative. Storytelling in games for dementia is a fascinating and promising area of game development, where interactive narratives are harnessed to benefit individuals suffering from dementia or cognitive impairments. These games utilize various techniques and strategies to provide therapeutic, engaging, and supportive experiences for both patients and caregivers. In these games aims to trigger emotional responses and memories. By presenting relatable and emotional narratives,

games can help individuals connect with their past and evoke positive emotions, which can be particularly valuable for individuals with dementia.

One of the therapeutic approaches that has been shown to be effective when working with people with dementia is using a story. In this case, we are using a story of a missing dog, that has to return home. Dogs can play a significant and positive role in the lives of people with dementia. A dog often leads to increased emotional well-being. Dogs can offer comfort, reduce anxiety, and provide a source of unconditional love and support. This technique involves discussing a hypothetical situation where a dog has gone missing, and the group is tasked with finding the dog. This exercise can help stimulate cognitive function, promote memory recall, and provide a sense of purpose and accomplishment to those involved. Additionally, it can serve as a topic of conversation and social interaction, which can be beneficial for individuals with dementia who may struggle with communication and socialization. Moreover, the story of a missing dog can tap into the emotional connections and memories of individuals with dementia. Many people have had positive experiences with pets, and this story can evoke feelings of empathy and concern, fostering emotional engagement. Simple and relatable stories are often easier for individuals with dementia to understand and follow. The story of a missing dog is straightforward and does not involve complex plotlines or multiple characters. The story can serve as a conversation starter. Caregivers, family members, or healthcare professionals can use the story to initiate conversations and connect with the person with dementia. Finally, engaging in the story can provide a distraction from any anxiety, confusion, or distress that individuals with dementia might be experiencing. It can redirect their attention to a more positive and engaging topic.

It is important to note that using the story of a missing dog is just one example of a therapeutic approach. The choice of story or method should be individualized to the person's preferences and cognitive abilities or to the population that we are working with.

4.6 Wireframes and firsts screens design

Wireframes play a crucial role in the design process, particularly in user experience (UX) and user interface (UI) design. They act as the fundamental blueprint for a digital product by outlining its layout, structure, and functionality before the actual design and development work begins. Wireframes serve as architectural sketches that guide designers, developers, and stakeholders through the initial stages of a project. In the following image (Figure 4 -8), we can find the wireframe made prior to the design of the application.

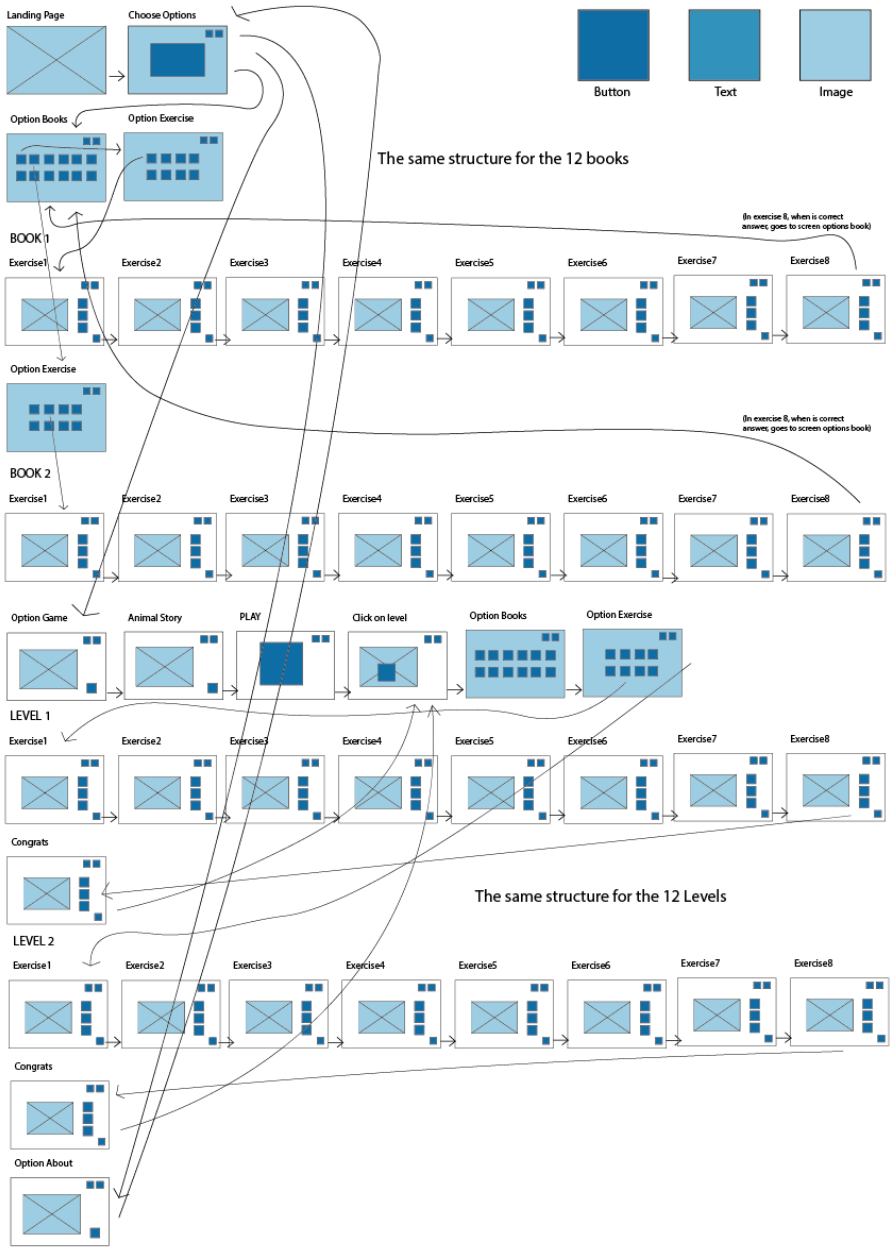


Figure 4 – 8 Application Wireframe.

After finishing the wireframe, we switched to the Adobe Illustrator program to start designing the application's screens, based on the participatory design and the state-of-the-art. As described in point 3.4 of this dissertation, following the participatory design, brainstorming, and initial sketches, the plan was to develop a cognitive stimulation app for individuals with dementia. This app should be designed to be used in formal settings. The initial idea was to create a game with levels as we can see in the figure bellow (Figure 4 – 9), in which users would have to answer several questions correctly until they reached the last level. To do this, users would play with a dog, this being one of the most common pets.

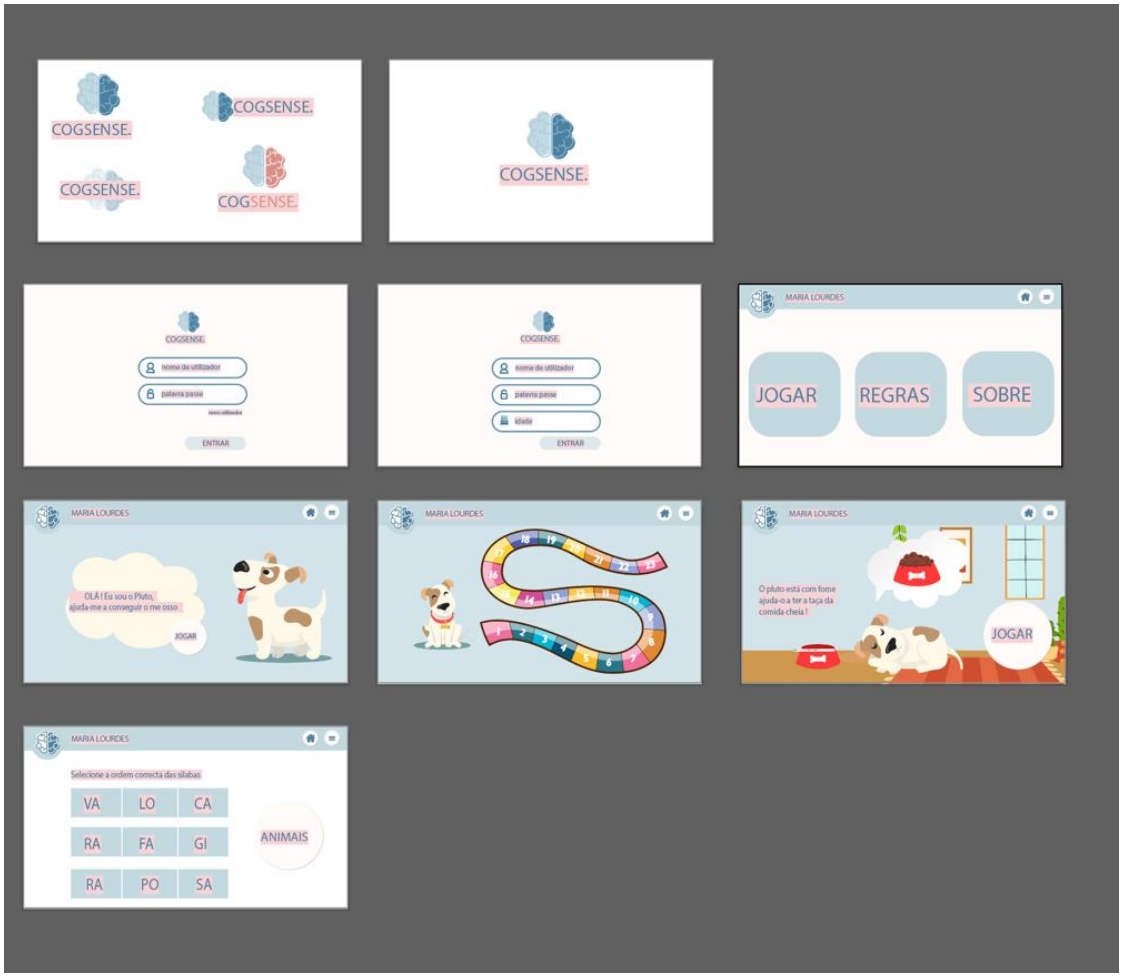


Figure 4 - 9 Initial Design in Adobe Illustrator.

In order to provide a clear visualization of the application's flow, a pre-programmed design study has been created and passed to Unity. The design study includes various elements that allow for a comprehensive understanding of the application's structure.

Figure 4-14 provides a visual representation of the design study, showcasing its complexity and functionality. By using this design study, it is possible to gain insights into the various stages of the application and ensure that it operates smoothly and efficiently.

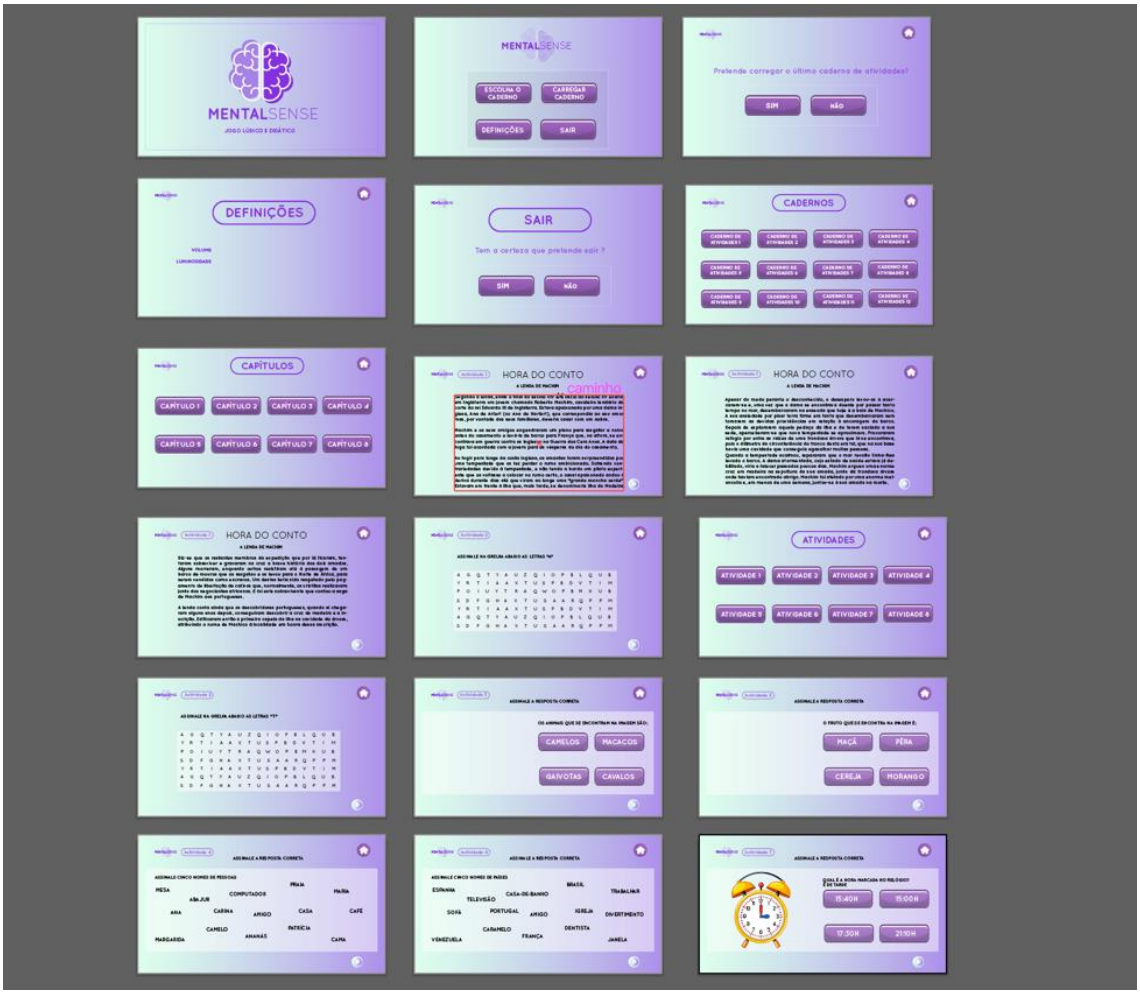


Figure 4 - 10 First Design Study programmed in Unity.

To gain insight into the application's visual aesthetics and layout, it is highly recommended to refer to Figure 4-11, which showcases the latest version of the design that is currently being finalized. The design was implemented in the pilot study as discussed in section 4.11 and serves as a concrete representation of the application's look and feel, including its color scheme, exercise regime, layout, and overall visual

appeal. By examining this design, we can gain a better understanding of the application's intended user experience.

Figure 4 - 11 Design Study used for the Pilot Study.

4.7 Flowchart

The image displayed below (Figure 4 – 12) illustrates a detailed flowchart of the MentalSense application, which provides an overview of the navigation process. This flowchart showcases every step that a user can take while using the application, allowing for a better understanding of the application's functionalities. By studying this flowchart, users can navigate through the application with ease and better comprehend the various features available to them.

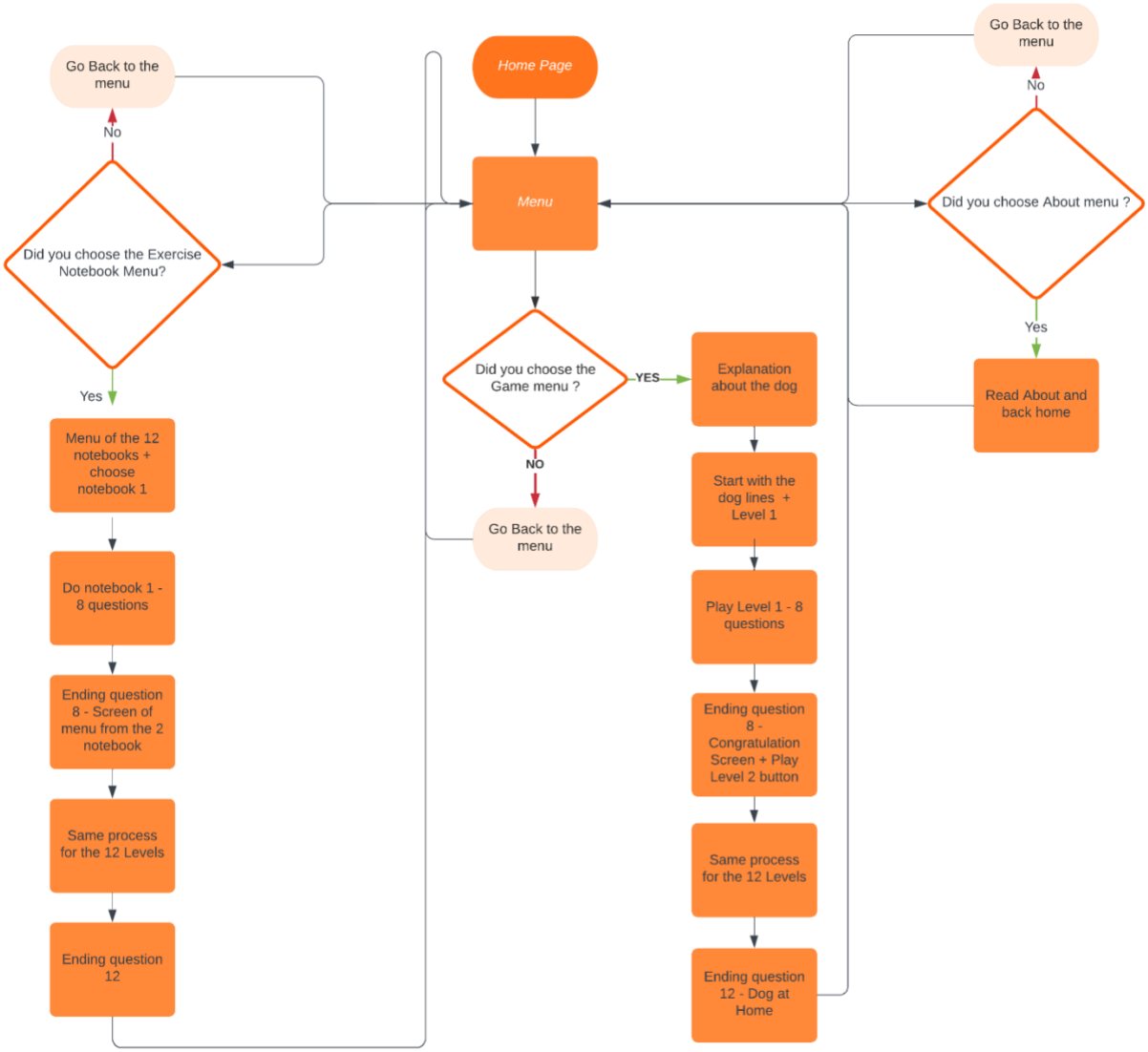


Figure 4 – 12 MentalSense flowchart.

4.8 Unity and Game Creator Plugin

Unity is a powerful and popular game engine that is widely used for developing both 2D and 3D games across various platforms, including PC, consoles, mobile devices, and VR/AR devices. It provides a comprehensive suite of tools for game development, including graphics rendering, physics simulation, animation, scripting, and more. Unity allows developers to create immersive and interactive experiences, making it a go-to choice for game developers of all skill levels.

One notable aspect of Unity is its extensibility through plugins and extensions, which can enhance its functionality and streamline the game development process. While Unity itself offers a wide range of built-in features, developers often turn to third-party plugins to further optimize their workflows and achieve specific goals. These plugins can cover various aspects of game development, from asset management and optimization to AI behavior and special effects.

One of the plugins, the "Game Creator" plugin, the one that was used to create the application, is designed to simplify game development within Unity. It is a visual scripting tool that allows developers to create gameplay mechanics and interactions without writing extensive lines of code. With Game Creator, users can create game logic, character behaviors, quests, and more using a node-based interface, often referred to as visual scripting or node-based scripting. Game creator plugins are particularly beneficial for indie developers, hobbyists, and those new to game development, as they offer an entry point into the world of game design and programming without requiring in-depth knowledge of programming languages. Game creator plugins typically offer a visual scripting interface, where developers can create gameplay mechanics and interactions by connecting nodes or blocks representing actions, events, and conditions. This approach eliminates the need for traditional coding, making game development more accessible.

Many game creator plugins include libraries of assets such as characters, animations, environments, and sound effects. These assets can be easily incorporated into games,

saving time and effort in asset creation. Popular examples of game creator plugins include Bolt for Unity and Blueprints for Unreal Engine. These plugins have empowered countless individuals to bring their game ideas to life and contribute to the diversity of the gaming industry.

4.8.1 Tablet app in Unity

Creating a tablet app with game creator tools in Unity involves combining the capabilities of the Unity engine with a visual scripting or game creator toolset to design and develop interactive experiences for tablet devices. In the ever-evolving landscape of digital technology, tablet apps have emerged as powerful tools that seamlessly blend utility, entertainment, and creativity. Leveraging the capabilities of Unity, a robust game development engine, developers have unlocked a realm of possibilities for crafting engaging and immersive tablet applications that captivate users across diverse demographics. Unity's versatile framework serves as an ideal canvas for tablet app creation, allowing developers to shape interactive experiences that range from educational wonders to captivating games and innovative utilities.

Here are some examples of programming done using Game Creator, in Unity. We created four scenes to create the application (Figure 4 – 13).

Figure 4 - 13 Scenes in Unity.

In the Scene Landing (Figure 4 – 14/15), we created a trigger with the following Actions: 1) Wait with the 0.5 time, and Load Scene, where we placed the name of the scene that we wanted to appear in the value, as shown in the images below.

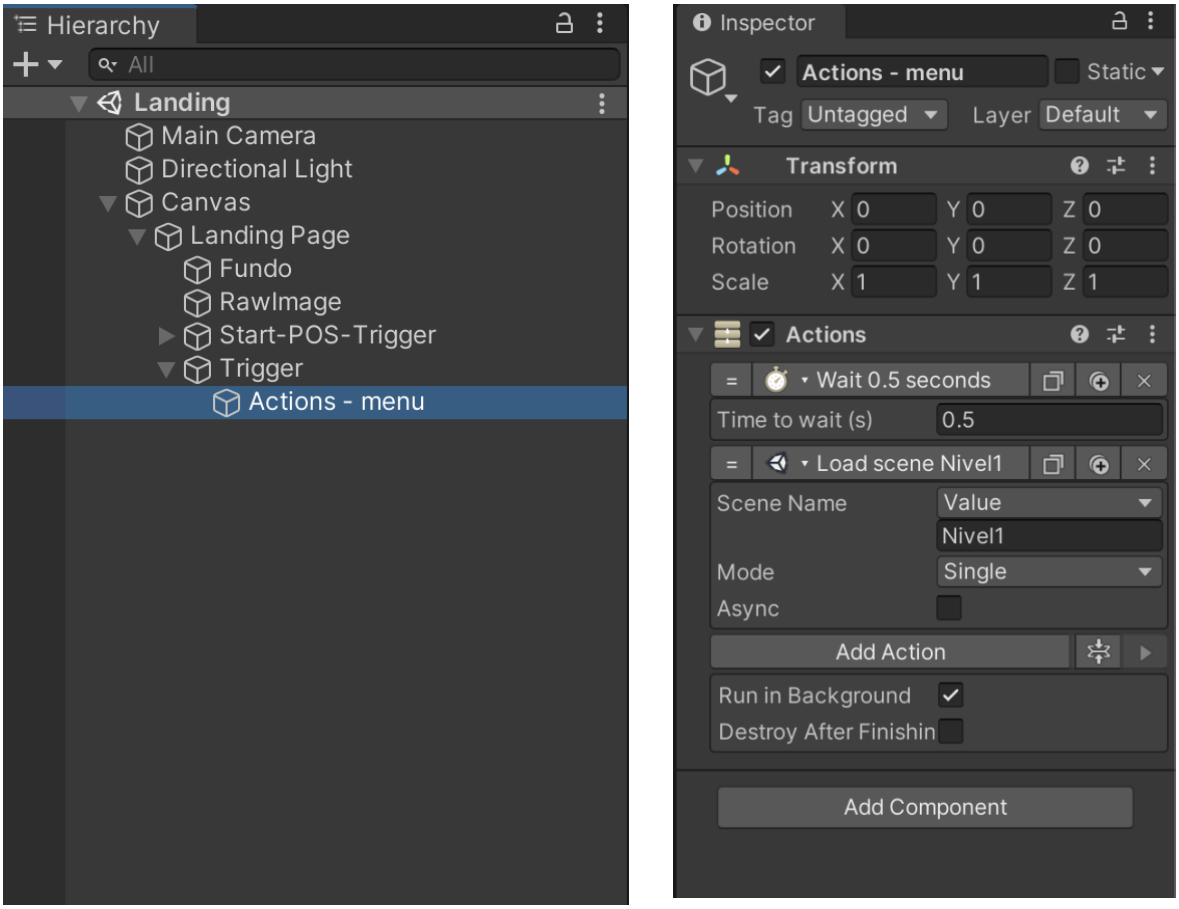


Figure 4 – 14/15 Trigger from Landing Page.

The scene Nivel1 (Figure 4 – 16/17), is where we have the application menu segment where we find the game with the animal as well as the notebooks by themselves and the about menu.

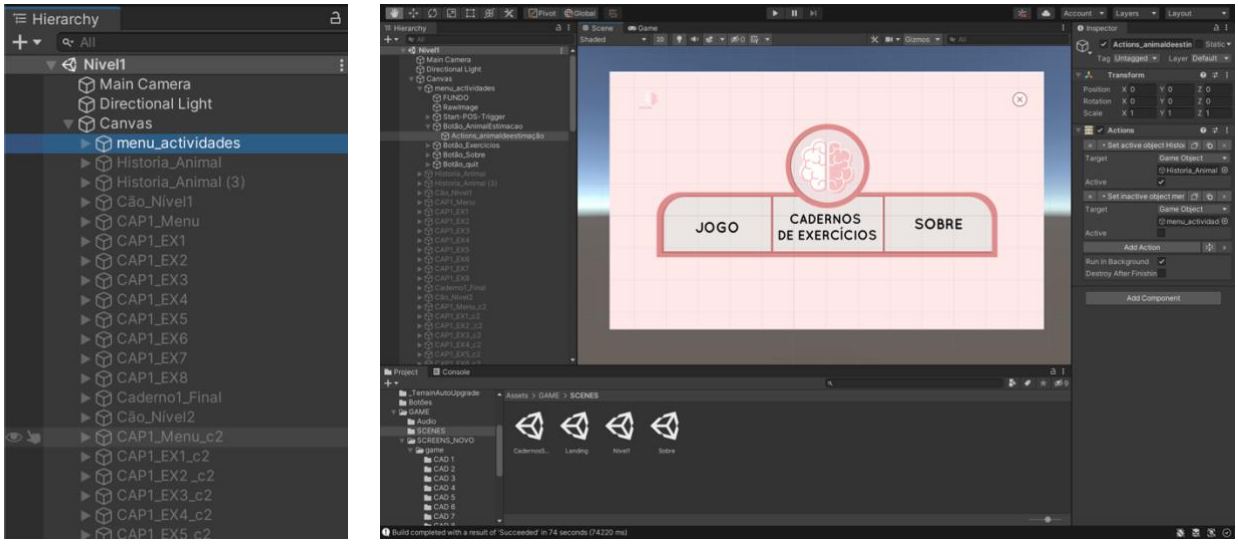


Figure 4 – 16/17 Activities Menu.

In these images we can see the menu of the application (Figure 4 – 18) as well the segment of the application in the game part (Figure 4 – 19). Basically, we put all the objects inactive, using the actions set active/inactive to create the applications, as we can see in the image bellow in the inspector area.

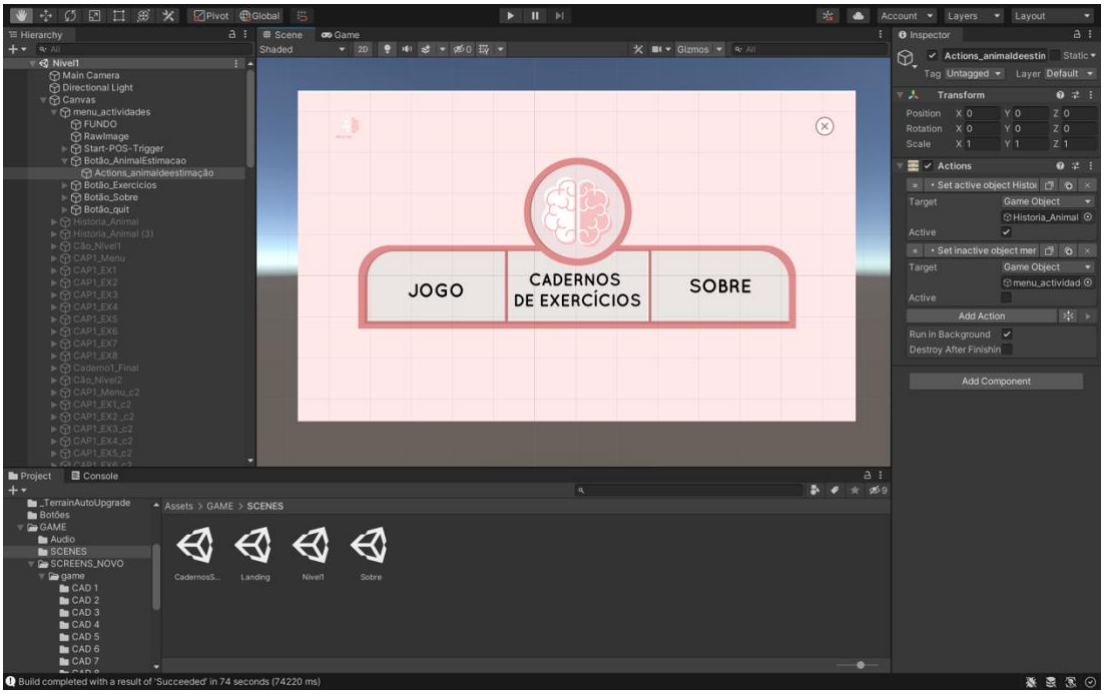


Figure 4 – 18 Game Object change with Set active/inactive.

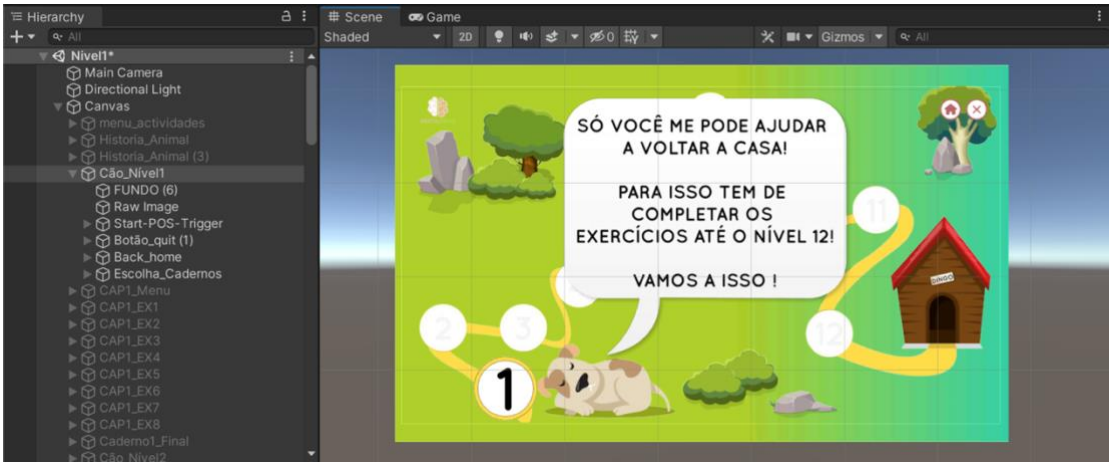


Figure 4 - 19 Active Game Object (Screen).

In Figure 4 - 19, we have an example of how it looks in Unity's hierarchy when we follow the application when we click on Game, and pass the text part, that is, Animal History and Animal History (3), all the previous ones are colorless, because these are inactive, and the screen we are on at the moment, the one that is active, is white.

The following images (Figure 4 – 20 and Figure 4 – 21) are the transition from one Game Object to another. In this case, when we click in the 1 we go to the first activity book in the Game.

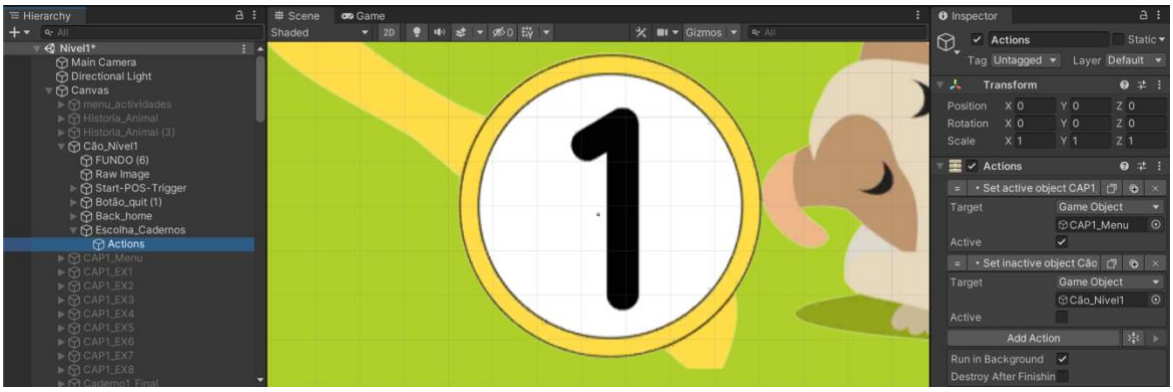


Figure 4 - 20 Action to book 1.

Figure 4 – 21 Screen Book 1.

One of the exercises in the book, is to click in more than one button, in this case consist of clicking in all the letters A (Figure 4 - 22). Here, we created one inviable button above all the “A”, that when we click, appears a circle in color. It also created a variable, with the Type: Number and the Value: 0, that we use in a condition, as we can see in the following image. This condition has a Clause If that says, if the Variable is equal 7 (number of letters “A” in this exercise), we wait 2 seconds, and this game object (screen) set inactive. The following game object (next screen) set active as we can see in the following image (Figure 4 – 22).

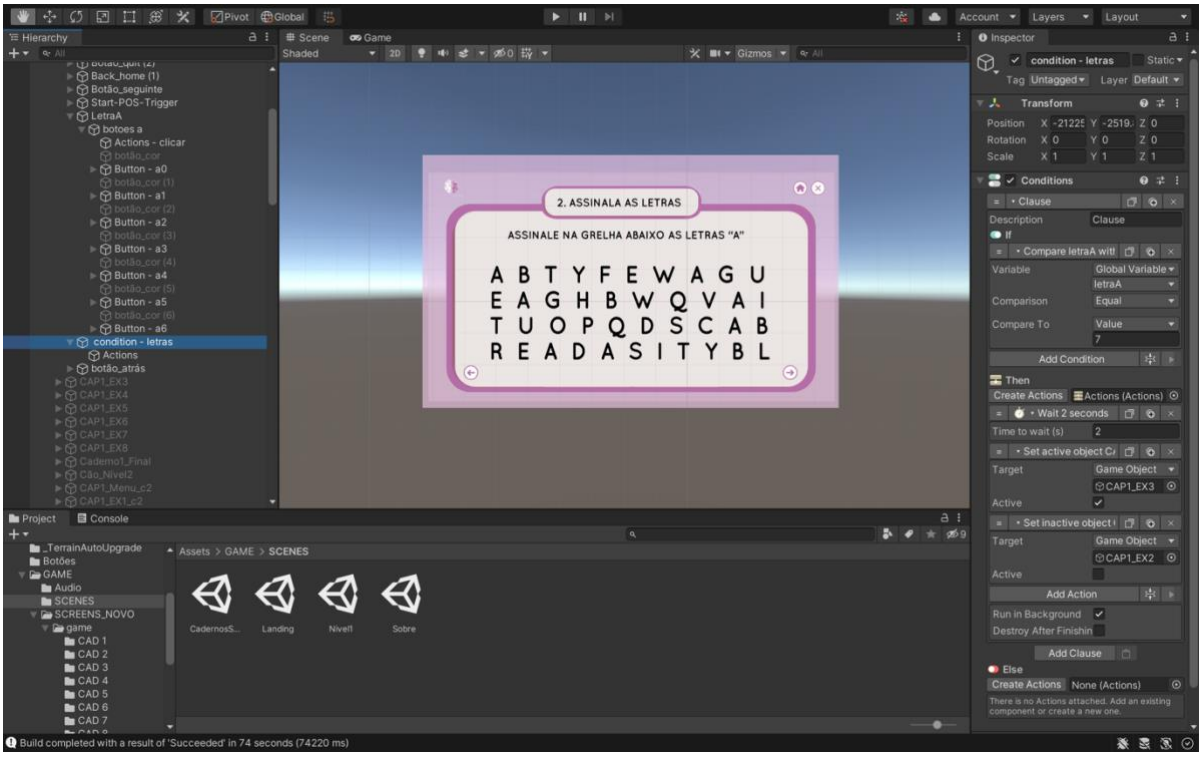
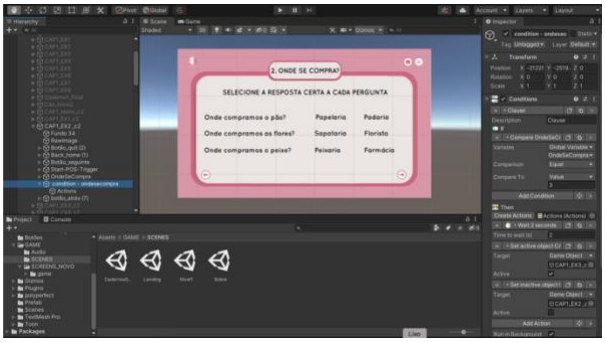


Figure 4 – 22 Example of condition.

This form of conditions and clauses (Figure 4 – 23/24) was used in the other exercises where we had to click on more than one button to answer the question, as we can see as an example in the following images.



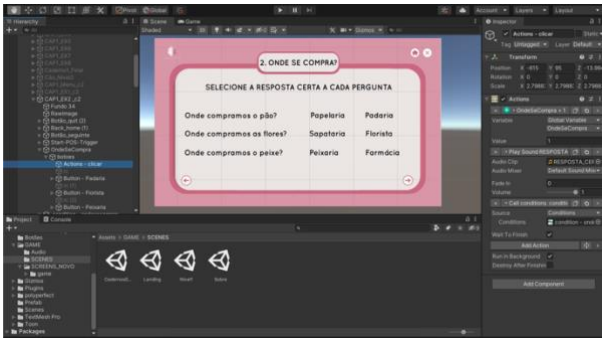


Figure 4 – 23/24 Example of conditio.n

Using sounds for the application users to hear was something we wanted to insert, so we created a button inserting an audio that can be visualized in numerous exercises of the application (Figure 4 – 25). In this case, the audio only starts when the person clicks on the button, and when the right answer is given, it turns off, as we can see in Figure 4 – 26.

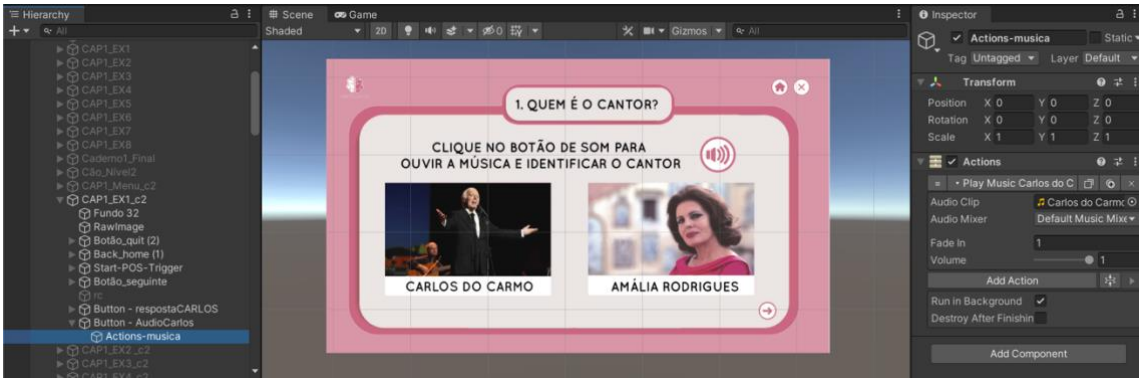


Figure 4 - 25 Example button with audio.

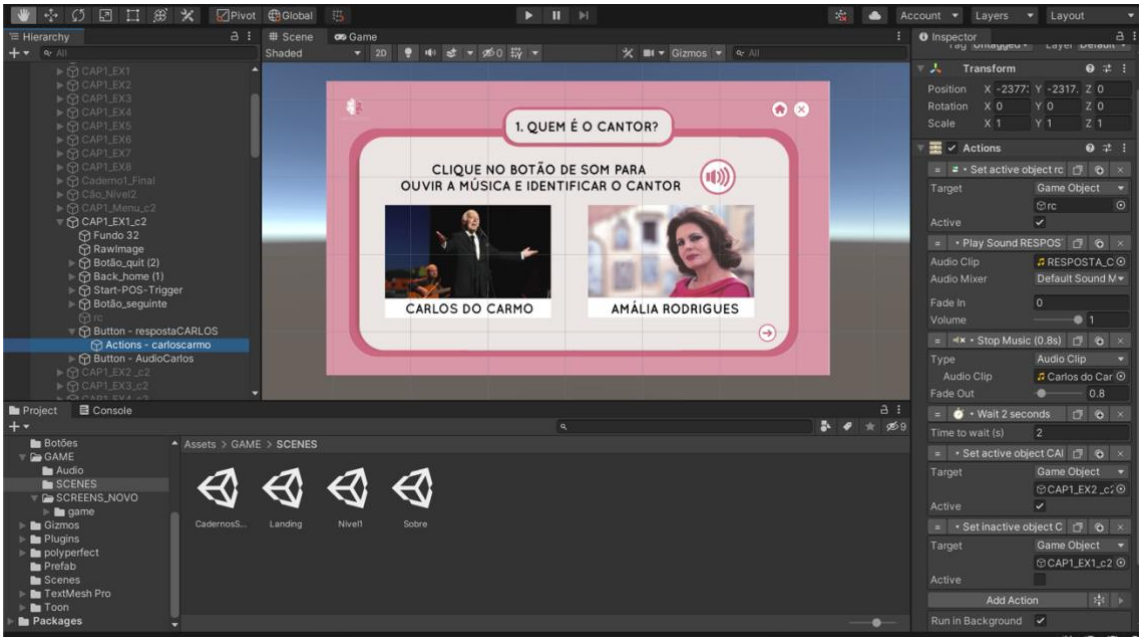


Figure 4 - 26 Example Inspector with audio when the answer is correct.

To be able to develop the exercises, several global variables were created, so that we could use them under the conditions (Figure 4 – 27).

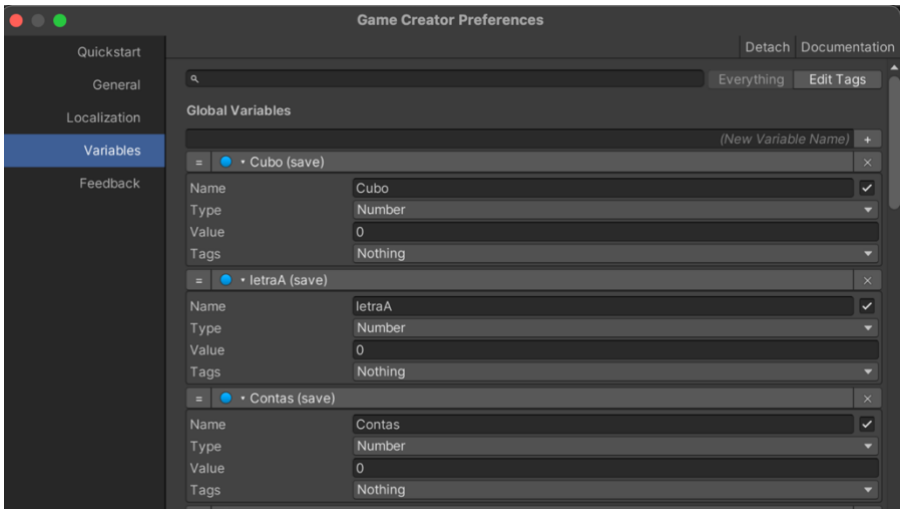


Figure 4 – 27 List of variables.

The decision to choose between a tablet and a computer for people with dementia was based on several factors. Firstly, it depends on the cognitive and physical abilities of the individual. Secondly, their specific needs and preferences should also be taken into consideration. For instance, if the person has limited mobility or visual impairments, a tablet with a touch screen might be a better option. Additionally, the type of activities the person will be performing on the device should also be considered. Ultimately, the decision should be made based on the unique needs and abilities of the individual with dementia.

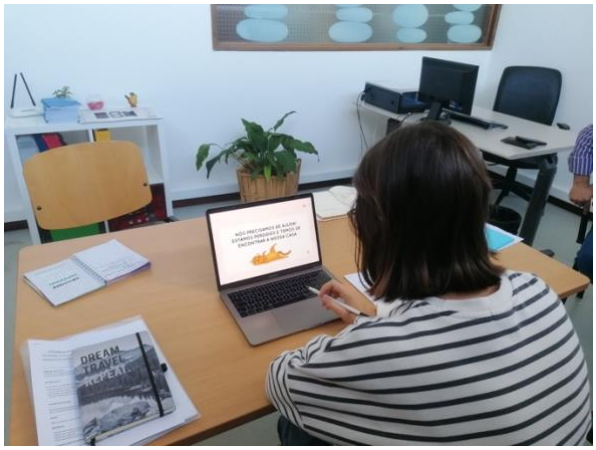
Tablets are typically smaller, lighter, and more portable than PCs, making them easier for individuals with dementia to handle and use. Many individuals with dementia find touchscreen interfaces more intuitive and less complex than traditional mouse and keyboard interactions. Tablets are designed with touchscreens, making them user-friendly for this population. Tablets are often simpler and have more user-friendly interfaces, which can reduce confusion and frustration for people with dementia. Caregivers or family members can remotely monitor and assist individuals with dementia using tablets, ensuring their safety and well-being.

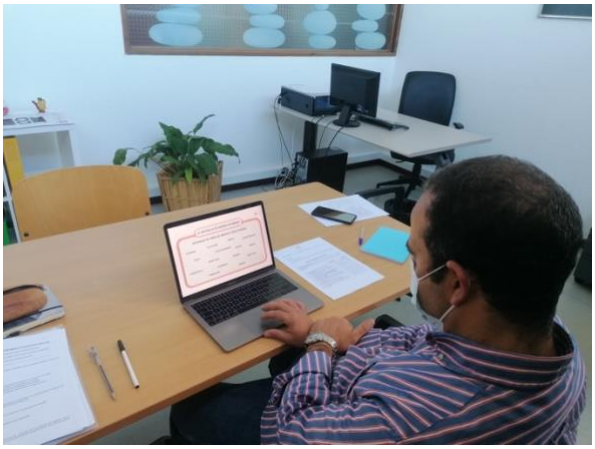
4.9 Pilot Study

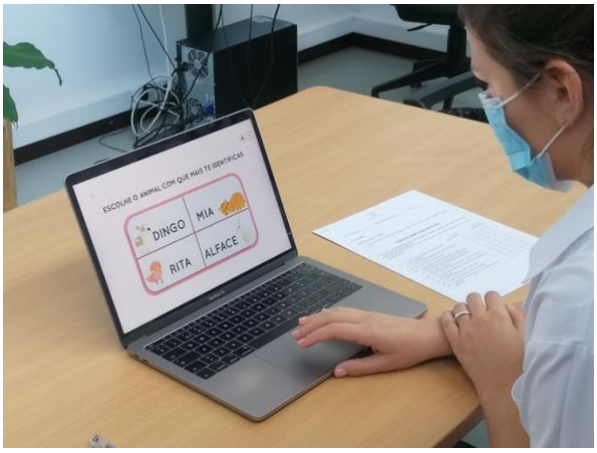
Upon completion of the primary functional prototype, we proceeded to conduct a pilot study to solicit feedback from potential users, which included both formal and informal caregivers. Our objective was to identify potential usability issues and implement improvements to the application based on the feedback provided. This pilot study was conducted at Centro Dia - Lugar de Memórias 1 e 2, Casa de Saúde São João de Deus and Unidade de Alzheimer da Ribeira Brava.

The present study enlisted the participation of twenty-four formal caregivers, comprising psychologists, neuropsychologists, music therapists, nurses, therapists, and physical education teachers, all of whom had prior experience with the application under investigation. User tests were conducted following a predetermined script on a day when participants had the most availability. Written informed consent was obtained from all participants prior to the commencement of the study. To anonymize the participants

who took part in the tests, the letter "P" was used as an identifier, followed by the number "1,2,3,..." to separate the tests. Participants were given a document with instructions on what to do in the test, which had four tasks. After they did these tasks, they had to answer the System Usability Scale (SUS, Annex 9.2).







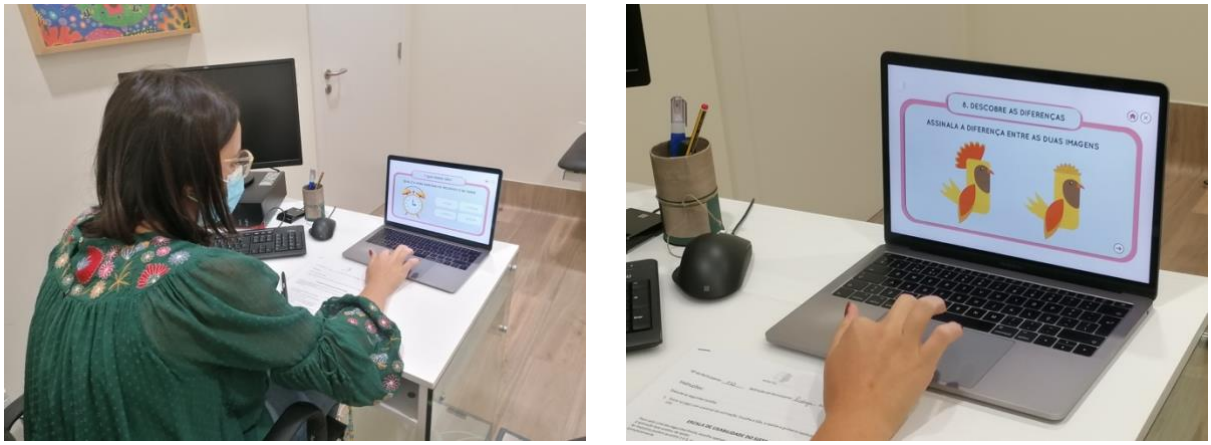


Figure 4 – 28/35 Images from the Pilot Study.

4.9.1. Results of the Pilot Study

From the SUS questionnaire made in this pilot study, we obtained the following scores per user (Figure 4 – 36).

Participant	Task 1	Task 2	Task 3	Task 4	Average
P1, Psychologist	100	100	100	100	100
P2, Psychologist	92,5	95	90	90	91,975
P3, Psychologist	92,5	97,5	92,5	92,5	93,75
P4, Music Therapist	90	87,5	85	82,5	86,25
P5, Occupational Therapist	100	85	100	95	95
P6, Sociocultural Animator	92,5	82,5	92,5	85	88,125
P7, Occupational Assistant	87,5	85	90	80	85,625
P8, Occupational Therapist	95	100	100	100	98,75
P9, Sociocultural Animator	75	72,5	87,5	80	78,75
P10, Psychologist	97,5	90	95	95	91,875
P11, Psychologist	92,5	82,5	92,5	85	88,125
P12, Nurse	85	90	92,5	92,5	90
P13, Neuropsychologist	90	90	92,5	92,5	91,25
P14, Psychologist	85	85	85	85	85
P15, Occupational Therapist	50	50	50	50	50
P16, Psychologist	47,5	47,5	47,5	47,5	47,5
P17, Nurse	62,5	62,5	62,5	62,5	62,5
P18, Nurse	87,5	57,5	87,5	57,5	72,5
P19, Social Worker	37,5	25	40	57,5	72,5
P20, Psychologist	92,5	82,5	85	85	86,25
P21, Nurse	95	97,5	95	95	95,625
P22, Monitor	50	50	52,5	52,5	51,25
P23, Monitor	95	95	95	95	95
P24, Monitor	95	100	95	95	96,25

Figure 4 – 36 Score per user from the SUS questionnaire

Based on the evaluation of scores from the twenty-four users involved in the pilot test of the application, the average score was 85.5. The use of the SUS in the test was crucial in providing a comprehensive overview of the application's performance, rather than just pinpointing specific issues.

When we asked for any suggestions on what to modify to improve the application, we got answers such as "In my opinion, the letters in the "choose the letters" game could be more visible (font size or weight)", "Shorter texts", "Avoid using the computer's touchpad", "Use the image of books in the books section", "Put a return arrow on all exercises", "Overall the exercises are fine", "Use different colors in each exercise book/level", "Make it more visually attractive in terms of colors", "If you use text, don't put too much information", "Uses "you" inadvertently", "Reduce text in introduction".

4.10. The use of the System Usability Scale

The System Usability Scale (SUS) is one of the commonly used surveys to assess the usability of a wide range of systems, including applications, websites, and software. It is a versatile and widely accepted tool for evaluating the overall usability of a system from the user's perspective. SUS has a long history of use and has been validated in numerous studies across different domains. It is considered a reliable tool for assessing usability and user satisfaction. SUS is a relatively short and straightforward questionnaire, consisting of ten items that are quick for users to complete (Annex 9.2). This is especially valuable when working with individuals who may have cognitive impairments as people with dementia, as it minimizes respondent burden.

SUS can be adapted to evaluate the usability of various types of systems, including applications for people with dementia. It provides a standardized and comparable measure across different applications and contexts. SUS results are easy to interpret, as they provide a single usability score that is expressed on a scale from 0 to 100, with higher scores indicating better usability.

In the context of applications for people with dementia, it is important to consider the unique needs and challenges of this user group, and the evaluation methods should be tailored to account for these factors. This might include conducting user testing, observing how individuals with dementia interact with the application, and seeking feedback from caregivers and healthcare professionals in addition to using surveys like SUS.

When addressing the experience of a person with a dementia disease, filling out a questionnaire with the formal caregiver communicating with the person with dementia is a common approach in research and clinical practice. This method allows for gathering valuable information about the person's experiences, preferences, and abilities while considering their cognitive impairments. The caregiver is an essential source of information, as they spend a significant amount of time with the person with dementia and have insight into their daily life and behaviors. Hence, caregivers can provide valuable insights into the individual's preferences, routines, and needs.

In research and clinical practice, it can be valuable to combine the perspectives of both the caregiver and the person with dementia. This holistic approach provides a more comprehensive understanding of the individual's needs and experiences. Therefore, whenever possible, it is beneficial to verify the information provided by the caregiver with observations and interactions with the person with dementia. Triangulating data from multiple sources can enhance the reliability and accuracy of the information.

From another perspective, using the SUS questionnaire when conducting user tests with both formal and informal caregivers can be a practical and efficient approach, especially when time is a constraint. The simplicity and user-friendliness of the SUS questionnaire make it accessible to a broad range of participants, even those who may not have extensive experience with usability testing or questionnaire surveys. This is particularly valuable when working with caregivers who may have varying levels of familiarity with technology and research methodologies.

While SUS is quantitative, it can still be complemented with qualitative feedback. After completing the questionnaire, caregivers can provide additional insights or comments, which can be valuable for understanding specific usability issues and improvement opportunities.

Finally, incorporating the SUS questionnaire into user testing with caregivers, especially when time constraints are a concern, streamlines the assessment process and ensures that valuable usability data is efficiently collected. However, it is important to recognize that while SUS provides a broad assessment of usability, it may not capture all nuances or specific challenges that caregivers might encounter when using the application.

5 Final Prototype

After identifying issues during the pilot study, we made the following improvements to the MentalSense prototype, which you can download from the following link: https://drive.google.com/drive/folders/1YVyyKOBYjeHoDpEmhtd_ZwkHJiTc6RNU?usp=share_link

Firstly, we removed the beginning where there would have to be a registration (Figure 5 - 1) by the user, because after testing and even talking to users, we found that at this point it didn't make sense for what we wanted to answer. So, in the initial part, the application is much simpler to use by the person with dementia.

Figure 5 – 1 Screen of the registration of the user in the app of the pilot study.

Afterwards we changed the menu screen from the pilot study (Figure 5 – 2), as there was no need for a settings button because, if the user wanted to reduce the brightness or audio while using the application, they could do so directly on the tablet, changing for the screen in the menu with the buttons “Jogo”, “Caderno de Exercícios” and “Sobre” (Figure 5 – 3).

Figure 5 – 2 Screen of the menu in the app of the pilot study.

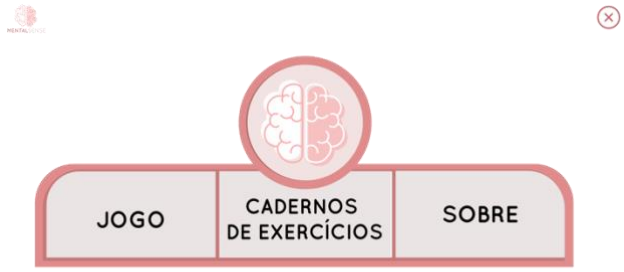


Figure 5 – 3 Screen of the menu in the app of the final prototype.

In the pilot study, the application presented two chapters per exercise book (Figure 5 - 4), which became confusing for the flow of the application. Some users mentioned that when they were working directly in the notebooks, they were unable to understand which chapter they were in, so they suggested placing only one chapter per notebook, and in the future of the application gradually increasing these chapters. So, when we click on the notebook we want, the exercises in it immediately appear (Figure 5 - 5).

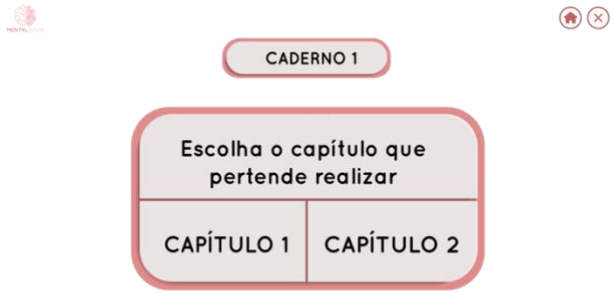


Figure 5 – 4 Screen of the menu to choose the chapter in the app of the pilot study.

Figure 5 – 5 Screen of the menu inside the book, of the final prototype.

Almost all the testers mentioned that the screen where they see the notebooks was a little confusing, because despite the notebook being mentioned at the top, only numbers appeared (Figure 5 – 6), which left them a little confused. Therefore, following some of the suggestions, we changed the design of this screen, placing the image of notebooks with the number on top, with each notebook having a different color (Figure 5 – 7), referring to the color that will appear at the bottom of each one.

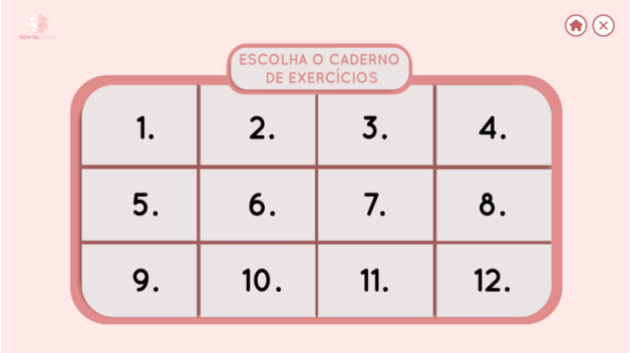


Figure 5 – 6 Screen of the menu to choose the book in the app of the pilot study.

Figure 5 – 7 Screen of the menu to choose the book in the app of the final prototype.

Another suggestion we received from several users during the tests was regarding the size of the text, as can be seen in one of the application's exercises, in which the user will have to find the letters "A". In the pilot study it was found that the letters were too small (Figure 5 – 8) for these people to be able to differentiate, so we change this in the final prototype (Figure 5 – 9).

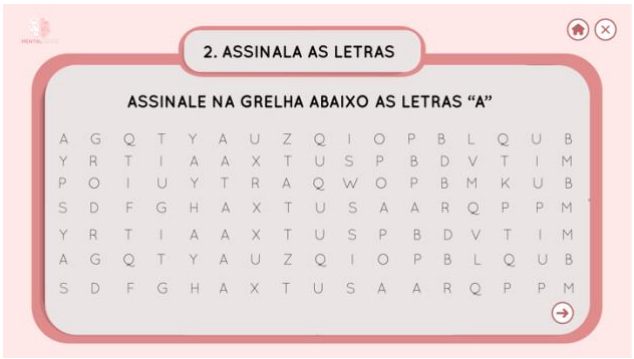


Figure 5 – 8 Screen of the exercise "Assinala as letras" in the app of the pilot study.

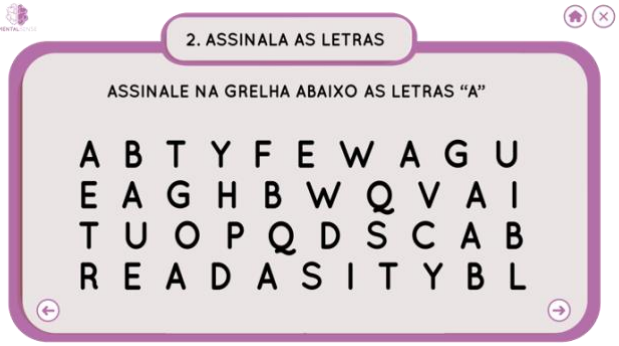


Figure 5 – 9 Screen of the exercise "Assinala as letras" in the app of the final prototype.

Regarding the pet part, an initial idea would be to create four different stories, such as a dog, a cat, a rabbit and a bird (Figure 5 – 10), and in the tests carried out in the pilot study we were able to realize that at this stage it would not be the most indicated, as we were making them undecided in their choice, creating some frustration, which was not at all what we were looking for, so we changed and composed the application with just the dog as the pet used in the game (Figure 5 – 11).

Figure 5 – 10 Screen of the menu of the pet in the app of the pilot study.

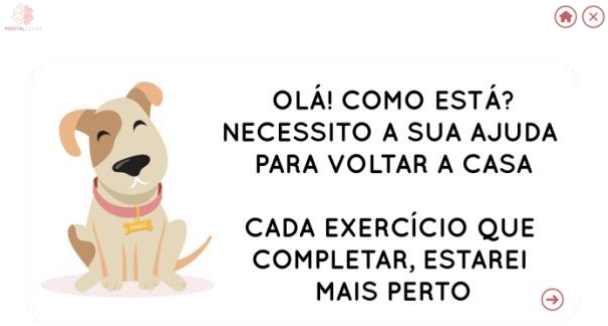


Figure 5 – 11 Screen of the menu of the pet in the app of the final prototype.

Another point to mention in the suggestions was that we are addressing our user as "You" informal (Figure 5 – 12), so we changed that point throughout the application, and we always use the formal “You”, to make the application more respectful and less childish, let's say (Figure 5 – 13).

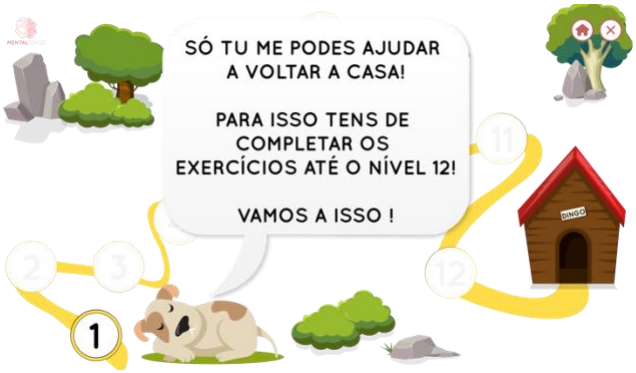


Figure 5 – 12 Screen of the level 1 with addressing to the user with “informal you” in the app of the pilot study

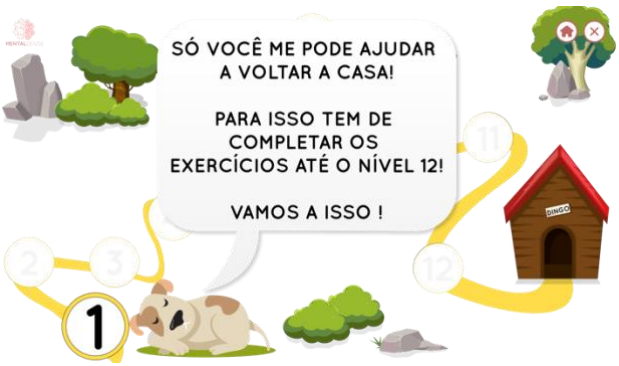


Figure 5 – 13 Screen of the level 1 with addressing to the user with “formal you” in the app of the final prototype

In the prototype used in the pilot study, it was also mentioned that we should insert a button to go back in the exercises, just as we had to go forward (Figure 5 -14/Figure 5 – 15).

Figure 5 – 14 Screen of exercise without return button in the app of the pilot study.

Figure 5 – 15 Screen of exercise with return button in the app of the final prototype.

6 Case Study

After the final version of MentalSense was implemented, we conducted a four-week case study with a formal caregiver, who is a psychologist. The study involved using the application with two patients suffering from dementia. This case study was carried out at the Day Centre, Lugar de Memórias I between the 5th of July 2023 and the 11th of August 2023. The participants provided their written informed consent, and the study was approved by the Ethics Commission of Universidade da Madeira (Approval P66/2023) (9.5).

6.1 Profile of the participants with dementia

Participant number 1:

Women, 71 years-old **Type of Dementia:** Alzheimer Disease

Schooling: 4th Year

Job: Housewife

Lifestyle: Widow, four children, middle class. She lived with one of her daughters and was never alone, always living with a family member, having already lived with a brother.

She entered Lugar de Memórias in 2020, having stayed a short time due to the confinement by Covid19, she usually used the space from 9:00/10:00 am until 4:00 pm. She was an easy-going person, sociable with good communication; liked to participate in activities, and usually presented a good final result. She was a person with excellent motivation, depending on when she felt the lowest; presented a stable dementia state with excellent results in the evaluations.

Participant number 2:

Women, 56 years-old **Type of Dementia:** Alcohol Related Dementia

Schooling: 6th Year

Job: Operational assistant in a museum

Lifestyle: Divorced, lived with daughter, middle class with daughter's help

She entered in Lugar de Memórias in 2023 at the beginning of the year and was usually in the space from 9:00h am to 5:00 pm. She was fully integrated into the place and had good communication and good interpersonal skills. She liked to participate in all activities, was a little impulsive in wanting to respond fast, and many times she made mistakes even knowing, due to haste. Since entering in Lugar de Memórias, the user had not regressed, with improvements and less agitation noted.

6.2 Procedure

For this particular case study, a tablet loaded with the designated application was utilized to conduct numerous sessions with two participants, all of which were attended by the formal caregiver. Prior to commencing the study, we had a meeting with the assigned psychologist, where we delineated the complete procedure that was required to be followed to carry out the research. During the meeting, it was determined that two specific individuals who use Lugar de Memórias will be taking part in the study. The names of these individuals were also decided upon at the meeting. They were left with the questionnaires that should be completed in each session, questionnaires such as the SUS, one about use by the user and another providing feedback on the application in general (Annex 9.2). Some surveys were answered for each one. To test the application, the SUS (Annex 9.2) was used for four tasks. After performing the tasks, they used the application freely. The Mini-Mental State Examination (MMSE) score, which was performed by the psychologist at Lugar de Memórias every 6 months, was used to assess the cognitive status of each patient.

6.3 Case Study Results

Participant number 1

This user was a 71-year-old female who had interacted with the app on multiple occasions. She possessed the ability to read and comprehend the content provided by the app, as well as listen to audio without any issues. The user was in need of guidance on how to smoothly transition from one exercise to another within the application. Additionally, she required assistance in selecting appropriate exercise books to further

enhance her learning experience. Overall, the user did not encounter any major issues while using the application. She was pleased with its functionality and content. However, she did find the navigation to be somewhat challenging, which is also mentioned in the second paragraph. Despite this, the user remained satisfied with the application.

According to Psychologist “GF”, who accompanied the tests, it had been observed that the individual's condition of dementia displayed signs of improvement following the use of the application.

Score in SUS

Task 1 – 72,5

Task 2 – 92,5

Task 3 – 80

Task 4 – 92,5

Average: 84,4

MMSE Score

Total – 30/30 Points

Participant number 2

As mentioned earlier, the user was a 56-year-old female who had used the app more than five times. She has demonstrated the ability to read and comprehend information on the app without assistance and has also shown proficiency in listening to audio content without any issues. It is worth noting that she has utilized various features of the app during her usage, indicating a level of familiarity with its functionality.

In general, this user did not have any problems using the application, she really liked the functionality, the look, and the content of the same, and what she least liked was the navigation in the first impact, and she did not have any problems after realizing how it worked. So, this user was quite satisfied with the application.

When the user first started using the application, she was in a positive state of mind and remained so throughout its use. She showed a keen interest in the application's features and functionalities, which kept her engaged and happy. Despite spending a significant amount of time using the application, the user did not experience any negative

emotions, which is a testament to the application's ability to provide a positive and enjoyable user experience.
According to Psychologist “GF”, who accompanied the tests, there appears to have been an improvement in the individual's dementia following her use of the application.

Score in SUS	**MMSE Score**
Task 1 – 87,5	Total: 24/30 points
Task 2 – 97,5	
Task 3 – 85	
Task 4 – 85	
Average: 88,8	

The overall average score in SUS for this case study was 86,6.

Feedback from formal caregiver

Regarding this case study, Psychologist “GF” mentioned that Participant 1 was quite down on the day she made the first use of the application, due to family problems, and the participant said that it would not be the best day to test the application, as she didn't feel available for that, so Psychologist “GF” spoke with her, and she accepted. In the first exercises, it was clear that she was a little reluctant to participate, but when the session ended, she mentioned that it was great to have participated, that she liked it a lot, and even left lighter.

The psychologist mentioned that the app's activities are designed in a way that makes them easy to access and understand. They noted that the absence of any sound that signals a wrong answer is a particularly positive aspect as it prevents users from feeling frustrated or demotivated. Additionally, the exercises are well-structured and suitable for users at slightly more advanced stages, making them inclusive for a larger audience.

“GF” has expressed a positive sentiment towards the notebook feature, highlighting its value as it grants users the ability to choose the desired notebook. In contrast, the game

option is deemed more effective in terms of user motivation, as it incorporates a story about a lost dog seeking to return home. Furthermore, the inclusion of applause at the conclusion of each level instilled a sense of pride and joy among users. Participant 2 was extremely ecstatic, and even after the end of the study, she always asked the psychologist if they were not going to do more exercises.

According to Psychologist "GF", the application is well suited to the user in a state of dementia from the point of view of always having someone to guide, whether formal caregiver or informal caregiver, supporting decisions within the application as well as its navigation. The same states that in the first impact of using the application, the two users looked at it in order to approve which button to touch, and throughout the sessions it became quite fluid, and they practically performed the exercises alone.

In exercises such as, for example, what is the adjective or verb in the sentence, it was necessary to give more support, because due to the background, it was more difficult to identify what is a verb or what is an adjective, however, it is a great exercise because it takes them to learn or remember something else.

According to the psychologist, the most difficult exercise in the application, based on what he was able to observe in relation to the sessions, was exercise two in notebook eleven (see Figure 6 - 1), since it relates the association of a symbol to a movement, as well as coordination, and it was necessary to provide a lot of support in this exercise.

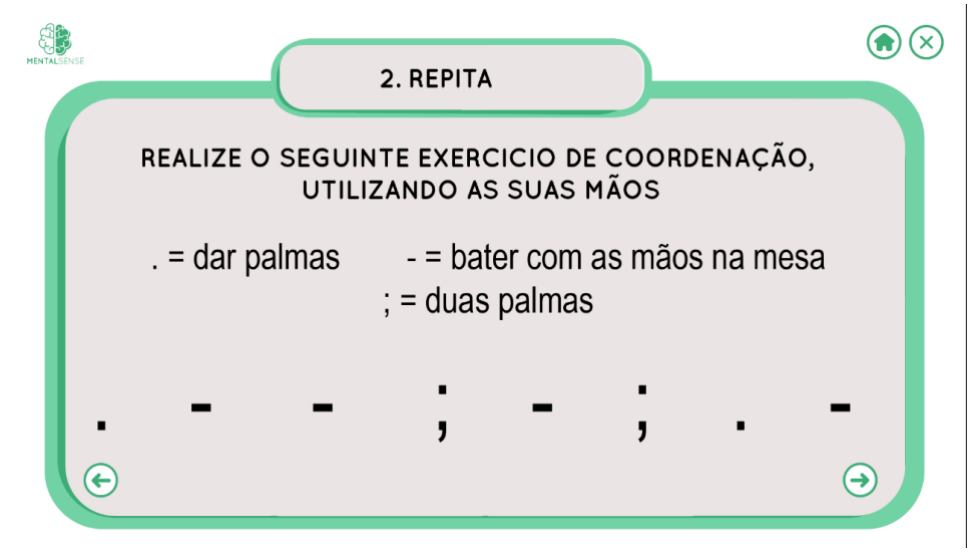


Figure 6 -1 Exercise 2, book 11.

It was also mentioned that the exercises with audio included were excellent and were very well accepted. All songs and sounds were identified, and the users hummed the songs.

In general, the performance of the people was quite positive, even in the mathematical exercises which are always the most difficult, even if they took a little longer, they managed to get there, something that is very good in the application, not having time associated with carrying out of the exercises. The application brings together several activities, which are very different from each other and meet the needs of the users in question (Figure 6 – 2/Figure 6 – 3).

The fact that the degree of difficulty of the exercises is mixed throughout the notebooks/levels of the game is excellent because it makes the user think a little more about a certain exercise, but then a simpler exercise may follow, which supports relaxation this.

Not having sounds associated with negativity/error is excellent, as it does not create demotivation or frustration for the user; this fact associated with the praise accompanied by applause at the end of each level is great, as we notice that it elevates the user, feeling good about what he is doing.

Psychologist “GF” also mentions that this type of activity is similar to the ones he usually uses in his sessions, and he really liked the application because everything is compiled in a single place, with a more fun version of animal support and a more serious version, being able to choose the one that would be more effective depending on who is using the application, and he would include this application in his sessions as he noticed that the users were much more motivated because it was something different, so much so that they asked when they would use the application or if they could make another notebook.

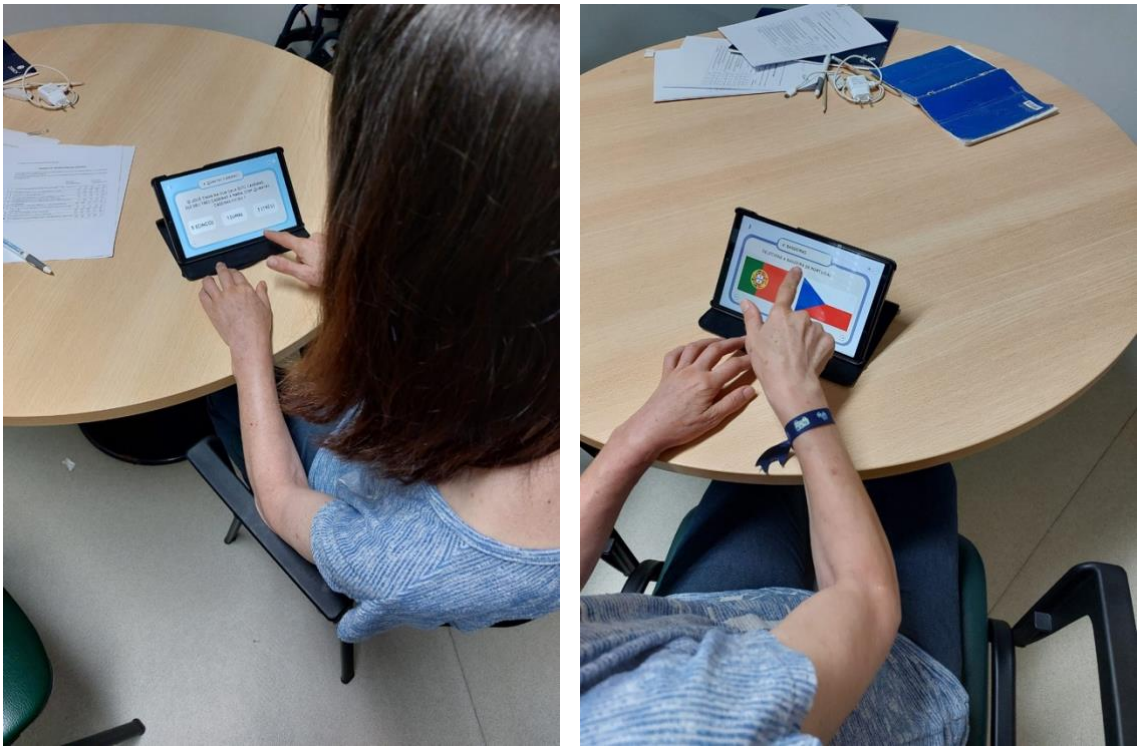


Figure 6 – 2/3 Case Study session. Photographies by Pshycologhist "GF".

6.4 Limitations

When conducting a dissertation thesis on dementia with specific limitations such as a small sample size for the case study, an inherently heterogeneous population, and conclusions based on feedback and observation from healthcare professionals, it is important to acknowledge these limitations and address the need for future research.
Dementia, a complex and multifaceted condition, presents a unique set of challenges when conducting research. This dissertation focused on understanding the potential benefits of a novel intervention and encountered several limitations that warrant discussion. It is imperative to recognize these constraints to ensure the integrity and applicability of the study's findings.

One of the primary limitations of this study is the relatively small sample size for the case study. The small number of participants involved in the research is not representative of the broader dementia population. The insights and conclusions derived from this limited sample should be interpreted with caution, as they may not capture the diversity and

variation present within the broader demographic of individuals with dementia. Moreover, dementia encompasses a wide range of cognitive and functional impairments, and the study population reflects this heterogeneity. The diverse backgrounds, etiologies, and stages of dementia among participants introduce additional complexity. It is essential to acknowledge that the intervention's impact may differ across this heterogeneity, and the findings might not be universally applicable.

The conclusions drawn in this dissertation are primarily based on feedback and observations from healthcare professionals. While this perspective provides valuable insights into the intervention's potential benefits, it is crucial to acknowledge that healthcare professionals' observations may be subjective and influenced by various factors. Additionally, the absence of validated questionnaires or quantitative metrics for assessing cognitive changes or quality of life is a limitation in accurately quantifying the intervention's impact.

To address these limitations and build upon the foundation laid by this research. Future research should aim to include larger and more diverse samples of individuals with dementia to improve the generalizability of findings and account for the heterogeneity within the population, validated questionnaires and objective measures should be incorporated to quantitatively assess cognitive changes and quality of life in individuals with dementia. This will provide a more comprehensive and rigorous evaluation of the intervention's effectiveness, conducting longitudinal studies over extended periods can offer a more comprehensive understanding of the long-term effects of interventions, which is especially valuable in the context of dementia, comparative studies can be instrumental in evaluating the relative efficacy of different interventions, shedding light on the best practices for improving the cognitive function and quality of life in dementia patients.

7 Conclusion

Dementia is a chronic and progressive condition that affects the brain, leading to a gradual decline in cognitive functions. This includes memory, thinking, reasoning, perception, and language skills. It is a complex disorder that progresses over time, with symptoms worsening as the disease advances. Dementia interferes with a person's ability to carry out daily activities and can have a significant impact on their emotional and social well-being. It is a condition that requires ongoing care, support, and treatment to manage its symptoms and improve the quality of life for those affected.

Dementia is a multifaceted condition that presents considerable obstacles for individuals, families, and society at large. Addressing it requires a comprehensive approach that incorporates medical, psychological, social, and caregiving support. On an ongoing basis, research is underway to gain insight into the causes, risk factors, prevention, and treatment of dementia. Experts are working diligently to identify effective interventions that can improve the quality of life for those impacted by this condition. Moreover, it's vital to raise awareness and diminish the stigma surrounding dementia to create a more inclusive and supportive environment for individuals with dementia and their caretakers.

The primary goal of this study was to offer cognitive stimulation to those with dementia using an engaging and educational tablet game. The game encompasses numerous activities centered on a unified platform that promotes stimulation sessions. The objective was accomplished through thorough research, development of the application, execution, and assessment, with the assistance of both professional and personal caregivers.

Our research has successfully devised a comprehensive plan for promoting the utilization of cognitive stimulation techniques in a manner that is devoid of any compulsion or frustration. We have developed a valuable resource that can be accessed at your convenience, with no restrictions on its duration of use. Additionally, we have

meticulously rectified all spelling, grammar, and punctuation errors to ensure a seamless and superior user experience.

The results that we obtained through the case study, in relation to the research questions posed at the beginning of this dissertation 1) Can a ludic and didactic cognitive game, that can be used in a tablet, be effective in helping the stimulation of people with dementia? 2) Can such a system increase positive emotions of the person with dementia?

1. Can a ludic and didactic cognitive game, used in a tablet, be useful in the stimulation of people with dementia?

Our research has shown that our application had a beneficial effect on users' cognitive capabilities. Following engagement with both notebook and game modes, users were able to remember past events and stimuli with greater ease, including specific moments, locations, music, and objects. As the sessions progressed, we observed a marked improvement in their ability to accurately complete tasks, evident in their faster response times compared to their initial usage of the app. All in all, our application proved to be a valuable tool for enhancing users' cognitive functions.

2. Can such a system increase positive emotions of the person with dementia?

After thoroughly analyzing the case studies, it has been observed that two specific individuals who utilized the application showed remarkable progress in their daily activities. They demonstrated enhanced performance and confidence, which had a direct impact on their overall productivity throughout the day. Not only did they exhibit improved social interactions with others at Lugar the Memórias, but they also displayed a more positive and engaging demeanor. As a result, they were able to shift from being the last to answer group questions to being the first, which is a significant improvement in terms of their participation and contribution to group discussions. These observations indicate that the application has the potential to positively impact individuals' personal

and professional lives, and it could be a valuable tool for enhancing their cognitive abilities and social interactions.

Following a comprehensive testing and case study, we have identified multiple aspects that could be enhanced to improve the application in the future. In order to improve the application, a suggestion is to develop a comprehensive database that would allow formal caregivers in day centers, health centers, and nursing homes to closely monitor and evaluate the performance of individual users. The proposed database would include data on various aspects of the user's experience with the application, such as the number of times they got the questions right, the number of times the click was wrong, the time taken to perform each question, the total time spent using the application per day, and the speed of response from the first session to more recent sessions.

By collecting and analyzing this data, caregivers would be able to gain deeper insights into the progress of individual users, identify areas where they may be struggling, and make informed decisions about their care. The database would also help caregivers to identify patterns or trends in the user's performance over time, which could be used to adjust the user's care plan or modify the application to better meet their needs. In summary, the proposed database would be a valuable tool for formal caregivers, providing them with detailed and actionable data to help them deliver the best possible care to their users.

Something else that would be even more interesting to add would be a narrator as well as a voice command to answer the questions, which could be a subgame/books that only respond to the voice, this is for users who are bedridden, blind or with very little vision, who are still in a phase onset of dementia.

Our team recognizes the significance of improving the interaction between the application and the user. We understand that the interaction with the user is a critical aspect of any successful application. Therefore, we plan to devote additional time and resources to enhance the system's overall design and layout, making it more user-friendly and visually appealing. Furthermore, we want to offer users the ability to select

different animals for the game. This will enable users to customize their preferences and have a more personalized experience. We believe that these changes will significantly improve the user experience, making it more enjoyable and engaging.

To enhance the user experience, it is highly recommended to consider expanding the number of available notebooks or chapters. By doing so, users can have access to more content, which can improve their learning and productivity. Additionally, it would be helpful to have some chapters unlocked after use, as this could create a sense of achievement and motivate users to engage more with the material. Overall, increasing the number of available notebooks or chapters, along with unlocking new content, could significantly enhance the value and appeal of the product.

To ensure the success of the application, it is important to form a cohesive team of workers who will collaborate and communicate effectively. Each member of the team should have a clear understanding of their role and responsibilities in the project. This will enable them to work together seamlessly and produce high-quality results. By creating a strong team, it will be possible to make significant improvements to the application. This can include fixing bugs, enhancing features, and improving the overall user experience. The team can also work together to develop new features that will make the application more useful and attractive to users.

Once the necessary improvements have been made, it is important to ensure that the application is easily accessible to users. This can be achieved by making it available for download through popular platforms such as the App Store or Play Store. By doing so, users can easily find and download the application, which will lead to increased usage and user satisfaction.

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9 Annexes

9.1 Informed Consent

Consentimento Informado, Esclarecido e Livre para Participação em estudos de Investigação

Investigador Principal: Maria João Conceição, Universidade da Madeira, maria_joao_gouveia@hotmail.com, Tlm 965364543
Outros investigadores: Mónica Cameirão, Universidade da Madeira
Título do estudo: Estudo de viabilidade da plataforma MentalSense: Jogo lúdico e didático para pessoas em estado Demencial

Objetivo do estudo: O estudo tem como objetivos principais:

- Avaliar se um jogo cognitivo lúdico e didático, apresentado num tablet, pode ser eficaz no auxílio à estimulação de pessoas com Doença Demencial.
- Avaliar se o referido sistema pode aumentar a integração da pessoa com Doença Demencial com a família, aumentando a sua autoconfiança e a motivação para serem estimulados.

Procedimento: O estudo inclui a realização de um programa de treino cognitivo através de tecnologias interativas num dispositivo móvel (tablet) durante 4 semanas por participante, baixo a supervisão de um cuidador formal ou informal.
Riscos: Este estudo não implica riscos físicos, psicológicos, ou emocionais superiores àqueles encontrados nas atividades do dia-a-dia ou sessões de reabilitação cognitiva tradicional.

Benefícios: Poderão não existir benefícios diretos pela sua participação neste estudo. Contudo, ao participar neste estudo, está a contribuir para o progresso da investigação, nomeadamente na forma como compreendemos a utilidade de ferramentas interativas no tratamento e melhoria de défices provenientes da demência.
Compensações e custos: Não haverá qualquer tipo de compensação monetária. No final do estudo, será entregue um certificado de participação.

Anonimato e confidencialidade: Dada a natureza presencial das recolhas de dados, os participantes não serão anónimos para os investigadores envolvidos na recolha de dados. No entanto, a recolha de dados não envolverá o registo do seu nome ou outra informação passível de identificação pessoal, sendo os participantes identificados por

códigos que não permitam identificá-los posteriormente. Serão esses códigos que serão utilizados na análise de dados e posterior publicação de dados recolhidos.

Direitos: A sua participação é voluntária. Você é livre de interromper a sua participação em qualquer momento. A recusa em participar ou interrupção da participação não resultará em qualquer penalização, ou perda de eventuais benefícios ou direitos.
Esclarecimento de Dúvidas & Contatos: Se tem dúvidas sobre este estudo, poderá fazer agora todas as perguntas. Se quiser fazer perguntas mais tarde ou desejar obter mais informações, entre em contato com o investigador principal. A informação de contato está disponível no início da primeira página deste documento.
Por favor, leia com atenção esta informação. Se achar que algo está incorreto ou que não está claro, não hesite em solicitar mais informações.

Se concorda com a proposta que lhe foi feita, queira assinar este documento.

Assinatura de quem pede consentimento:

_____

UNIVERSIDADE da MADEIRA

Declaração de Consentimento do Participante

Declaro ter lido e compreendido este documento, bem como as informações verbais que me foram fornecidas pela/s pessoa/s que acima assinam. Foi-me garantida a possibilidade de, em qualquer altura, recusar participar neste estudo sem qualquer tipo de consequências. Desta forma, aceito participar neste estudo e permito a utilização dos dados, que de forma voluntária forneço, confiando em que apenas serão utilizados para fins científicos e publicações que delas decorram e com as garantias de confidencialidade e anonimato que me são dadas pelo/a investigador/a.

Assinatura legível e manuscrita:

_____

Data: ___ / ___ / _____

Assinatura do representante legal, se aplicável:

_____

Data: ___ / ___ / _____

UNIVERSIDADE da MADEIRA

Autorização opcional

Entendo que os investigadores podem querer usar fotografias ou vídeo por razões ilustrativas nas apresentações e publicações deste trabalho, para fins científicos ou educativos. Eu dou autorização para fazê-lo, desde que o meu nome e rosto não apareçam.

Assinatura legível e manuscrita:

_____

Data: ___ / ___ / _____

Assinatura do representante legal, se aplicável:

_____

Data: ___ / ___ / _____

9.2 Data collection instruments

Nº do Participante: _____ Data:_____

Instruções:

Execute as seguintes tarefas.

1. Entre no jogo com o animal de estimação, e realize o primeiro capítulo do caderno de exercícios.

ESCALA DE USABILIDADE DO SISTEMA

Para cada uma das seguintes frases, escolha apenas uma opção que melhor descreva as suas reações à aplicação que acabou de testar.
As respostas podem se entre 1 e 5, sendo que 1 equivale a Discordo Completamente e 5 a Concordo Completamente

		Discordo Completamente				Concordo Completamente
1	Eu acho que gostaria de usar esta aplicação com frequência.	☐	☐	☐	☐	☐
2	Eu acho o sistema desnecessariamente complexo.	☐	☐	☐	☐	☐
3	Eu achei o sistema fácil de usar.	☐	☐	☐	☐	☐
4	Eu acho que precisaria de ajuda de uma pessoa com Conhecimentos técnicos para utilizar a aplicação.	☐	☐	☐	☐	☐
5	Eu acho que as várias funções da aplicação estão muito bem interligadas.	☐	☐	☐	☐	☐
6	Eu acho que a aplicação apresenta muita inconsistência.	☐	☐	☐	☐	☐
7	Eu imagino que as pessoas poderão utilizar rapidamente esta aplicação.	☐	☐	☐	☐	☐
8	Eu achei a aplicação confusa de utilizar.	☐	☐	☐	☐	☐
9	Eu senti-me confiante a utilizar a aplicação.	☐	☐	☐	☐	☐
10	Eu necessitei aprender coisas novas antes de utilizar a aplicação.	☐	☐	☐	☐	☐

2. Entre no menu exercícios, dirija-se ao caderno número seis e realize o 5º exercício.

ESCALA DE USABILIDADE DO SISTEMA

Para cada uma das seguintes frases, escolha apenas uma opção que melhor descreva as suas reações à aplicação que acabou de testar.
As respostas podem se entre 1 e 5, sendo que 1 equivale a Discordo Completamente e 5 a Concordo Completamente.

		Discordo Completamente				Concordo Completamente
1	Eu acho que gostaria de usar esta aplicação com frequência.	☐	☐	☐	☐	☐
2	Eu acho o sistema desnecessariamente complexo.	☐	☐	☐	☐	☐
3	Eu achei o sistema fácil de usar.	☐	☐	☐	☐	☐
4	Eu acho que precisaria de ajuda de uma pessoa com Conhecimentos técnicos para utilizar a aplicação.	☐	☐	☐	☐	☐
5	Eu acho que as várias funções da aplicação estão muito bem interligadas.	☐	☐	☐	☐	☐
6	Eu acho que a aplicação apresenta muita inconsistência.	☐	☐	☐	☐	☐
7	Eu imagino que as pessoas poderão utilizar rapidamente esta aplicação.	☐	☐	☐	☐	☐
8	Eu achei a aplicação confusa de utilizar.	☐	☐	☐	☐	☐
9	Eu senti-me confiante a utilizar a aplicação.	☐	☐	☐	☐	☐
10	Eu necessitei aprender coisas novas antes de utilizar a aplicação.	☐	☐	☐	☐	☐

3. Realize a exercício número dois, de um caderno de exercícios à sua escolha.

ESCALA DE USABILIDADE DO SISTEMA

Para cada uma das seguintes frases, escolha apenas uma opção que melhor descreva as suas reações à aplicação que acabou de testar.
As respostas podem se entre 1 e 5, sendo que 1 equivale a Discordo Completamente e 5 a Concordo Completamente

		Discordo Completamente				Concordo Completamente
1	Eu acho que gostaria de usar esta aplicação com frequência.	☐	☐	☐	☐	☐
2	Eu acho o sistema desnecessariamente complexo.	☐	☐	☐	☐	☐
3	Eu achei o sistema fácil de usar.	☐	☐	☐	☐	☐
4	Eu acho que precisaria de ajuda de uma pessoa com Conhecimentos técnicos para utilizar a aplicação.	☐	☐	☐	☐	☐
5	Eu acho que as várias funções da aplicação estão muito bem interligadas.	☐	☐	☐	☐	☐
6	Eu acho que a aplicação apresenta muita inconsistência.	☐	☐	☐	☐	☐
7	Eu imagino que as pessoas poderão utilizar rapidamente esta aplicação.	☐	☐	☐	☐	☐
8	Eu achei a aplicação confusa de utilizar.	☐	☐	☐	☐	☐
9	Eu senti-me confiante a utilizar a aplicação.	☐	☐	☐	☐	☐
10	Eu necessitei aprender coisas novas antes de utilizar a aplicação.	☐	☐	☐	☐	☐

4. Realize 3 cadernos de exercícios à escolha.

ESCALA DE USABILIDADE DO SISTEMA

Para cada uma das seguintes frases, escolha apenas uma opção que melhor descreva as suas reações à aplicação que acabou de testar.
As respostas podem se entre 1 e 5, sendo que 1 equivale a Discordo Completamente e 5 a Concordo Completamente

		Discordo Completamente				Concordo Completamente
1	Eu acho que gostaria de usar esta aplicação com frequência.	☐	☐	☐	☐	☐
2	Eu acho o sistema desnecessariamente complexo.	☐	☐	☐	☐	☐
3	Eu achei o sistema fácil de usar.	☐	☐	☐	☐	☐
4	Eu acho que precisaria de ajuda de uma pessoa com Conhecimentos técnicos para utilizar a aplicação.	☐	☐	☐	☐	☐
5	Eu acho que as várias funções da aplicação estão muito bem interligadas.	☐	☐	☐	☐	☐
6	Eu acho que a aplicação apresenta muita inconsistência.	☐	☐	☐	☐	☐
7	Eu imagino que as pessoas poderão utilizar rapidamente esta aplicação.	☐	☐	☐	☐	☐
8	Eu achei a aplicação confusa de utilizar.	☐	☐	☐	☐	☐
9	Eu senti-me confiante a utilizar a aplicação.	☐	☐	☐	☐	☐
10	Eu necessitei aprender coisas novas antes de utilizar a aplicação.	☐	☐	☐	☐	☐

QUESTÕES GERAIS

Para cada uma das seguintes frases, escolha apenas uma opção que melhor descreva as suas reações à aplicação que acabou de testar.

		SIM	NÃO	TALVEZ
1	Acha que as cores da aplicação estão adequadas à população alvo?	☐	☐	☐
2	Acha que os tamanhos dos botões da aplicação estão adequados à população alvo?	☐	☐	☐
3	Acha que as imagens utilizadas na aplicação estão adequadas à população alvo?	☐	☐	☐
4	Acha que as pessoas que se encontram em estado demencial irão interessar-se pela aplicação?	☐	☐	☐
5	Acha que o estilo de perguntas da aplicação está adequado a estimulação cognitiva?	☐	☐	☐
6	Acha que utilizaria esta aplicação com uma pessoa em estado demencial?	☐	☐	☐
7	Acha que a aplicação está confusa?	☐	☐	☐
8	Aconselharia esta aplicação a outras pessoas?	☐	☐	☐

Gostaria de deixar alguma sugestão?

Nº do Participante: _____ Data:_____

QUESTIONÁRIO DE FEEDBACK DA APLICAÇÃO

1. Como avalia a aplicação que acabou de experienciar?

Nada Satisfeito Bastante Satisfeito

☐ ☐ ☐ ☐ ☐

2. Qual dos problemas abaixo foram o maior problema durante o uso da aplicação?

☐ Experienciei bugs

☐ Visualmente a aplicação não é apelativa

☐ A aplicação é confusa de utilizar

☐ A aplicação fechava inesperadamente

☐ Não obtive qualquer problema a utilizar a aplicação

3. O que gostou mais na aplicação?

☐ A funcionalidade

☐ A navegação

☐ O conteúdo

☐ O visual

4. O que gostou menos na aplicação?

☐ A funcionalidade

☐ A navegação

☐ O conteúdo

☐ O visual

5. A aplicação é fácil de manusear?

Nada Satisfeito Bastante Satisfeito

☐ ☐ ☐ ☐ ☐

6. Acrescentaria algo à aplicação? Se sim, o quê?

_____

_____

_____

_____

Nº do Participante: _____ Data:_____

QUESTIONÁRIO SOBRE A UTILIZAÇÃO DA APLICAÇÃO POR PARTE DA PESSOA EM ESTADO DEMENCIAL (DIRIGIDO A CUIDADORES FORMAIS/INFORMAIS)

1. Qual a idade da pessoa em estado demencial, que utilizou a aplicação?
   _____

2. Feminino ☐ / Masculino ☐

3. Quantas vezes utilizou a aplicação?

1 vezes ☐

2 vezes ☐

3 vezes ☐

4 vezes ☐

+ de 5 vezes ☐

4. A pessoa em estado demencial consegue ler sozinho?

Sim ☐

Não ☐

5. A pessoa em estado demencial consegue ouvir sem problema?

Sim ☐

Não ☐

6. A pessoa em estado demencial teve dificuldade para utilizar a aplicação?

Sim ☐

Não ☐

7. Como caracteriza o estado emocional da pessoa em estado demencial antes de utilizar a aplicação?

☐ Alegre

☐ Triste

☐ Amedrontado

☐ Surpreso

☐ Ansioso

8. Como caracteriza o estado emocional da pessoa em estado demencial após utilizar a aplicação?

☐ Alegre

☐ Triste

☐ Amedrontado

☐ Surpreso

☐ Ansioso

9. Como caracteriza o comportamento da pessoa em estado demencial durante a utilização da aplicação?

☐ Interessado

☐ Desinteressado

10. Após o uso da aplicação em causa, considera que existiu uma melhoria na pessoa em estado demencial?

Sim ☐

Não ☐

11. Quais as melhorias que verificou?

_____

_____

_____

_____

_____

12. Considera a aplicação uma mais-valia?

☐ Sim

☐ Não

13. Considera que a utilização da aplicação num tablet é vantajosa para a pessoa em estado demencial?

☐ Sim

☐ Não

14. Explique porquê.

_____

_____

_____

15. Gostaria de acrescentar algo?

_____

_____

_____

_____

9.3 Online Inquiriring

Destinado aos Profissionais de Saúde e Auxiliares de Acção Médica de doentes em estados demenciais.

Este inquérito tem como base fundamentar um estudo universitário que decorre na Universidade da Madeira, para uma tese de mestrado do curso de Design de Media Interativos, sobre cuidadores de doentes em situação demencial.

* Indica uma pergunta obrigatória

1. Qual é a sua profissão ? * *Marcar apenas uma oval.*

   - ◯ Profssional de Saúde
   - ◯ Auxiliar de Acção Médica
   - ◯ Outro

2. Se respondeu outro, indique qual? *

   _____

3. Qual é o seu local de trabalho? * *Marcar apenas uma oval.*

   - ◯ Hospital
   - ◯ Lar de 3º Idade
   - ◯ Casa de Saúde
   - ◯ Centro de Dia
   - ◯ Outro

4. Se respondeu outro, indique qual ? *

5. Qual a sua idade ? *

6. Há quanto tempo trabalha com doente em estado demencial? *

7. Com quantos doentes trabalha por dia? *

8. Qual a idade dos doentes com os quais trabalha? *

Marcar tudo o que for aplicável.

- [ ] 40 - 49
- [ ] 50 - 59
- [ ] 60 - 69
- [ ] 70 - 79
- [ ] 80 - 89
- [ ] 90 -100

9. Qual a maior dificuldade que sente no seu trabalho ? *

10. Após começar a trabalhar com doentes em situação demencial, acha que a sua saúde física e mental obteve alguma alteração? Se sim, quais?

11. Se pudesse escolher algo a nível tecnológico para o/a apoiar na sua profissão, no cuidado a estes doentes o que escolheria?

12. É fácil após terminar a sua jornada laboral por dia, pôr de parte tudo o que passou durant o dia ?

13. Relativamente aos familiares ou Cuidadores destes doentes, acha que estes sentem dificuldades para cuidarem dos doentes ? Se sim, quais?

14. Na sua opinião que género de tecnologia poderia apoiar um familiar/cuidador de um doente em estado demencial?

15. Com toda a situação de isolamento social que vivemos neste momento, com o surgimento do vírus Covid-19, acha que dificultou o seu trabalho ?

16. Gostaria e nos contar alguma situação que tenha passado enquanto trabalhador directo com doentes em estado demencial ?

17. Desde já agradeço a sua disponibilidade, se numa futura fase deste estudo quiser continuar a participar no estudo poderá deixar o seu e-mail/número de telefone, que de forma alguma será divulgado.

Dirigido aos Cuidadores Informais de doentes em situação demencial

Este formulário tem como base fundamentar um estudo universitário que decorre na Universidade da Madeira, para uma tese de mestrado do curso de Design de Media Interativos, sobre cuidadores informais de doentes em situação demencial.

* Indica uma pergunta obrigatória

1. Qual é a sua idade ? What is your age? *

2. Qual é sua relação com a pessoa com Demência? What is your relationship in the person with Dementia Disease?

3. Há quanto tempo é cuidador informal? Since when you are informal caregiver? *

4. Qual é a fase da doença na qual o doente se insere? What is the stage of the disease?

5. Qual é a idade do doente ? What is the age of this person? *

6. Após ser cuidador informal, o que mudou no seu dia-a-dia? *

7. Acha que ser cuidador informal, teve algum impacto na sua vida social ? *

8. Como descreve a sua condição física após começar a ser cuidador informal? *

9. Quanto tempo por semana dedica a si mesmo? Porquê ? *

10. Poderia descrever alguma situação pela qual tenha passado após ser cuidador informal ?

11. Se pudesse escolher algum tipo de tecnologia de apoio, qual escolheria ? *

12. Com a nova situação de distanciamento social devido ao Covid-19, tem sentido mais dificuldades em ser cuidador de um doente em estado demencial ?

13. Se gostaria de ser incluído em uma futura parte deste estudo, poderá deixar o seu contato neste campo.

9.4 Authorization from the place where the study was conducted

Declaração

A Associação de Desenvolvimento Comunitário do Funchal, representada por Arquiteto Ricardo Emanuel Andrade Silva, na qualidade de Presidente da Direção, declara, para os devidos efeitos, autorizar a realização de testes, através de uma aplicação digital de estimulação cognitiva para pessoas com demência, nas suas valências de Centro de Dia – "Lugar de Memórias I" e "Lugar de Memórias II" – no âmbito da tese de mestrado da aluna Maria João Gouveia em Design de Media Interativos, da Universidade da Madeira.

Funchal, 09 de fevereiro de 2023

O Presidente da Direção

Rua da Alegria, 14 B – Sé – Funchal – Tel. 291755232 / Fax 291752312
Site: www.garoutadocalhau.com / Correio eletrónico: sede@garoutadocalhau.com

9.5 Photography's of the user tests

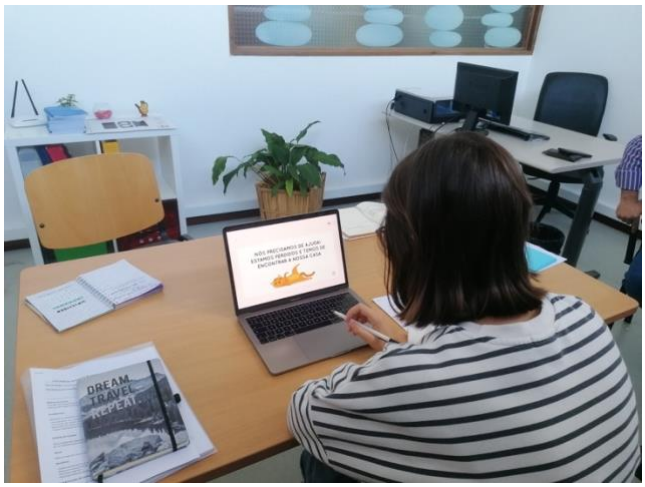
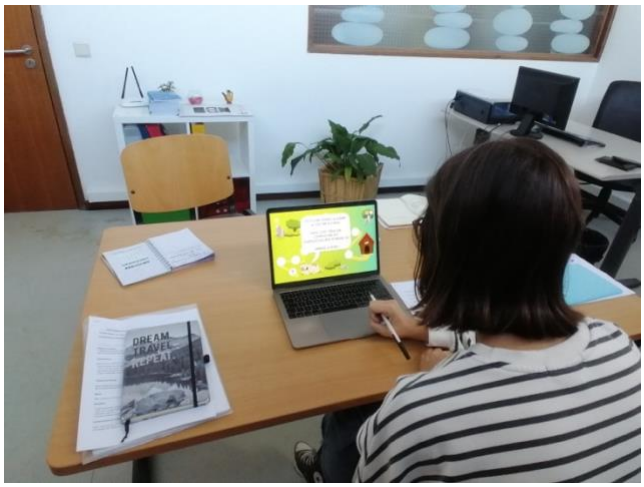
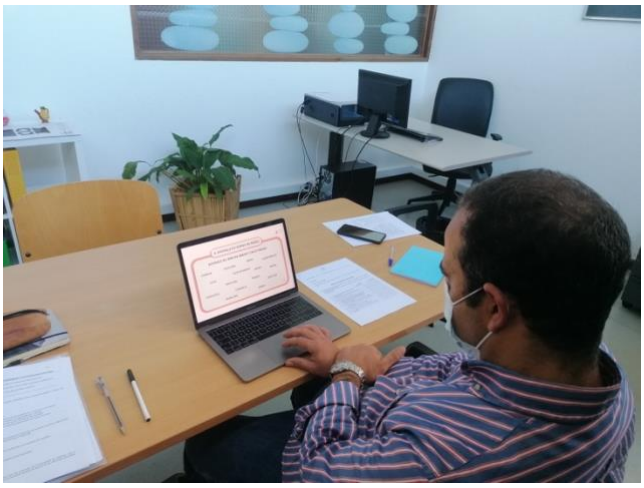
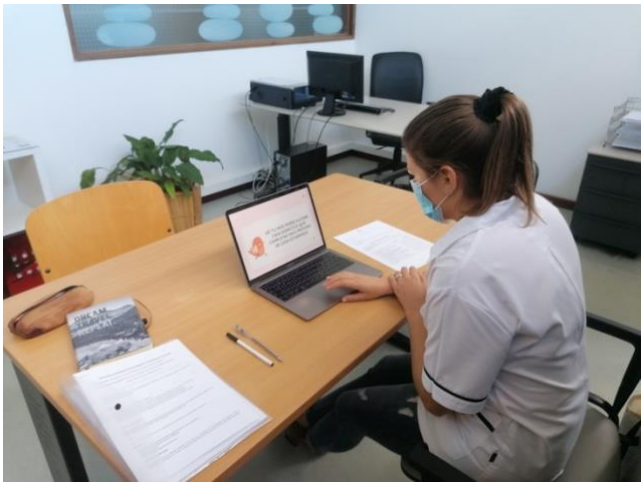
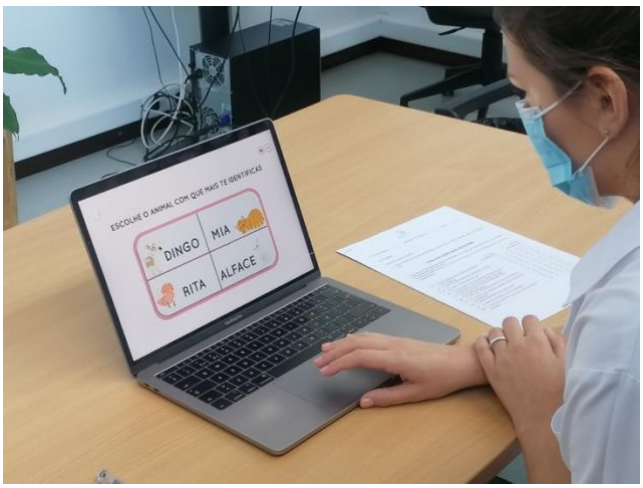






Figure 9 - 1/6 Photography's of the user tests







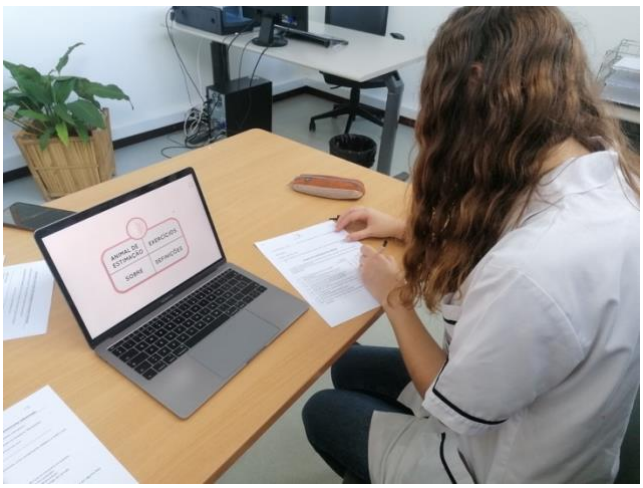
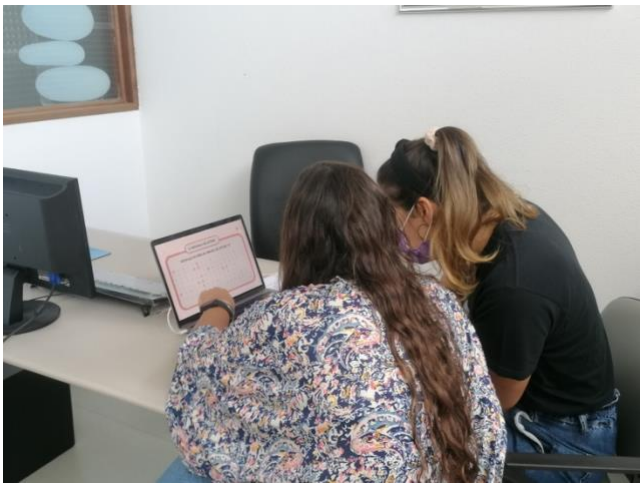


Figure 6 – 7/12 Photography's of the user tests





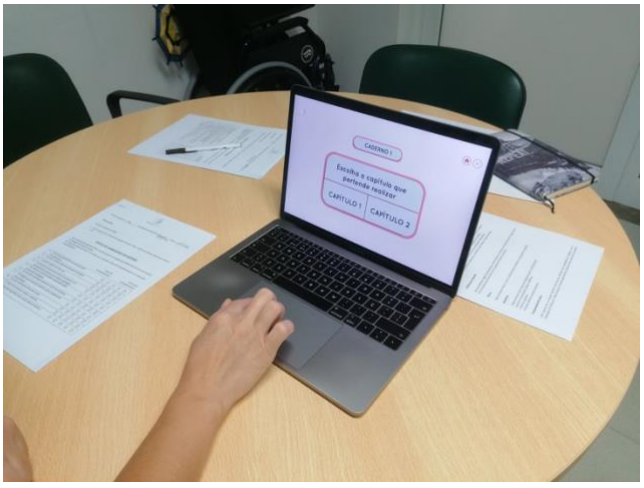
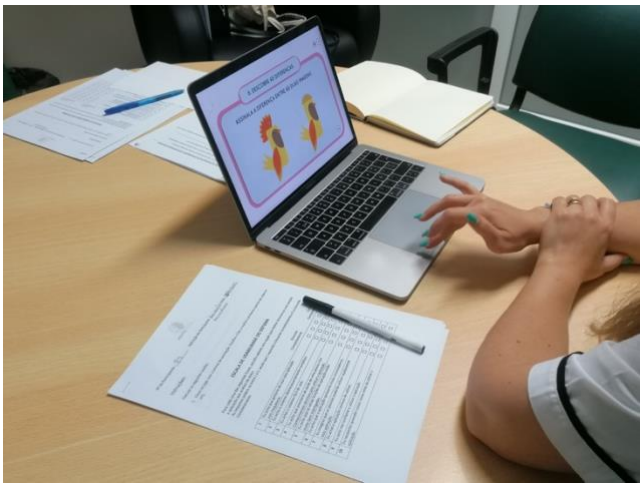
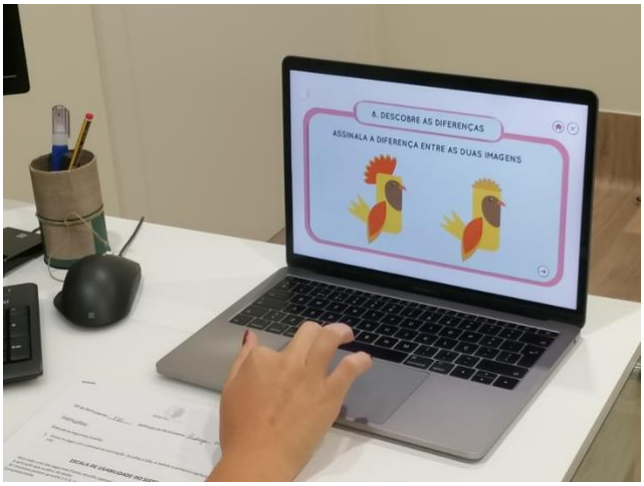


Figure 9 – 13/18 Photography's of the user tests





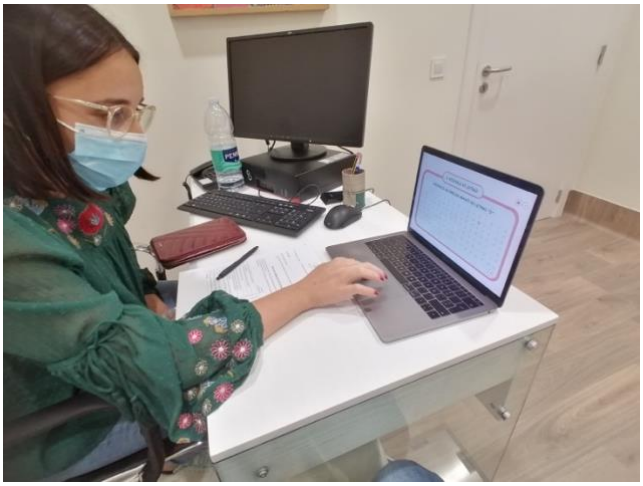
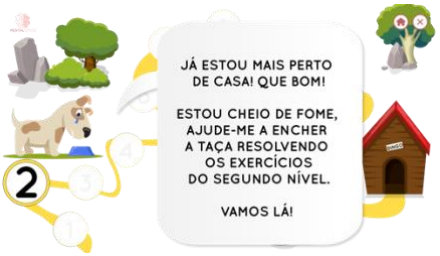
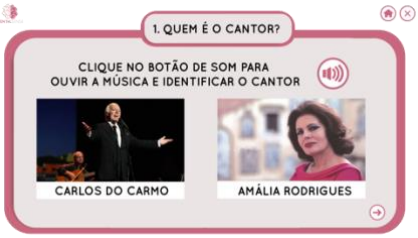


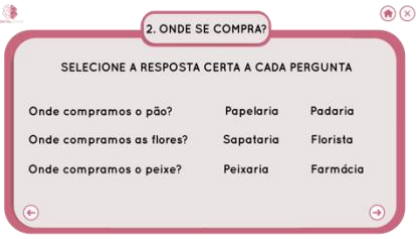
Figure 9 – 19/24 Photography's of the user tests

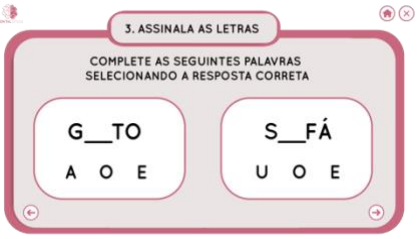
9.6. Screens of the final prototype

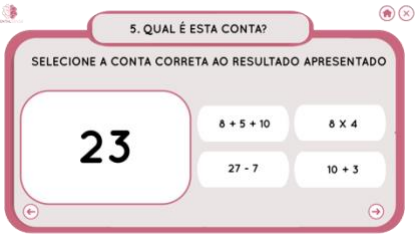
Figure 9 – 25/39 Screens of the final prototype

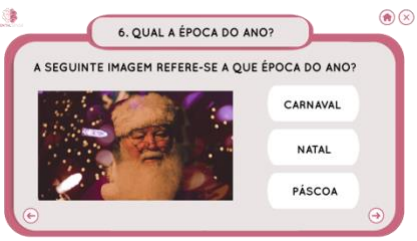


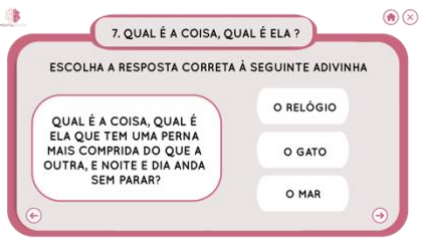












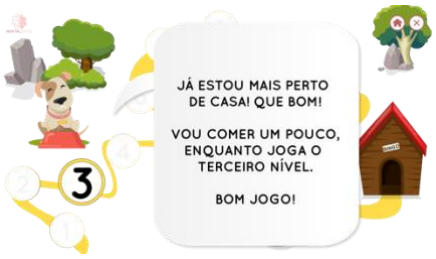


Figure 9 – 40/57 Screens of the final prototype

Figure 9 – 58/75 Screens of the final prototype

Figure 9 – 76/93 Screens of the final prototype

Figure 9 – 94/111 Screens of the final prototype

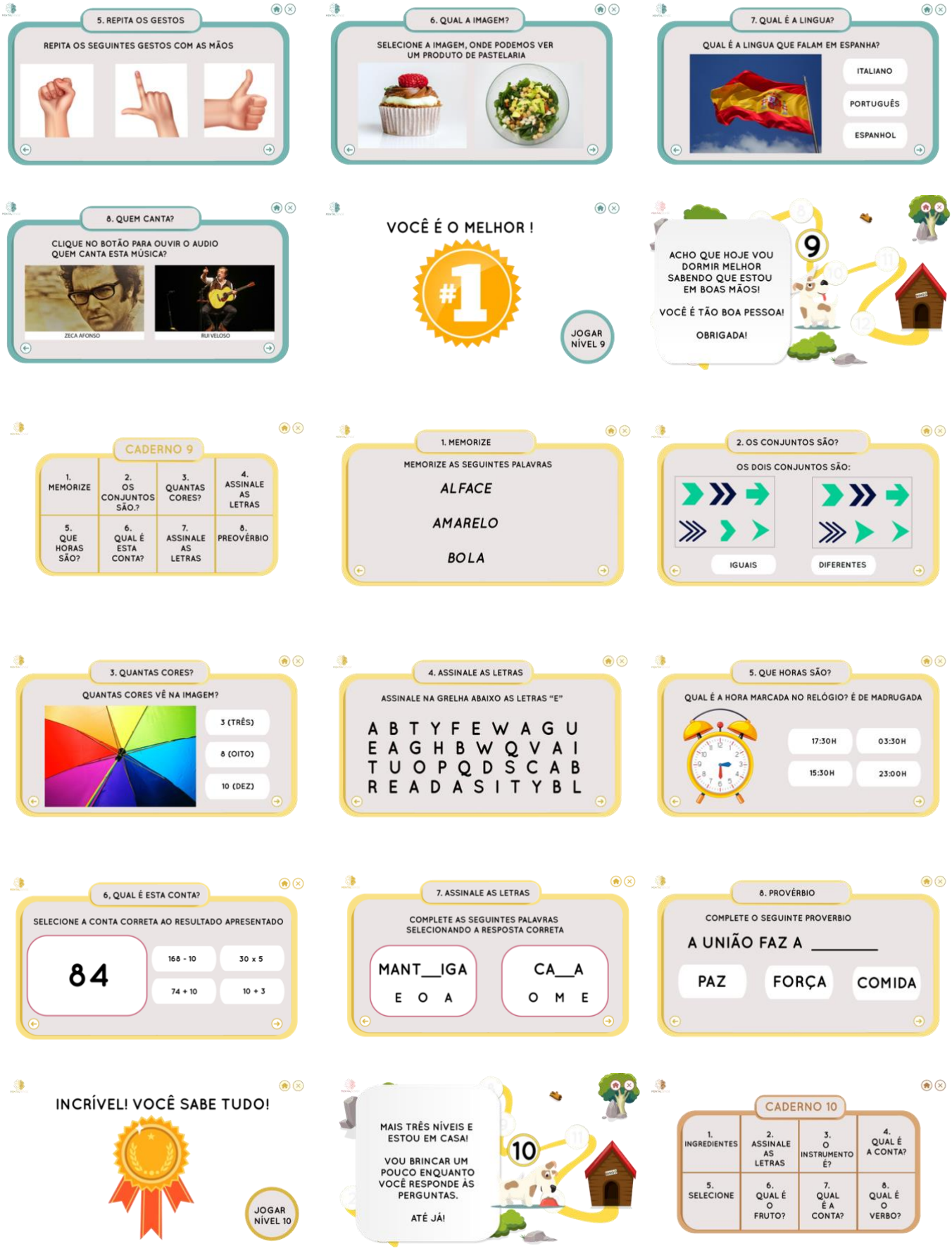


Figure 9 – 112/129 Screens of the final prototype

Figure 9 – 130/147 Screens of the final prototype

Figure 9 – 148/160 Screens of the final prototype