Design and Evaluation of Serious Games for Cognitive Diagnosis and Stimulation with Older Adults: A Preliminary Study

Helio C. Silva Neto^{1*}, Joilnen B. Leite¹, Durval P. César Neto¹, Joaquim Cerejeira^{2,3}

Licinio Roque¹

University of Coimbra, Dep. of Informatics Engineering, Portugal¹ University of Coimbra, Dep. of Medicine, Portugal² University Hospital of Coimbra, Gerontopsychiatry Unit, Portugal³

ABSTRACT

The aging process is often influenced by brain diseases affecting cognitive and physical abilities. From a clinical perspective, methods for neuropsychological assessment and cognitive stimulation adapted for an older population are crucial to quantify the cognitive and functional decline. Ideally, these methods should include relaxed, non-tiring and engaging tasks in order to motivate the elderly. Serious Games that adapt the current neuropsychological tests in order to assess performance of the players can enable useful data collection for medical evaluation. Here were port on initial steps for a methodology concerning the development of serious games for cognitive assessment, involving usability tests on two proposed prototypes. We present and discuss the behavior of the players during usability tests: the responses of players to the interview. An analysis of relevant points from the study concerning the challenges of working with an older population has revealed that the main challenge of working with a senior population is to awaken in them an interest to use the games, fundamental to overcome an initial resistance; and that there is need to develop strategies to design simple, yet useful, motivating games, allowing the collection of relevant results for health professionals working with this target group.

Keywords: Serious Games; Games Design; aging.

1 INTRODUCTION

Population aging is a fact that can be observed worldwide, particularly in developed countries. It is a diverse experience between individuals, which contributes to a multiplicity of genetic, biological, social, environmental, psychological and cultural factors. There is a linear correlation between chronological age and biological age [7]. In this context of aging process, it is observed that strategies should be employed to ensure the quality of life and autonomy/independence of older adults [7].

One of the strategies proposed by the World Health Organization, which aims to promote healthy aging, is the "Active Ageing", where physical activity is determinant for a healthy lifestyle, behavioral factors and active participation in the care of their own health [25]. Maintaining health and independence in old age, identified as good quality of physical, mental and social life, are the relevant factors to preserve the potential for achievement and development in this stage of life. It is also necessary to reduce the social impact issues surrounding the care of dependent older adults. For these and other demographic and socioeconomic motivations, health promotion has been highlighted in the axis of contemporary policies in the area of aging.

Mazo, Lopes and Benedetti [19] emphasize that, especially for older adults, the practice of training/cognitive stimulation, when Society has got in touch with a category of games developed to address issues not related to entertainment only; known as Serious Games, they employ the well-known game industry approach to make the games more attractive and to enable the use of simulations, while offering activities that promote the exercise of psychomotor skills. Therefore, the term Serious Games has been used to identify the games for a specific purpose, i.e., that go beyond the idea of entertainment and offer other experiences, such as those related to learning and training [3].

Consequently, the aim of this study is to map challenges in serious games design applied to cognitive stimulation and assessment with the elderly population, using two serious game prototypes as technological artifacts designed for data collection and analysis.

2 STATE OF THE ART IN GAME DESIGN FOR OLDER ADULTS

Aging affects the quality of life on many levels. In addition to sensory factors of vision and hearing [11], adults and senior public often experience cognitive impairments that affect problem solving skills and information processing, resulting in a reduced ability to perform complex tasks, in a decline in motor skills, in changes in attitude and balance that negatively affect motor learning. Finally, emerging chronic diseases ranging from arthritis to serious heart conditions have an impact on the physical skills and mobility [5].

The study carried out by IJsselsteijn et al. [14] identified the decline of visual and auditory skills, as well as loss of motor sensory skills as main issues. IJsselsteijn et al. propose visually adjustable games, for example, in relation to the sources, the window size, color and contrast, which provide multimodal return, over a communication channel, with the user. A game with a low complexity interface to improve usability is also proposed.

The European project ElderGames [10] aimed to development Serious Games for older adults, using visualization levels and advanced interaction interfaces, suitable for adaptation with advancing age, i.e., the design of the games includes the development of appropriate cognitive challenges, trying to maintain senior player's interest [8]. The results of the ElderGames project were compiled and their assessment based on usability criteria of advanced technologies for older adults. Older players had a higher preference for puzzle genre games (simple puzzles and quiz games), apparently because of their familiarity and previous knowledge with games of this type [10]. This study drew attention to the fact that this population is interested in using these technologies, despite having, initially, the fear of not being

well directed and performed regularly, can lead to many benefits, such as maintaining the independence and autonomy, greater longevity, improved cognitive ability in patients with chronic diseases, in addition to psychological and social benefits, for example, improved self-esteem and social contact.

^{*}e-mail: helio.hx@gmail.com

able to use them, which raises the issues of incentives and sensibility in the presentation of these tools.

Other factors relevant in game design for older adults are the impact of the content to be addressed in digital games, the kind of activity taking place and, the expected benefits of game play. IJsselsteijn et al. [14] identified as appropriate games for the public: a) Games for relaxation and entertainment; b) Games that support social activities; c) Games to sharpen the mind; d) effort (or exertion) games.

Another design strategy has been proposed by De Schutterand Abeele [6] which consists in connecting the players, valuing the skills (prior knowledge) of the players as important aspects of digital games for older adults. In terms of game features, the game social aspect is often approached by recommending a multiplayer mode; in practice this recommendation is insufficient. There are also a lot of older adults who participate in a peripheral way, i.e., they watch others as they play, twist and comment on situations of the game [20].

Other heuristics concerning design issues using touch technology can also be mentioned, bearing in mind the operation by an aged adult audience [13]: 1) Bimodal feedback: using the bimodal feedback (vision and hearing) within an adequate response time to the specific needs of senior user through the process of interaction with multitouch applications; 2) Appropriate metaphors: development of patterns of gestures and interface elements based on metaphors that are consistent with the cultural identity of the older adult; 3) Appropriate sizing and spacing: development of touch, goals and proper spacing for physical disabilities or characteristic of older users; 4) Interfaces consistent with the visual acuity: make the interfaces focus on reading, being consistent with the visual acuity needs of the older adult; 5) Number of affordances/interaction points: to limit the number of interaction elements when affordances and develop specific multitouch screens, so that there is a decrease in the senior user cognitive load; 6) Graphics and consistent interaction: developing consistent and stable compositions of graphics for the touch interface, to preserve the standard gestures within the space of possible interactions with the application.

2.1 Design of Cognitive Games

In this section, we review serious games applications as possible ways of weakening, stop or even reverse the impairments due to aging. But before commenting such studies, it should be understood what we will consider under cognition.

Cognition is a complex collection of mental functions including attention, perception, understanding, learning, memory, problem solving and reasoning, among others that allow man to understand and relate with the world and its elements.

Specifically, studies concerning digital games in the general adult population have also concluded that these specific instruments bring different benefits to users [17] at different levels: visual [12]; space display; reaction time [4]; Eye-hand coordination and quality of life [18]. Green and Bavelier [13] hypothesize that these benefits may be associated with increased levels of dopamine in the brain, triggered by playing digital games, that are in decline in old age and has been suggested as an important factor in the brain after modification by cognitive training.

Digital games have characteristics of cognitive stimulation techniques. These tools comply with, for example, the characteristics of cognitive stimulation techniques advocated by Franco-Martín and Orihuela-Villameriel [9] since it is an activity that can be continuous, systematic, reinforcing and stimulating to the patient and avoiding the routine reiteration. It can still be meaningful for patients, including the stimulation of other functions, especially of attention-attention spans, whose training increases the effectiveness of the stimulation of other functions, focuses mainly on the functions that are conserved and, finally, can be extended in time.

In addition to comply with these mentioned features, also meet the requirements supported by Thompson and Foth [24] for cognitive stimulation techniques applied to older adults, i.e., have easy access, are not too expensive and are pleasant to use.

In addition to the memory tasks, which are similar tasks in digital games memory, many of the tasks encompassed in digital games resemble those of stimulation of reasoning and of processing speed [13].

One aspect that can be an advantage of the digital games concerns the fact that they trigger a high level of interest in their users (as well as several specific emotions), as concluded in the study of Zagalo et al. [26], which encourages the involvement of individuals in the tasks and enables the achievement of the benefits that can arise from these activities. This feature seems particularly relevant, because cognitive stimulation exercises, developed specifically for this purpose, not often present this characteristic, what probably happens because they are routines without a purpose of entertainment, as is the case of digital games.

One example of a research project focused on the cognitive effects of digital games in the older adults is the European project ElderGames [10], which aims to develop games for the elderly population, employing visualization and advanced interaction interfaces, suitable to adaptation as the age of the user advances. This study drew attention to the fact that this population is interested in using these technologies, despite the initial fear of not being able to use them. So, there must be incentives promoting the sensibility in using these tools.

The digital game "Age Invaders" [16] is a game designed to be played by grandchildren and grandparents with parental supervision. This game has several objectives, including: increased interaction, intergenerational sharing and family support; to provide the opportunity to carry out physical exercise and use body language; to cognitively stimulate the older adult through activities based on puzzle-solving embedded in the game and, more broadly, to promote family well-being. It is important to mention that the intergenerational interaction proves to be beneficial for the several generations involved, as noted, for example, in the study of Kessler and Staudinger [15], which concluded that this type of interaction leads seniors to achieve higher levels of fluency measures and verbal speed.

What is still unclear is the determination of specific cognitive functions that are being stimulated with the use of these instruments, which could explain why the results indicated the level of cognitive functions in general. In addition, it is also uncertain what are the characteristics of games that contribute to this potential stimulation capacity, as discussed by Green and Bavelier [13].

A research proposal by Baniqued et al. [2] aims to evaluate the use of digital games for improving cognitive function. The work methodology was as follows: a group of 209 people (young and old individuals) were trained using various types of digital games for a period of 15 hours. Such digital games used were designed to work in the following cognitive domains: logical reasoning, working memory, attention, episodic memory, perceptual speed, and executive function. At the end of the training, the authors were able to conclude that the group did not present a significant improvement in the areas of logical reasoning, working memory, episodic memory, perceptual speed, and executive function. However, the authors reported a significant improvement in the field of group attention. Finally, the authors conclude that more research is needed to determine the real benefits of digital games focused on cognitive environment. The study carried out by Oei and Patterson [21] intended to analyze possible cognitive improvements with the use of digital games, the action genre in relation to a non-action genre. The methodology of work consisted in establishing five groups that explored various game types on mobile devices, in the course of an hour a day, five days a week for a four-week period, reaching a total of 20 hours of usage. By analyzing the results, the authors concluded that for users of the action games, there was an improvement in the cognitive domains of attention and spatial vision. In addition, in players that explored other game genres, there were significant improvements in the areas of memory and verbal fluency, i.e., these results indicate that different game categories have positive effects on cognitive domains. That is, digital games must be selected according to the cognitive domain that should be improved or stimulated.

3 METHODOLOGY

Our evaluation of the design and construction of two game prototypes, for cognitive stimulation with older adults, followed two steps: 1) Usability Testing and 2) Interview Analysis. These steps are detailed below.

This cross-sectional study was conducted in the Department of Psychiatry of the Centro Hospitalar Universitário de Coimbra. The cutoff point employed in the selection of participants in both groups was fifty years old or older (age ≥ 50 years). The research sample consists of two groups: profile 1, composed of four people (companion to patients) (N = 4) with no diagnosed cognitive pathology; and profile 2, composed of five people diagnosed with cognitive disease (N = 5). Both samples are composed of people with diversity of age, gender, education levels and occupations. Tests were run with a dual core, 7" Android tablet, 1280x800 res.

The game usability test aimed to conduct a survey of player behavior during the use of the prototypes.

The procedure was standard with all nine persons. This approach had five steps, which are set out below:

1. Information profile regarding by the researcher.

2. Explanation of the game, emphasizing that it is being developed for the elderly population, without informing the real purpose of the game [22, 23].

3. Explanation about game rules and gameplay (demonstration of the two games).

4. Autonomous experimentation by players, (with the occasional initial encouragement); Registering of direct observations and logging of player activity.

5. Finally, a list of questions was asked after five minutes of game use.

After the games usability testing, the following questionnaire was presented to the players:

- 1. What do you think of the game?
- 2. Are sheep and wolves moving nicely, slow or too fast?
- 3. Are the games intuitive?
- 4. Would you like to play these games at home?
- 5. Is the screen size a problem? Colors? Sounds?
- 6. Something else?

The main purpose was to collect feedback that could help explain difficulties users might have had during experimentation and clarify expectations about this kind of applications.

4 PROPOSED SOLUTION

The main idea behind these prototypes was to develop serious games to collect data which could help health professionals in the diagnosis of any suspected cognitive problems, also helping to monitor the progression of these conditions [22, 23]. Thus, game concepts were selected to exercise specific cognitive abilities.

In order to make it accessible to the public with mobility issues (i.e. bedridden or in a wheelchair), this proposal uses mobile technology (Tablets or Smartphones), i.e., it can be used anywhere [22, 23].

4.1 Separate the Sheep from the Wolf (Game 1)

The Game to Separate Wolves from Sheep aims to isolate all the moving Sheep from the moving Wolves, noting that the Wolves should be kept on the right side of the Enclosure and the Sheep on the left side of the Enclosure. The player must use the fingertip to open/move the Gate, so that the Sheep or Wolves can move to the correct side of the Enclosure.

The game is based on a mechanical operation, having the following steps (Figures 1, 2 and 3): 1) The scenario consists of two Enclosures. The possibility to pass from one to another is given by Gate; 2) Initially, Sheep and Wolf are generated, randomly, in the Enclosure; 3) The Sheep and the Wolf walk erratically, that is, the player can't control these animals; 4) Once the player reaches the goal of the game, the difficulty level increases; 5) When the game levels up, an additional Sheep and an additional Wolf are generated; the set is scrambled, which the player has to separate again.



Figura 1: Initial Interface - Separate the Sheep and Wolf Game.



Figura 2: Game Tutorial Interface - Separate Sheep and Wolf.



Figura 3: Game Interface - Separate Sheep and Wolf.

As it can be seen in figure 4, the game features two operating modes, which are: "Awaiting Separation" and "End Game". Thus, when starting the game, the first state is "Awaiting Separation" in which the player must perform the function of separating the Wolf(s) from Sheep(s). After the conclusion of the level ("Goal [Level Completed]"), the game will enter in a conditional that will depend on the player's choice. If the player chooses to continue the game, which is "Answer == True", the guard condition will lead to performing the "Level Up" and returning to the state "Awaiting Separation". If the player chooses "Exit Game" the condition "Exit Game == True" is reached, entering in the "End Game" finally running method "End the Game" and the function "Save Game Results".



Figura 4: Game State Diagram - Separate Sheep and Wolf.

4.2 Counting Sheep (Game 2)

In the Counting Sheep game the player will be asked to identify the number of Sheep that will appear in the Enclosure. The Sheep will be presented during a brief period of time and the player will not be able to count them before time runs out. To identify the number of Sheep, the player should simply focus on the screen such that the visual stimuli (Sheep) will be automatically processed by neural networks located in specific visual brain areas. To increase the stimulation of this cognitive region, Wolves will also be randomly generated and the player will be asked to identify the number of these animals [10].

The operation of the game goes through the following steps: 1) When the game starts, the player will have one second to observe the number of Sheep and/or Wolves in the Enclosure; 2) Sheep and/or Wolves will be moving, although slowly; 3) After one second, the player will have to answer with the number of Sheep and/or Wolves in the enclosure; 4) The player will be asked randomly about the number of Sheep or Wolves, to resist conditioning; 5) In case the answer about the number of Wolves is not correct the player will not be penalized; 6) If the player provides a correct answer the difficulty level of the game will rise;

7) If the player gives a wrong answer, the difficulty level of the game will be reduced and the player can only miss two more times, i.e., the player will only be entitled to three attempts.

Figures 5, 6, 7 and 8 show the game's interface. Figure 9 depicts the operation of Counting Sheep Game through a state diagram.



Figura 5: Initial Interface of Counting Sheep Game.



Figura 6: Tutorial Interface of the Counting Sheep Game.



Figura 7: Counting Sheep Game Interface.



Figura 8: Response Interface of Counting Sheep Game.

The initial state of the Counting Sheep game is "Awaiting Start". When requesting the start of the game, it follows to the state "Show Sheep". This activates a "Time" counter in seconds, i.e., the time that the player will have to identify the amount of Sheep or Wolves in the Enclosure; The guard condition to present the question of the player is "[Time == 1]" ("Asks Quantity"). When the player answers the question, it follows to the choice point. Given the correct answer ("Correct [True]"), the game continuous and the level is risen ("Level Up"). A wrong answer ("Wrong [True]") activates the functions "Subtract Life" and "Down Level". After performing the functions previously mentioned (wrong answer) a new choice is presented, which depends on the player's life counter. If there is a possibility to play on, it activates the "New Opportunity [Life> 0]". If the player meets the guard condition "[Life == 0]", the game goes to the "End Game" state, and by implementation in will "Save Game Results".



Figura 9: State diagram of the Counting Sheep Game.

5 EXPERIMENTAL RESULTS

In this section, we present and discuss the behavior of the players during usability tests, the responses of players to the interview and, finally, an analysis of relevant points in the study of serious games and usability, in the context of the challenges of working with the older adults.

5.1 Usability Testing

During the usability testing of prototypes, the players presented the following behaviors:

5.1.1 Person 1 (profile 2 or patients):

<u>Game 1</u>: From the home screen of the game, the patient did not have any trouble in recognizing the button to exit or start the game. The patient did not realize that the logo of the game was an icon to play and view the authors of the game. During the tutorial phase, s/he perfectly understood the rules and the written text in Portuguese. Once the game starts, the patient recognized the gate and how to select the up and down movements. However, "Person 1"could not slide his finger above the gate to see the passage of the animals. Also, there were complains about the long time it took for the sheep to get to the gate (sometimes they get close and return). He asked if the wolf could eat the sheep when they are on the same side. Finally, the player completed the first level of the game.

<u>Game 2</u>: The patient knew how to start the game, but had difficulty in seeing the amount of sheep on the screen; said that the game was too quick. S/he recognized the buttons on the home screen and the display that indicates the amount of sheep. The player considered game 2 more fun than game 1, because "it was more dynamic". Finally, the player only answered correctly three times, among fourteen attempts.

5.1.2 Person 2 (profile 2):

<u>Game 1</u>: The player emphasized that s/he liked the initial screen and did not have any problems in starting the game. S/he did not realize that the logo of the game was an icon for game credits. The patient read carefully the history of the game and the tutorial, however, did not realize where the gate was, taking a few seconds to find it. The player was all the time with his finger on the gate when s/he could slide to the side to better see it. S/he asked if the wolf could eat the sheep when they were on the same side. S/he said that the speed of animals was good and liked the sound of the wolves and the sheep. S/he completed both level one and two of the game.

<u>Game 2</u>: The player had difficulty in understanding the rules and complained about the speed at which the animals were shown for memorization/counting. S/he knew how to use the game buttons, so as to initiate and respond with the amount of sheep. The player scored twice in four attempts

5.1.3 Person 3 (profile 2):

<u>Game 1</u>: The player had no interest in participating in the test, claiming not to understand new technologies. However, found it interesting the development of these games for older adults.

<u>Game 2</u>: Re-iterated commentaries when asked to play game 2.

5.1.4 Person 4 (profile 2):

<u>Game 1</u>: The player did not play the game, however, requested the researcher to demonstrate the gameplay. In addition, this patient was curious about technology, but seemed overwhelmed or embarrassed by not knowing how to handle such artefacts.

Game 2: Same reaction as with game 1.

5.1.5 Person 5 (profile 2):

<u>Game 1</u>: A relevant characteristic of this player is that s/he is an active person in engaging with technology, arguing that s/he uses the Nintendo Wii and iPhone games. S/he did not realize that the logo of the game was an icon for info about the game authors. S/he started the game smoothly and carefully read the history of the game and the tutorial. Asked if the wolf would eat the sheep when they were on the same side of the enclosure. Initially, s/he found the gate and in less than a minute hand held exchange of sheep, taking less than two minutes to complete one stage of the game. S/he considered the game very boring and without much challenge. S/he finished the first four levels of the game.

<u>Game 2</u>: The behaviour was similar when compared to the first game, in the game-handling aspect. However, initially, s/he missed twice the amount of sheep and then, after the first contact, got it right every time continuously. S/he reported that this game was more challenging and, therefore, preferred the second game. Thirteen trials were recorded, and the player just missed twice.

5.1.6 Person 6 (profile 1 or companions):

<u>Game 1</u>: The player had no interest to take part in the test, alleging that s/he did not understand the technology.

Game 2: Similar reaction.

5.1.7 Person 7 (profile 1):

<u>Game 1</u>: The companion read the story of the game and the tutorial, claiming it is written in a manner slightly different from the language he is used to. S/he did not realize that the logo of the game was an icon to play the game credits. For a few seconds, the player stood watching the animals moving on the screen. The player also asked if the gate representation was really the gate. The player struggled to keep it open and moved the gate with his finger on top of it. Finally, he concluded one level of the game.

<u>Game 2</u>: When using the second game, the player did not make any complaints about screens or buttons. Reported that the speed the animals are exposed is fast and difficult to see. The player scored three times, among six attempts.

5.1.8 Person 8 (profile 1):

<u>Game 1</u>: The player did not play the game, however, requested the researcher to demonstrate the game enabling the observation and the answering of questions. This player was curious about technology, but felt overwhelmed or embarrassed by not knowing how to handle such artefacts.

Game 2: Same as with game 1.

5.1.9 Person 9 (profile 1):

<u>Game 1</u>: The player started the game smoothly and was amused by the farmer and sheep drawings. S/he did not realize that the logo of the game was an icon to play game credits. S/he had no problems handling the gate at a distance and explained the technique to another player who had previously tested the game. Asked if the wolf would eat the sheep if they are on the same side. Player completed four levels and claimed that the sheep and the wolves should move faster.

<u>Game 2</u>: This companion showed no problems with the handling of the game and its features. Commented that it felt very good that the images of the wolves and the sheep were identical to the previous game. Finally, s/he missed once among seven trials.

5.2 Interviews

After testing the prototypes from a usability perspective, we applied a questionnaire with six questions, as explained previously, in order to gather general feedback about the games.

The responses to the questions were as follows:

5.2.1 Person 1 (profile 2):

1- Found the game to be very funny; 2- The speed of the animals is considered too slow; 3- Found the games both easy and intuitive; 4- Would like to play them at home; 5- Indifferent. He did not pay much attention to the sounds of the games. He found the colors beautiful; 6- In the first game, he suggested to accelerate the animals and, in the second game, said that the speed was too fast.

5.2.2 Person 2 (profile 2):

1- Liked the images. Found images and sounds beautiful; 2- The speed is good. Only game two is too fast; 3- Found the first one a

good intuitive game, but had difficulty in understanding the second game; 4- Would play at home; 5- Said that, in a larger device would have trouble viewing the amount of animals; 6-Recommended a video tutorial for each game.

5.2.3 Person 3 (profile 2):

Did not answer the questions.

5.2.4 Person 4 (profile 2):

1- Found the games very interesting; 2- The figures are moving perfectly; 3- Thinks that the game is very easy to play and the rules are simple; 4- Would play at home; 5- In a smaller device, would have trouble in seeing because wears glasses; 6- No.

5.2.5 Person 5 (profile 2):

1- The second game is more lively and dynamic. The first is slow and tiring; 2- The animals are slow and do not interact with each other; 3- Found the games very easy and quite intuitive; 4- Yes, especially the second game; 5- Had no problems; liked the colors, design and sounds (mainly the ones produced by the sheep); 6-Suggested to include more challenges in the game, for example, the wolves would eat the sheep.

5.2.6 Person 6 (profile 1):

Did not answer the questions.

5.2.7 Person 7 (profile 1):

1- "Liked enough"; 2- The speed is very good; 3- Found them easy, the rules are simple and uncomplicated; 4- Yes, I would have some doubts, but I would love to be able to play; 5- Said a slightly larger screen would be better for the eyes; 6- The second game is very fast.

5.2.8 Person 8 (profile 1):

1- Yes; 2- No; 3- Yes; 4- Yes; 5- No; 6- No.

5.2.9 Person 9 (profile 1):

1- Played the first game with patience and the second game with more attention; 2- In the first game the animals are slow; 3- Easy and intuitive; 4- Yes, would play at home; 5- In the second game, more time to observe and memorize is needed; 6- Would only change animal speed in the first game.

5.3 Relevant Points for Research

In this section we will point out relevant aspects observed during usability tests, i.e., referencing important behaviors of the players with the two prototypes and, aspects revealed by interviews.

The graphical interface of both prototypes had no critical issues hindering the use or cause any problems for the players, since we can conclude from observation and interviews they understood how to play. The non-recognition by the group of the logo as a button, with which players could interact and get info on developers and institutions involved in the research, was not critical and easily solved with an explicit label or animation.

Concerning rules and tutorials, it is of fundamental importance to work with language, texts and everyday scenarios familiar with the target group because some players face the problem of language variation, causing problems in understanding gameplay, especially when the first prototype was evaluated. We highlight the problem of non-recognition of the gate representation by some players. The rules, however, were not an issue to the players; all players mentioned the rules of both games were understandable.

In the context of the gameplay, the control of the gate presented difficulties in the first game, with several players keeping a finger on top of the gate, which affected the visibility of which animals traded sideways. Players complained about the time they had to view the animals in the enclosure and this caused errors in the initial phase for some players. These two aspects point towards a need for an adjustment period in the interaction with the games and to some difficulties felt by the older adult population, relative to cognitive-motor and - visual health. Since this challenge is critical for the purpose in the games it should be calibrated for individual or population performance.

Additional problems encountered in the use of the prototypes were the speed at which the animals moved and the lack of more challenges during the game, which caused occasional boredom with some testers. The time that the player had to memorize the number of animals in the enclosure may also need calibration.

The attitude of the players towards the games was promising, since all the players in the analysis said they enjoyed and would play at home. Another important factor confirming interest is that none of the players gave up the activity during the gameplay, even when problems were encountered.

All players who used the two games were able to complete some levels of the game, with very diverse levels of performance, which adds plausibility to the idea of using these games as stimulation/measurement devices with a possibility of performance being associated with player cognitive health/ageing. This is a key aspect that will be addressed in future studies with a wider population and requiring extensive testing, logging, and measurements.

In order to improve prototypes and obtain data to better address the object of study, some work should be carried out in the future, such as: calibrating animal movement speed and size of the game representation; changing animals so there will be two differently colored sheep, to avoid wolf eats sheep distraction; calibrate the exposure time to view and count the animals; implement a performance logging database of gameplay interactions in both games; conduct research with two homogeneous sample groups (control and patient) with the aim of mapping different behavior indexes of people with diagnosed cognitive pathologies.

6 CONCLUSION

In short, the research developed so far intends to present a practical study of the challenges in the context of serious games designed for an older adult population, using two prototypes for a first usability and adoption analysis of technological artifacts.

It was found that the handling of the tablet technology was not a problem, requiring only minor adjustments in the games to improve performance and interest of the target group. Speed, timing and representations needed adjustments or calibration to ease the initial entry and engagement of older players.

Players interpret that the sheep would be attacked by wolfs, if they were on the same side. Such unintended interpretations can become an issue and stop gameplay. Still, older players need to effectively distinguish and be able to comfortably interact with the representations, pointing towards the usefulness of subjectspecific calibration.

It should be emphasized that in this usability testing context we included not only patients, but also people accompanying them to the doctor, in order to generate interest and capture a more diverse sample. The companions of patients have great potential to become a control group during the course of the research.

From this preliminary study, the main challenge is to use simple yet interesting games, allowing the assembly of relevant data for health professionals, thus enabling further studies concerning the diagnosis potential and therapeutic effects.

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