Universidade do Minho
Escola de Engenharia
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Structural Cognitive Training with Immersive Virtual Reality

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Nuno Afonso Araújo Pereira

ABSTRACT

In this thesis, a systematic review was conducted on the study of the use of VRSs. VR is an immersive technology capable of simulating real life events through image, sound and headed mounted devices or technologies such as windows kinnect. These technologies can be used to evaluate the performance and evolution of IADLs in older adults. An electronic data search was conducted, during January 2022. The final analysis includes 12 studies with 285 participants in total. The use of VRSs is an innovative and feasible technique to support and improve the functional autonomy of older adults living in the community compared to conventional treatment. Between 20% to 25% of community-dwelling people over 75 years old have limitations in the ability to perform ADLs. The ability to perform ADLs is extremely important as it enables individuals to have a good quality of life by creating a sense of competence, self-esteem, confidence, identify and realisation. In this thesis we present the concept of structural cognitive training, in which cognitive training tasks (executive functions and cognitive abilities) are combined with training of instrumental activities of daily living. The methodology adequacy is assessed by the design of a digital game to train older adults to conduct IADLs.

Keywords: virtual reality; functional autonomy; rehabilitation; exergame; head-mounted devices, activities of daily living

RESUMO

Nesta tese, foi realizada uma revisão sistemática sobre o estudo do uso de sistemas de realidade virtual. A realidade virtual é uma tecnologia imersiva capaz de simular eventos da vida real através de imagem, som e *head-mounted devices* ou tecnologias como o *windows kinnect*. Estas tecnologias podem ser utilizadas para avaliar o desempenho e a evolução dos *IADLs* em adultos mais velhos. Foi realizada uma pesquisa electrónica de dados, durante o mês de Janeiro de 2022. A análise final inclui 12 estudos com 285 participantes no total. A utilização de sistemas de realidade virtual é uma técnica inovadora e viável para apoiar e melhorar a autonomia funcional dos adultos mais velhos que vivem na comunidade, em comparação com o tratamento convencional. Entre 20% a 25% dos habitantes da comunidade com mais de 75 anos de idade têm limitações na capacidade de realizar *ADLs*. A capacidade de realizar *ADLs* é extremamente importante, pois permite que os indivíduos tenham uma boa qualidade de vida, criando um sentido de competência, auto-estima, confiança, identificação e realização. Nesta tese apresentamos o conceito de treino cognitivo estrutural, na qual as tarefas de treino cognitivo (funções executivas e capacidades cognitivas) são combinadas com o treino de actividades instrumentais da vida quotidiana. A adequação da metodologia é avaliada através da concepção de um jogo digital para treinar os adultos mais velhos a realizar actividades instrumentais da vida quotidiana.

Palavras-Chave: Realidade virtual; autonomia funcional; reabilitação; exergame; dispositivos montados na cabeça, actividades da vida quotidiana

CONTENTS

LIST OF FIGURES

ACRONYMS

A

ACE Addenbrooke Cognitive Examination.

AD Alzheimer dementia.

ADL Activities of Daily Living.

B

B-ADLS Bristol Activities of Daily Living Scale.

BADL Basic Activities of Daily Living.

BBS Berg balance scale.

BBT Box and Block Test.

BDI Beck depression inventory.

BI Barthel Index.

C

CDR Clinical Dementia rating.

CDT Clock Drawing Test.

CVVLT Chinese version of the Verbal Learning Test.

D

DST-B Digit span test-backward.

DST-F Digit span test-forward.

E

EEG Electroencephalogram.

F

FAB Frontal Assessment Battery.

FAQ Functional Activities Questionnaire.

FCSRT Free and cued selective reminding test.

FIM Functional Independence Measure.

FMA Fugl-Meyer Assessment.

G

GDS Geriatric depression scale.

H

HMD Head Mounted Device.

I

IADL Instrumental Activities of Daily Living.

ITVRP individually tailor made virtual reality programs.

IVR Immersive Virtual Reality.

K

K-MBI Korean Modified Barthel Index.

L

LBIADL Lawton-Brody Instrumental Activities of Daily Living.

LOTCA Loewenstein Occupational Therapy Cognitive Assessment.

M

MANOVA multivariate analysis of variance.

MBI Modified Barthel Index.

MCI Mild Cognitive Impairment.

MFT Manual Function Test.

MMSE Mini-Mental State Examination.

MMSE-DS Mini mental state examination-dementia screening.

MMT Manual Muscle Test.

MOCA Montreal Cognitive Assessment.

N

NPI-Q DEPRESSION Neuropsychiatric Inventory brief questionnaire form, Depression.

P

PSP The Personal and Social Performance Scale.

R

RAVL Rey Auditory Verbal Learning.

S

SBT Short Blessed Test.

SIS 3.0 Stroke Impact Scale 3.0.

SLOF The Specific Level of Functioning Assessment Scale.

SUS System Usability Scale.

T

TMT Trail Making Test.

TMT-A Trail making test-A.

TMT-B Trail making test-B.

U

UPDRS-II Unified Parkinson's Disease Rating Scale.

UPSA-B UCSD Performance-Based Skills Assessment Brief Version.

V

VR Virtual Reality.

VRFCAT The Virtual Reality Functional Capacity Assessment Tool.

VRS Virtual Reality System.

W

WAIS III Wechsler Adult Intelligence Scale III.

1

INTRODUCTION

Over the years, human beings undergo morphological and functional changes that have negative consequences on the performance of Activities Of Daily Living (ADLs). These ADLs can be defined as activities that individuals perform autonomously on a daily basis, substantially contributing to the feeling of fulfilling their social role. Performing these activities develops a positive sense of competence, self-esteem and self-efficacy when responding to various life demands Romero-Ayuso et al. (2019). ADLs are divided between Basic Activities Of Daily Living (BADLs) and Instrumental Activities Of Daily Living (IADLs).

BADLs are the skills needed to manage basic physical needs. Which include personal hygiene, dressing, bathroom use, moving around, eating, toileting, and bathing.

IADLs are tasks that involve complex interactions related to the ability to live independently. Such as managing finances, care pets, child rearing, care of others, driving and community mobility, shopping, cleaning and housekeeping, health management and maintenance, managing communication and medication.

The ability to perform ADLs is extremely important as it enables the individual to have a good quality of life, gain a positive sense of competence, self-esteem, confidence, and self-efficacy.that between 20-25% of community-dwelling people over 75 years old have limitations in the ability to perform ADLs Corregidor Sanchez et al. (2020).

The most traditional solutions for training ADLs are based on physical exercise, through planned, structured, and repetitive movement to improve or maintain one or more components of physical fitness Lee et al. (2003). These exercises can be exercises of resistance, aerobic, or balance, like aerobic exercise training (AET), where the body's large muscles move in a rhythmic manner for sustained periods. Typically based in the physical training program on article Chodzko-Zajko et al. (2009).

In Europe 71% of older adults aged 55 or over, are less likely to do vigorous physical activity, compared to people under 40-54 year olds for Communication (2018). Moreover, according to the 2014/15 European Health Interview Survey (EHIS), only 6% of older adults do physical activity.

Cognitive exercises consist on groups groups of protocolised tasks that target one or more domains of cognition Fan and Wong (2019), such as memory, attention, decision making, perception, reasoning, planning, judgment, general learning, overall executive functioning and more Ball et al. (2002). A type of exercise, consists in learning mnemonic strategies, so that participants memorise lists of words, sequence of items, text material, main ideas and details of stories.These mnemonic strategies involve organising a list of words into meaningful categories, to create visual images and mental associations to recall words and texts. Cognitive exercises do not involve any form of ADLs or IADls.

Near transfer is the transfer of acquired skills and knowledge to similar domains. So the "transfer effects between training or an intervention in one domain on performance in similar domains" Dowker (2019).

Far transfer is the transfer of acquired skills and knowledge to other domains in order to be applied in new contexts DaCosta and Seok (2010) and van Zyl and Mentz (2022). For example, playing chess or working memory games and transferring these skills to mathematical calculation or other domain. Some studies support this transfer Jaeggi et al. (2008) and Bart (2014) and others refute it Hänggi et al. (2014) and Sala and Gobet (2017). But there is further evidence that no far transfer occurs in different domains Sala and Gobet (2017). While there are positive correlations between music, working memory and IQ, the scientific evidence so far does not support this hypothesis Sala and Gobet (2017). Despite being cognitively demanding activities, they do not enhance any skill, beyond the skills trained. And most of the scientific evidence points to marginal or even non-existent results of far transfer between learned skills Sala and Gobet (2017). But in the article Bigand and Tillmann (2021), shows that the music case is special and allow for small, but statistically significant far-transfer effects.

The studies Faria et al. (2016), Schecker et al. (2013) and Jeon et al. (2019), show that cognitive exercises do not significantly increase the performance of ADLs. Therefore, there are no significant improvements in far trasnfer, only in near transfer. While physical activity with occupational therapy showed better results, they are still lower than in VR interventions. The reason for this is because occupational therapy train ADLs and the physical exercise improves more specifically the transportation ADL. Physical activities in the long-term study of the article Rolland et al. (2007), report smaller improvements than shorter duration physical exercises, which may be an effect of the burden on long-term physical exercises.

In our quest to create more efficient process of IADL training, we depart from the substantial scientific evidence that far transfer has very little or even no effects at all. This path takes us to propose the concept of Structural Cognitive Training (SCT), a training strategy that integrates a selection of cognitive training tasks into training simulations of specific complex activities. The objective is to overcome the current problem of little or no far-transfer learning between cognitive abilities training and the performance of complex activities, such as IADLs. SCT starts by reverse engineering the activity to be trained to identify the main cognitive abilities that are needed to execute the activity in an independent and satisfactory way. A training plan is then devised, integrating cognitive training tasks that have shown near-transfer effects on the cognitive abilities identified with concrete simulation exercises of the activity to be learned.

Virtual Reality (VR) is a technology that has substantially evolved in the last decade and has raised increased attention to support the functional capacity of older adults Corregidor Sanchez et al. (2020), Costa et al. (2019), Skjaeret-Maroni et al. (2015) and Belchior et al. (2018).

VR can create an immersive through a three-dimensional environment supported by realistic graphics, sounds, physics and other sensory inputs convey a sense of presence in another place. These environments are created by graphical simulation tools that generate variations of environments and situations. This naturally engage the user towards a blended reality containing virtual elements that potentially makes the user less aware that these elements are not part of a physical reality. Although virtual immersion can be achieved without Head-Mounted Displays (HMD), these devices provide a very relevant contribution to achieve an immersive effect more easily.

The addition of gamification elements and the possibility of doing these exercises indoors and without traveling, allows additional motivation and the possibility of performing the exercises without real world. For example, a VR simulation can be used to train taking a shower without the risk of the older adult falling, and in functional mobility to be run over on the road while going somewhere.

1.1 OBJECTIVES

The goal of this Master's work is to create a VR application with an HMD, capable of achieving adequate immersion to simulate realistic environments to improve the IADLs performance and overcome the limitations of far transfer. In order to increase motivation, closed-loop methods will be created that adjust the training to the user in real time, according to his or her performance.

1.2 Research Method

The following sub-objectives can be considered:

- Systematic literature review on the training of cognitive instrumental activities of daily living in virtual reality
- Specification of an IVR structural cognitive training solution for the assessment and training, cognitive and physical, of IADLs.
- Implementation of the specified solution on a VR platform.
- Design of the test protocol to be conducted.
- Test execution and analysis of results.
- Writing of scientific papers and master thesis.

1.3 Document Structure

This pré-thesis is divided in 2 main chapters. The "State of the art" and the "Proposed Approach". In the "State of the art" chapter, we collect, analyze and discuss the data of several studies related to the use of VR for assessing and training ADLs with HMD or less immersive instruments such as wii, microsoft kinect and others. This chapter is divided into 3 sections:

- **Sistematic Literature Review -** describes the research methods that were done and which data were extracted from each article. This section is further divided into 5 subsections:
  - **Search Strategy -** here we talk about the strategies used in the research of the literature, such as the search query, inclusion criteria and the databases in which the literature was found.
  - **Data items -** which data were taken from the articles.
  - **Search results -** Research Results
  - **Studies -** What do the studies assess.
- **Results -** The results of the studies.
- **Discussion -** Discussion about the articles' results.

- **Conclusion -** Conclusion of the results.

In the following chapter, "Go Catch a Bus Proposal", we will present our game proposal, based on adls from the Amini et al. (2014) article and on structural cognitive training. This chapter is divided in 2 sections:

- **VR Game Specification -** description of the VR game architecture.
  - **Game brief description -** A game description.
  - **Gameplay synopsis -** Short summary of the game
  - **Target Audience -** Audience for the game.
  - **Detailed Description -** Description of Game Type.
  - **House exploration -** Explains the mechanics inside the house. In which we have two core mechanics:
    * **Closet -** Here the mechanics of the closet is explained.
    * **Notebook -** Here the mechanics of the Notebook is explained.
    * **Kitchen -** Here the mechanics of the Cooking is explained.
  - **Game elements -** Shows a table with the interactive elements.
  - **Punctuation and Assumptions -** Shows the conditions and scores that the player must achieve to win the game.
  - **Scoring Rules -** Condition that the player has to increase or decrease his score in the game.
  - **Condition and victory -** Condition that the player has to win the game
  - **Defeat condition -** Condition in which the player loses the game
- **Example of game play -** Just an example of gameplay.

2

STATE OF THE ART

2.1 SISTEMATIC LITERATURE REVIEW

2.1.1 *Search strategy*

The articles were found in 10 different databases (Hindawi, PubMed, Plos one, Journal of NeuroEngineering and Rehabilitation, J-Stage, IOSPress, mdpi, NCBI, Science Direct, JPTRS) by October 26, 2021, using a search query ("IADL" OR "ADL" OR "BADL" OR ("activities" AND "daily" AND "living")) AND "virtual" AND "reality". Inclusion criteria include older adults over the age of 65 who perform cognitive exercises with VR in order to improve ADL performance. All studies must have some way of assessing the performance of ADLs. Any technologies that can be considered immersive were included. All the included studies were published in the last eighteen years between 2003 and 2021.

2.1.2 *Data items*

The following variables were extracted from the articles:

- Objective type (purpose of the studies)
- Trial type (total duration of the study)
- Intervention period (type of study)
- Intervention frequency (frequency of each session)
- Intervention duration (duration of each session)
- Comparisons (types of intervention groups)
- Criteria (inclusion and/or exclusion criteria)

- Intervention type (material that was used to evaluate the patients in the VR interventions)
- Side effects (side effects of interventions using VR)
- Evaluation (what methods were used to evaluate the patients)
- Results (results of the VR interventions)
- Limitations (limitations of the interventions)

2.1.3 *Search results*

17 articles were found. The articles found were the following, 2 articles that screen and assess individuals with MCI using IADLs tests (Seo et al., 2017), (Liao et al., 2019), 2 that studies the development of cognitive functions (Liao et al., 2019), (Cho and Sangheon, 2019), 3 that studies the development of physical functions (Liao et al., 2019), (Faria et al., 2016), (Kwon et al., 2012) and one that studies the quality of life (Eun and Kim, 2020). This technology can also help in rehabilitation of stroke patients (Faria et al., 2016), (Cho and Sangheon, 2019), (Jeon et al., 2019), (Kim et al., 2016). The following 9 studies studies the performance of ADLs/IADLs through repetitive VR training (Lee et al., 2003), (Liao et al., 2019), (Faria et al., 2016), (Kwon et al., 2012), (Cho and Sangheon, 2019), (Kwon et al., 2012), (Gerber et al., 2018), (Jeon et al., 2019), (Kim et al., 2016). The article (Kwon et al., 2012) show an increase of motivation. The article (Oliveira et al., 2021) studies the performance of ADLs in Alzheimer's disease patients. The last article (Pompeu et al., 2012), studies the performance of ADLs, cognitive and physical functions in people with Parkinson's disease.

Five studies were removed because they did not evaluate the performance of ADLs. The study (Mugueta-Aguinaga and Zapirain, 2017) was removed due to it being a study aimed at reducing frailty through FRED game in older adults. The study (Li et al., 2018), explores the validity of virtual daily living tests as a new diagnostic approach to assess MCI. The article (Atkins et al., 2015) checks whether the VRFCAT is able to measure functional capacity in older adults. The (Tarnanas et al., 2013), verifies the validity of the VRDOT against traditional assessments of IADLs. And the article (Lindenmayer et al., 2020), verifies the validity of the VRFCAT to assess ADLs. None of these studies attempt to assess the performance of ADLs.

2.1.4 *Studies*

Nine studies evaluated the overall impact of VRSs on ADLs with significant improvements in the studies of articles (Liao et al., 2019), (Lee et al., 2003), (Lee et al., 2015), (Cho and Sangheon, 2019), (Kwon et al., 2012), Jeon et al. (2019), Pompeu et al. (2012), Kim et al. (2016), (Faria et al., 2016), (Cho and Sangheon, 2019) and one of them with no significant improvements (Faria et al., 2016). While in the studies that examined IADLs, two of them show significant improvements (Eun and Kim, 2020), (Liao et al., 2019) the rest show no significant improvements (Oliveira et al., 2021). Four studies evaluated the effectiveness of VR in improving cognitive abilities (Oliveira et al., 2021),(Pompeu et al., 2012), (Eun and Kim, 2020), (Cho and Sangheon, 2019), another four show improvements in functional ambulation (Jeon et al., 2019),(Pompeu et al., 2012), (Lee et al., 2015), (Faria et al., 2016), two show extra motivation (Oliveira et al., 2021), (Lee et al., 2015), six show improvements in physical ability (Faria et al., 2016), (Lee et al., 2015), (Kwon et al., 2012), (Jeon et al., 2019), (Kim et al., 2016), one shows increased neuronal efficiency (Liao et al., 2019) and one last study shows improvements in concentration (Eun and Kim, 2020). All improvements were compared with before and after of VR interventions versus interventions with traditional methods.

The only intervention technique that was used were VRSs. Four studies use head-mounted displays (Eun and Kim, 2020), (Liao et al., 2019), (Lee et al., 2003), (Gerber et al., 2018), only one use kinect sensors (Kim et al., 2016), two use the wii (Lee et al., 2015), (Pompeu et al., 2012) Finally only one uses IREX VR (Kwon et al., 2012) and Moto cog (Jeon et al., 2019). The selection of the studies can be seen in the figure 1.

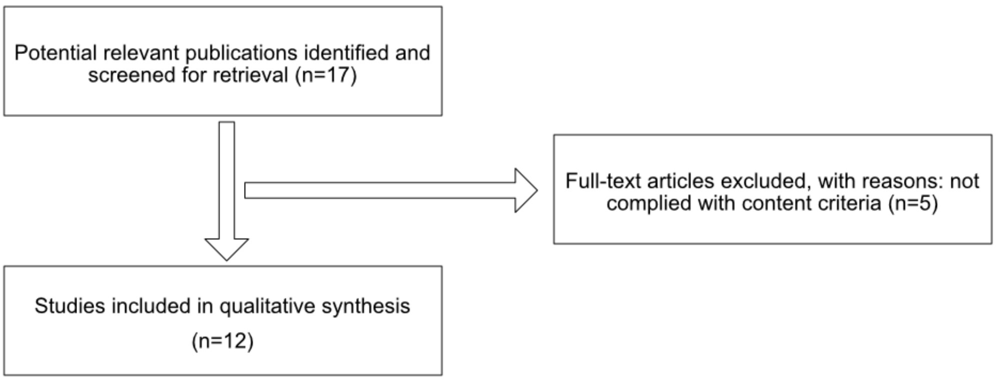


Figure 1: Selection of studies

2.2 RESULTS

All comparative studies of VR groups with groups that include the performance of traditional rehabilitation methods, show that VR exercises always perform better in performing ADLs through repetitive training.

Within the articles that reported improvements, let's look at the exercises that had a positive effect on ADLs or IADLs.

In the article (Eun and Kim, 2020), we have 3 different VR exercises that use HMD. A memory game, a reaction game and a judgment game. The memory game consists of choosing the correct order of 3 boxes, each with different colors that were previously shown, and then inserting them in order into a box, with a 60 second time limit. This exercise allows the individual to keep track of a particular problem and also provides the order of the colors. The following exercise is a reaction exercise, where the user's goal is to jump in order to dodge the bullets. The jump operation is performed by receiving the input value from the user via leap motion, such as grab. The difficulty of the game can increase or decrease depending on the performance in the game, this difficulty is managed through the speed of the bullet. The last game in this article is a judgment game. It consists in choosing a box with a corresponding color that is described in words, these words also have different colors. The difficulty of this game is determined by the number of color changes and the time adjustment and the level of difficulty by the user's performance and analysis. Concentration results are measured from the EEG, and an increase in concentration of 17.7% was recorded. The increase in problem solving ability was from an average of 59.05 game points in the first month to 73.35 in the third month. The level of satisfaction was measured with the likert scale, with positive results after the 3 months, exceeding 8 points in "Good" and "Normal" satisfaction level with the same points. Finally the ability to solve the problem indirectly allows for improvements in cognitive functions, the validity of ADL content and content development ADLs is demonstrated by continuous testing for 3 months and the overall improvement in satisfaction and cognitive functions of 30 people respectively.

In the article (Liao et al., 2019) VR-based physical exercises were created with HMD and Kinect systems. These exercises are based on simplified 24-form Yang-style tai chi, resistance exercises, aerobic exercises, and functionally oriented tasks such as cleaning windows, collecting goldfish, passing obstacles, climbing stairs, and walking, designed to improve upper and lower extremities, balance, stability, muscle strength, and endurance. All of these games are based on IADLs. Cognitive exercises were also designed based on IADLs, such as shopping, food preparation, handling finances, and transportation. Therefore, 4 games were created, take mass rapid transit (MRT), is a game that was built in a way to imitate an MRT, which includes gates, ticket vending machines, and ATMs. The goal of the participants is to follow the normal subway procedure, such as finding the desired station and the amount of money needed to buy the ticket from the vending machine. The next game is called kitchen chef, in which the user will have to cook a dish with the instructions and tools available in the game. The instructions for the preparation of the dish and the dish itself will have to be memorized. The third game is called looking for a store, in which players will have to go looking for the stores marked on the map with a maximum of 3 minutes. If players don't find the stores in 2 minutes, red direction marks will appear on the map in order to guide players. Finally, the last game in this article is called convenience store clerk, this game takes place in a convenience store, where players have a list of items and step-by-step instructions available to facilitate the finding of the items easier. The found items must be inserted in the shopping basket. The results are as follows, there are significant effects within the VR group on MoCA ($P<0.001$, effect size=1.03), EXIT-25 ($P=0.01$, effect size=0.65), CVVLT immediate and delayed recall ($P<0.001$, effect size=0.64 and $P=0.002$, effect size=0.89 respectively) and IADLs ($P<0.001$, effect size=0.87), have higher values than the CPC group.

In the paper (Faria et al., 2016), there is a VR-based cognitive intervention consisting of a simulation of a city, called Reh@bCity. It is composed by streets, sidewalks, commercial buildings, parks and moving cars. All exercises are ADL-based, with various levels of progression, from the simplest to the most complex that involves more cognitive domains. For example, go to the supermarket and buy two bottles of water, this is a simple instruction, with a minimap, an arrow on the map, and a list of clues. Another simple task, would be to go to the pharmacy and buy a cream. Next the article presents two complex instructions, the first one asks the player to go to the Post-office in order to buy two stamps and pick up 3 packages. Then the article presents two complex instructions, the first one, asks the player to go to the Post-office in order to buy two stamps and pick up 3 packages. The next instruction tells the player to go to the supermarket and buy orange juice, two boxes of cereal and 4 loaves. Finally we have two more levels of progression that are problem solving instructions. The first is to pay the electric bill and the second is to buy food for breakfast. For global cognitive functioning there are statistically significant improvements with the wilcoxon test, ACE ($W(9) = 44.000$, $Z = -2.549$, $p = .011$, $r = .85$) and MMSE ($W(9) = 34.000$, $Z = -2.246$, $p = .025$, $r = .75$), improvements in attention ($W(9) = 28.000$, $Z = -2.375$, $p = .018$, $r = .79$), memory ($W(9) = 28.000$, $Z = -2.384$, $p = .017$, $r = .79$) and visuospatial ability ($W(9) = 28.000$, $Z = -2.388$, $=.017$, $r = .80$). For the executive functions experimental group have better performance, when compared to the control, at the end of the intervention (U = 19.500, Z= -2.042, p = .063, r = .24). And finally there is no significant improvement in ADL's (W(9) = 38.000, Z = -1.838, p = .066, r = .61).

The exercises proposed by Lee et al. (2003), consist of simulating a supermarket, which contains 4 displays, 4 refrigerators each with a door and 2 open refrigerators. The main goal is to pick up all the items and put them in the cart, so that then the subject can head to the exit of the supermarket and traverse its structure in 10 shifts in total. There were improvements in the parameters measured between day one and day five. The first parameter measured was elapsed time. The time decreased from 174.15s on the first day to 159.10s on the fifth. The distance also decreased from 252 to 272.6, as did the error from 0.57 to 0.32. The number of selected products from an average of 0.8 to 2.6. And finally the number of times the button is pressed which went from 3.8 to 6.

For this article (Lee et al., 2015), subjects participated in a virtual reality dance exercise on the wii console in addition to neurodevelopmental treatment (NDT) and functional electrical stimulation (FES). There were significant improvements in balance in the experimental group (46.0±1.3 to 48.1±3.0; $p<0.05$) as opposed to the control group (45.0±1.3 to 45.4±1.5; $p>0.05$). In ADLs the improvements were also felt mainly in the experimental group, where with the MBI it went from a score of 87.9±1.4 to 91.1±3.0, while the control group went from 87.4±1.7 to 88.2±1.8.

In the article (Cho and Sangheon, 2019), there are two games, Fishing and Picture matching. The first game consists of catching fish using the top edges, the game ends when a number of fish are caught. The Picture matching game consists in finding cards that are identical. Initially 8 cards are placed face down, the player can see the face of all of them. Then you have to choose two cards, already face down, that are identical, when you find all the cards you win the game. The results were as follows, experimental group scored 10.24 in the ACPT, and the control group scored 3.29. For the VRT-1, the experimental group scored 1.76 and the control group scored 0.76. For the VRT-recall the experimental group had a score of 1.81 while the control group had a score of 0.81. Finally the FIM total score for the experimental group scored 19.19 and the control group scored 9.43.

In the article (Kwon et al., 2012) 4 games are included, the first one is called Bird and Ball, this game consists of hitting balls that appear randomly on the screen and directing them against birds. The second game is called Coconuts, in this game the patients have to put the coconuts that fall from the top of the screen into the basket by moving their hands left and right. The third game is called Conveyor, in which conveyor belts appear on the left and right sides of the screen, while the patient holds a box coming from the conveyor belt on one side and moves it to the opposite side of the conveyor belt. The fourth game is Soccer, in which the patient is the goalkeeper and must defend the balls with his hand. Last is the game Drums where the patient has to create his own beat. According to the article the VR group showed improvements in FMA and MFT scores ($p < 0.05$). In the K-MBI score for ADLs, the VR group score increased from 60.31 ± 24.21 to 85.00 ± 16.01. While the CT group had an increase from 63.08 ± 16.75 to 84.69 ± 14.10, a lower increase than the VR group.

In another article (Gerber et al., 2018), a simulation of tea preparation was made. The user has the mission to pour the tea into the cup, then add milk and sugar in order to finish, stir everything with a teaspoon. Next a comparison was made between the mouse device and the handheld controller. In terms of usability the handheld controller performed better MD = 81.3 ± 11.3 compared to the mouse device MD =42.1 ± 16.5. The average tea preparation duration was shorter for the handheld controller 255.6 ± 109.6 seconds while the mouse device was 377.2 ± 127.7. The object possession duration was also shorter for the handheld controller 63.9 ± 28.3 and 159.4 ± 85.13 for the mouse device. While immersion and presence the handheld controller had an average score of 4.7 ± 1.2 and the mouse had 4.6 ± 0.8, on a scale of 0 to 5. While realism and involvement in tea preparation the score was lower on the handheld controller 3.8 ± 1.2 than on the mouse device 4.0 ± 0.6, due to unrealistic physics.

Oliveira et al. (2021), studies nine different tasks. Which are the following, Morning hygiene, Shoe closet test, Wardrobe test, Memory test, Virtual kitchen, TV news, Grocery store, Pharmacy, and Art gallery test. All of these games can be tested in the site 28. For the executive functions assessed with FAB, he had a greater improvement than the control group. The distribution of the total FAB score from baseline and post-treatment followed a normal distribution according to the KS test, which are tested with repeated measures ANOVA. With one within-subject factor (baseline vs. post-treatment) and one between-subjects factor (groups: experimental vs. control). The results showed no statistically significant ($p > 0.05$), or interaction effects ($F(1, 15) = 2.032$; Eta2p = 0.119; $p = 0.174$). There is also an increase in the mean FAB score for the post-treatment assessment from 9.30 to 10.00 in the experimental group and a decrease for the control group from 8.00 to 7.71. The TMT results show no significant differences in the experimental group for both TMT part A ($Z = -2.121$; $p = 0.063$) and TMT part B ($Z = -1.342$; $p = 0.50$) and in the control group for TMT parts A and B ($Z = 0.000$; $p > 0.05$).

Both groups, the control and experimental in the article (Jeon et al., 2019), used virtual reality with balance training, with the difference that the experimental group performed the training on unstable platforms. Two types of exercises were then performed: the hand function and ADL courses. The hand function course consisted of a door lock, turning on a gas stove, squeezing, and hammering. The ADL course involved performing ADL-related activities such as washing, cooking, and bathing. The difficulty level of training in all courses was divided into five levels, from level 1 being very easy to level 5 being very difficult. There were no significant differences in MFT, BBS, and K-MBI between both groups (p>0.05). But the scores were always higher on MFT, BBS, K-MBI and Locomotion for the experimental group. The scores of the experimental group were as follows, MFT with 6.57 (5.65), BBS with 6.57 (3.41), K-MBI with 18.43 (8.38) and Locomotion with 11.14 (3.34). The control group has the following scores MFT with 5.43 (3.31), the BBS with 3.71 (2.63), K-MBI with 14.86 (9.26) and Locomotion with 8.14 (6.74).

In the article (Pompeu et al., 2012), the games in the experimental group are performed on the nintendo wii and are divided into 3 groups. Static balance (Single Leg Extension and Torso Twist), dynamic balance (Table Tilt, Tilt City, Soccer Heading and Penguin Slide), and stationary gait (Rhythm Parade, Obstacle Course, Basic Step and Basic Run). The exercise Single Leg Extension consists of balance on one leg while moving arms and leg contralaterally while remaining stable, the torso twist perform torso twists, moving arms and keeping feet still while remaining stable, the table tilt consists of shift centre of gravity slowly in all directions with feet in a fixed position, the tilt city consists of shift centre of gravity sideways keeping feet still while moving arms. The Soccer Heading consists of shift center of gravity latero-laterally while keeping feet still. The Penguin Slide consists of Shift centre of gravity latero-laterally while keeping feet still. A Rhythm Parade consists of perform stationary walk to auditory and visual rhythm provided by game, while performing flexo-extension of elbows in different rhythm to walk. Thw obstacle course consists of perform stationary walk as fast as possible, halt and resume walking. The exercise Basic Step, consists in alternate steps mounting and dismounting Wii Balance Board, according to rhythm determined by game. All of these games are played on a wii balance board. The game Basic Run is the only game that is not played on the wii balance board platform and consists of performing stationary walk as fast as possible on soles. Descriptions are given in the article (Mendes et al., 2012). According to Section II of Unified Parkinson's Disease Rating Scale which assesses the among other things IADLs. The experimental group scored better than the control group, before the training the experimental group had a score of 10.1 (3.8) and after the training they got a score of 8.1 (3.5). The group maintained after 60 days a score of 8.3 (3.6). The control group, before training got a score of 7.6 (2.9) and after training got an average of 8.1 (3.2), the score remained at 8.1 (3.2) after 60 days. Both groups showed significant improvements on the Berg Balance Scale, Unipedal Stance Test (with open and closed eyes) and Montreal Cognitive Assessment. The improvements were maintained after 60 days.

Finally in the article (Kim et al., 2016), the patients have about 4 training mode and 3 game modes. The first training mode is called Diagonal 1 Shoulder Flexion pattern (D1 Flexion pattern) and consists of the following movement, the arm begins in an extended position slightly out to the side, about one fist width from the hip, with the wrist stretched and the fingers opened. Then, the arm is lifted to about nose level across the body with the elbow crossing the midline. This pattern often thought of as functional for self-feeding. The following training mode is called Diagonal Shoulder Extension pattern (D1 Extension pattern) and consists of the following movement, the arm begins in a lifted position at about nose level across the midline of the body. Then, the arm is extended slightly out to the side, about one fist width from the hip, with the wrist stretched and the fingers opened. This pattern often thought of as fastening a seat belt. The third training mode is called Diagonal Shoulder Flexion pattern (D2 Flexion pattern) and consists of the following movement, the arm begins in an extended position about one fist width from the hip across the midline of the body. Then, the arm is lifted at about one fist width from the ipsilateral ear with the wrist stretched and the fingers opened. This pattern often thought of as throwing a wedding bouquet. The last training mode is called Diagonal Shoulder Extension pattern (D2 Extension pattern) and consists of the following movement, the arm begins in an extended position about one fist width from the ipsilateral ear with the wrist stretched and the fingers opened. Then, the arm is extended about one fist width from the hip across the body with the elbow crossing the midline. This pattern often thought of as resheathing a sword. Next we have the game modes, we start with the game Whack-a-mole game, which consists of playing with one hand using the D1 and D2 Flexion and Extension patterns. Moles appear in the following patterns, wherein the participant performs diagonal and spiral arm movements to hit the moles with a hammer in a cave: right up and then left down; right down and then left up; left up and then right down; left down and then right up of the right. If the participant catches a mole with the correct velocity and angle, it disappears, making a pained expression and saying, "ouch!" However, if the participant does not hit it, it disappears after 5 s. The following game is called Nutcracker which consists of playing with both hands using the D1 and D2 Flexion and Extension patterns. Nuts appear in the same patterns as the whack-a-mole game. The participant makes diagonal and spiral arm movements to crack the nuts with a hammer in the forest. If the participant hits a nut with the correct velocity and angle, it cracks and disappears, making a cracking sound. However, if the participant does not hit it, it disappears after 5 seconds. And lastly the Jet ski game which consists of, playing with the trunk as a warm-up exercise. In this game, which reflects the participants' trunk movement, the participant tries to catch coins to increase their score as they advance in the sea. Coins appear on the left and right sides, prompting the participant to move the trunk laterally. All participants improved in FMA score ($t = -6.599$, $p < 0.001$), in MFT ($Z = -2.624$, $p = 0.009$) and MBI ($Z = -2.315$, $p = 0.021$), there were no significant improvements in BBT score. Only two participants had negative scores according to MFT, BBT, and MBI.

The summary of the studies are integrated in Tables 1, 2, 3, 4, 5 for later discussion.

Table 1 Summary and Intervention of the Studies

Article	Addressing Study			Participants	Intervention		Tests	
Title	Objective Type	Trial Type	Comparisons	Criteria	Intervention type	Category	Evaluation	Results
Design and Implementation of ADL Content with VR Sensor at aSmart Human-Care Service Eun and Kim (2020)	Improve cognitive and physical functions, improve quality of life	3 months, 2 times/week, total of 16 times. Three tipes of mini games.	-	Average age 68 80 years old	EEG device's CPU was designed with an ARM M4 CPU. ARM M4 core CPU, EEG sensor, RTC, LCD display, and BLE solution. In the ARM, a 12-bit 200 kbps ADC capable of handling analog signals and 32 flexible GPIOs, a Leap Motion device and a HMD	vr HMD, Leap Motion device, and EEG	Test method EEG data analysis to evaluate ADLs, game performance degree analysis, and satisfaction analysis	Content show a higher concentration by 17.7%.For the performance evaluation, improvement of overall cognitive function and satisfaction. The difference in content solving ability between the first month (average 59.05 points) and the third month (average 75.35 points.
FRED: Exergame to Prevent Dependence and Functional Deterioration Associated with Ageing. A Pilot Three-Week Randomized Controlled Clinical Trial Mugueta-Aguinaga and Zapirain (2017)	reduce frailty risk via the use of a FRED game	Three weeks of 20 minutes physical activity performed three times a week	Study group -FRED Game and control group- they had no physical activity scheduled	Inclusion: people over 65 years of age with a Barthel score equal to or above 90 points who carry out no scheduled physical activity. Exclusion: people who carry out scheduled physical activity	FRED is a game that has been developed using a 3D unity motor, and needs a Kinect game controller connected to a computer and a screen or TV.	VR - kinetic (non-imersive VR)	Frailty screening was undertaken using the short physical performance battery (SPPB), The Wilcoxon test was carried out to determine that the results from the study group improved.	Our findings support the hypothesis that FRED, an ad hoc designed exergame, significantly reduced the presence and severity of frailty in a sample of sedentary elders, thus potentially modifying their risk profile. The FRED game is a tool that shows a 99% certain improvement in the degree of frailty in frail elderly subjects
Using virtual reality-based training to improve cognitive function, instrumental activities of daily living and neural efficiency in older adults with mild cognitive impairment Liao et al. (2019)	Investigated the effects of 12 weeks of VR-based physical and cognitive training on cognitive function, brain activation and IADL	group for 36 sessions over 12 weeks, three times a week, 60-minute each	VR group and CPC (Combined physical and cognitive training) group	inclusion criteria: aged >= 65, able to walk more than 10 meters without walking aids, had an MMSE >= 24 and a MoCA < 26, had self-reported memory complaints, had the ability to perform ADLs.	Vr -The VIVE system developed by the HTC company was used for the present study.	VR-HMD	MoCA was used to assess global cognition. The EXIT-25 assess executive functions, The CVVLT to assess verbal memory, functional status was measured by the LBIADL, a 16-channel NIRS device was used to measure brain activation simultaneously with the assessment of the MoCA	The present study showed that cognitive functions of older adults with MCI benefited from 12 weeks of the VR intervention. A decreased activation in the prefrontal areas, indicative of increased neural efficiency, was also found in the VR training subjects. Furthermore, VR-based physical and cognitive training was superior in improving IADL compared to CPC training.
Virtual daily living test to screen for mild cognitive impairment using kinematic movement analysis Seo et al. (2017)	This study explored the validity and dis-criminative power of a virtual daily living test as a new diagnostic approach to assess MCI	All subjects received a 10 minute training session to become accustomed to the immersive virtual environment	virtual daily living test and conven-tional neuropsy-chological tests for patients with MC vs healthy control subject	Inclusion: MCI was diagnosed with criteria described by Albert et al. Exclusion: subjects who abused drugs or drank alcohol heavily within four weeks of starting the study were excluded through clinical interview, history of neurologi-cal/psychiatric diseases and brain surgery.	Setting for the VDLT was a room-sized cube (4m x 2.5m x 2.5m) that had four rear-projection screens which could project an immersive and realistic 3D environment. Subjects wore stereoscopic glasses (weighs around 50g) and reflective markers (weighs less than 1g) and eight motion tracking cameras (OptiTrack™, NaturalPoint Inc., USA) recorded the subject's body movements by tracking the markers	room-sized cube	Neuropsychological tests -MMSE-DS for assessing general cognitive function, K-IADL for assessing IADL deficits, FCSRT for immediate and delayed free-recall memory, DST-F, DST-B for executive function, TMT-A, and TMT-B for psychomotor speed. And we use Virtual daily living test (VDLT) to measured a subject's body movements while performing IADL tasks.	In the neuropsychological test results, MCI patients had statistically significantly lower scores in immediate free-recall memory (FCSRT) compared to healthy controls. The questionnaire-based IADL assessment (K-IADL) was not statistically different between healthy controls and MCI patients due to a ceiling effect. The VDLT sensitively differentiated MCI patients from healthy controls using virtual IADL tasks.

Table 2 summary and intervention of the studies

Article	Addressing Study			Participants	Intervention		Tests	
Title	Objective Type	Trial Type	Comparisons	Criteria	Intervention type	Category	Evaluation	Results
Benefits of virtual reality based cognitive rehabilitation through simulated activities of daily living a randomized controlled trial with stroke patients Faria et al. (2016)	Improve cognitive rehabilitation by supporting carefully personalized and ecologically valid tasks through accessible technologies such as vr.	Takes twelve-session intervention of 20 to 30 min distributed from 4 to 6 weeks. Both pre and post assessment moments had an approximate duration of 60 min.	VR-based intervention vs conventional rehabilitation	inclusion criteria: hemispatial neglect as assessed by the clinicians with the Line Bisection test, capacity to be seated, ability to read and write, minimum cognitive function as assessed by MMSE >= 15.	Reh@City was implemented using the Unity 3D. Desktop computer running Windows 7 (CPU: Intel core 2 duo, RAM: 4Gb) with a 24"LCD monitor. Joystick was used (Topway's Digiusb Joystick Tp-usb670, China) with 2 customized colored buttons corresponding to the in-game actions "selection"and "help".	Non-immersive VR.	Global cognitive functioning as assessed through the ACE. To assess attention we used the (TMT A and B). To specifically assess executive functions we used the Picture Arrangement test from the WAIS III. Subjective general health status, as assessed by the SIS 3.0, a self-reported questionnaire that functionally assesses 8 domains: motor strength,ADL's, mobility, communication, emotion, memory, and social participation. SUS, to assess satisfaction and usability with the Reh@City system.	Experimental group improved significantly in the physical domain, namely strength and mobility, memory, emotion, social participation and overall recovery. Instead, the control group decreased in the physical domain and only improved in memory, mobility and social participation. And no significant diferences in communication, ADLs, and hand function, but the experimental group (VR) performed better.
A Virtual Reality System for the Assessment and Rehabilitation of the Activities of Daily Living Lee et al. (2003)	Assess and train cognitive ability in ADL in order to rehabilitate	All subjects performed the main task 5 times over a period of 5 days.	vr group	Inclusion: Five subjects with TBI or stroke who were receiving rehabilitation treatment at the National Rehabilitation Centear	VR system consisted of a Pentium IV PC, DirectX 3D Accelerator VGA Card, Head Mount Display (HMD, Eye-trek FMD-250W), 3 Degrees Of Freedom Position Sensor (Intertrax2), Joystick (Airstik 2000) and a 3D Accelerator VGA Card	VR-HMD	VE was designed to assess and train cognitive functions involved in basic ADL. Measured the elapsed time, the distance moved, the number of collisions with walls, the number of selected goods, the number of refrigerator doors opened, the number of joystick button presses, and the error rate.	The time, distance, and number of collisions tended to decrease, the number of selected goods and button pressings also tended to increase with time, and the error rate tended to decrease. After the third day, on which they began to coordinate two tasks simultaneously, the performance rates of the subjects improved. These results show that repeated training in VR is effective.
Effect of virtual reality dance exercise on the balance, activities of daily living, and depressive disorder status of Parkinson's disease patients Lee et al. (2015)	Study the effects of virtual reality dance on the balance, activities of daily living and depressive disorder of Parkinson's disease patients	30 minutes of neurodevelopment treatment and 15 minutes of functional electrical stimulation, 5 times per week for 6 weeks. The experimental group additionally performed 30 minutes of dance exercise.	experimental group (virtual reality dance exercise) vs the control group	participants with Parkinson's disease that are able to understand the study requirements and to communicate sufficiently, and could ambulate independently	The virtual reality dance exercise used the K-Pop Dance Festival (Nintendo Inc., Japan) game for the Wii. A strap was used to fix the remote control to the hands.	VR-Wii (non-imersive VR)	Balance was assessed using BBS. ADL was assessed using the MBI. The presence and severity of depressive disorder was assessed using the BDI.	Balance improved significantly in the experimental group. Virtual reality exercise improves balance through integration of feedback from the scala vestibule and proprioceptors. Virtual reality exercise provides active learning and motivation to patients through an experiential environment. The present study also found there was a significant enhancement of ADL of PD patients following their performance of virtual reality dance exercise.

Table 3 Summary and Intervention of the Studies

Article	Addressing Study			Participants	Intervention		Tests	
Title	Objective Type	Trial Type	Comparisons	Criteria	Intervention type	Category	Evaluation	Results
Effects of virtual reality immersive training with computerized cognitive training on cognitive function and activities of daily living performance in patients with acute stage stroke: A preliminary randomized controlled trial Cho and Sangheon (2019)	Investigate the impact of virtual reality immersive training with computerized cognitive training on the cognitive function and activity of daily living in patients with acute stroke.	The training was 5 times for 4 weeks in 20 sessions in total. More 30 minutes of VR training while the control group took 60 minutes of training.	experimental group (virtual reality HMD) vs the control group	Selection criteria: pacients diagnosed with a stroke within 3 months, those who scored 80 or more in the Motor-free Visual Perception Test and had no visual perception including unilateral neglect, and those who scored 24 or higher in the Korean Version of Mini-Mental Status Examination and could understand what the examiner said and read texts.	A HMD is wearable on the head or as part of a helmet that has a small display optic in front of one (monocular HMD) or each eye (binocular HMD). It consists of goggles, the main body, and the camera. The HMD's hardware uses the gyro sensor, the acceleration sensor, and the magnetometer to allow the goggles to detect head movements in real time.	HMD	The LOTCA to assess the standardized cognitive and perception function of adult patients with strokes, those with brain damage, and normal people. Functional independence measure, measure motor function, identifies what the subject is doing, and the level of help (ADLs).	Changes before and after the intervention in LOTCA items between the groups were not significant. For changes before and after the intervention in CNT items between the groups, the experimental group scored 10.24 in the ACPT, whereas the control group scored 3.29; the experimental group scored 1.76 in VRT-1, whereas the control group scored 0.76; and the experimental group scored 1.81 in VRT-recall, whereas the control group scored 0.81. The combined intervention (HMD and computerized neurocognitive training)positively recovered cognitive function and daily living performance (ADLs) in patients with acute stroke.
Effects of virtual reality on upper extremity function and activities of daily living performance in acute stroke A double-blind randomized clinical trial Kwon et al. (2012)	To examine the effects of conventional therapy (CT) combined with intensive virtual reality (VR) program on upper extremity function and activities of daily living (ADL) in individuals in the acute stage of stroke.	VR was provided for 30 minutes per day, 5 days per week for 4 weeks in addition to CT. Conventional therapy was provided for 70 minutes per day, 5 days per week for 4 weeks.	VR plus CT (experimental group) vs Conventional therapy (control groups)	The inclusion criteria were as follows: adults who are within a 3 month post-stroke period, individuals with capacity to understand and follow simple instructions, adults demonstrating 3 grades on the MMT of elbow joint movement, ability to grasp and release affected hand, ability to maintain standing or sitting position independently, and no visual deficit.	The VR intervention was conducted using the IREX VR system. This VR system consists of a television monitor, a video camera, cyber gloves and virtual objects, and scenes displayed on a large back screen.	IREX VR system (non-imersive VR)	FMA assesses motor impairment of the upper extremity after stroke. MFT measures upper extremity function in individuals with stroke. The K-MBI assesses independence in ADLs in individuals recovering from stroke.	VR group showed a significant improvement between pre- and post-test in FMA scores and on the MFT ($p < 0.05$). The CT group showed a significant difference between the pre- and post-test in FMA scores ($p <0.05$), but not on the MFT ($p > 0.05$). VR group showed improvement between pre- and post-test in K-MBI total score. However, there was no significant difference between CT combined VR group and CT alone group in the outcome measures. But significant improvementes in Arm and Coordination and Speed sub-tests was observed in the VR group.
Virtual reality for activities of daily living training in neurorehabilitation: a usability and feasibility study in healthy participants Gerber et al. (2018)	Analyze the feasibility of a simple virtual ADL (tea preparation task) using two different input devices for diagnostic and rehabilitative purposes.	The initial phase was followed by letting participants get used to the virtual environment and the input device for three minutes.	HMD with handled controller vs HMD with a mouse	The main inclusion criteria were age > 18 years and absence of neurological deficits and visual impairments.	The HMD (Oculus Rift DK2, Facebook). Computer (graphic card NVIDIA GTX980, Nvidia, CPU Intel i7, Intel, handheld controller used (Razer Hydra Sticks, Razer) and a mouse (MX Anywhere 2, Logitech).	HMD (Oculus Rift DK2)	Questionnaires about the usability of the system (System Usability Scale SUS), presence and immersion (iGroup presence questionnaire IPQ) and the workload to solve the task (NASA Task Load Index TLX).	We found that the implemented virtual ADL is highly immersive. Second, performing the task with the handheld controller was highly intuitive and simple to use, which was also reflected in low workload ratings, whereas the mouse device was given less favorable results rating. Overall, a beyond state of the art HMD-based VR setup to simulate an ADL was successfully implemented. Due to high immersion, the learned skills in the ADL should be easily transferred from real to the virtual world and thus represent a good ADL training opportunitys

Table 4 Summary and Intervention of the Studies

Article	Addressing Study			Participants	Intervention		Tests	
Title	Objective Type	Trial Type	Comparisons	Criteria	Intervention type	Category	Evaluation	Results
Virtual Reality-Based Cognitive Stimulation on People with Mild to Moderate Dementia due to Alzheimer's Disease: A Pilot Randomized Controlled Trial Oliveira et al. (2021)	Explore the effect of a cognitive stimulation reproducing several IADL in VR on people with mild-to-moderate dementia caused by Alzheimer's Disease	This intervention lasted two months, with a total of 10 sessions (two sessions/week). Each session lasts 45 min.	Experimental group consisted of VR cognitive stimulation at residential care homes for older adults vs the control group that received treatment-as-usual at care units for older adults.	Inclusion criteria: being older adults with AD, fluent in Portuguese, above 65 years old, and keen to participate in the study.	non-immersive VR exposure on a laptop screen of 17 inches.	Non-immersive VR.	The executive functions were assessed with the FAB and the TMT. FAB, the Portuguese version. Global cognition was assessed with the Mini-Mental State Examination—MMSE. CDT, Portuguese version, is a paper and pencil instrument for cognitive screening in dementia. The LBIADL aims to measure disability in instrumental everyday activities through caregivers' reports. The Geriatric Depression Scale-15—GDS was used as a self-reporting instrument for depression. The CDR is aimed at evaluating cognition and behavior, as well as the ability to perform activities of daily living.	Improvement in overall cognitive function in the experimental group, which suggests that this approach is effective for neurocognitive stimulation in older adults with dementia. For the executive functions this study did not show improvements. And the IADL assessment, the ANOVA did not reveal statistically significant differences. Use of serious games elements contextualized in IADL contributed to improving their motivation and to retaining patients during this intervention program.
Effect of Nintendo WiiTM-based motor and cognitive training on activities of daily living in patients with Parkinson ' s disease : A randomised clinical trial Pompeu et al. (2012)	Investigate the effect of Nintendo Wii-based motor cognitive training versus balance exercise therapy on ADLs in patients with Parkinson's disease.	4 different series, each lasting for 30 minutes. Balance training for the experimental group was composed of 14 sessions, each lasting 30 minutes, Furthermore, an additional session was performed 60 days after the end of training.	control group (balance exercises without feedback or cognitive stimulation) vs experimental group (Wii Fit games)	Inclusion criteria: Parkinson's disease treated with levodopa; age 60 to 85 years; Hoehn and Yahr stages 1 and 2; good visual and auditory acuity; 5 to 15 years of education, dementia assessed by the MMSE or depression according to the GDS-15. The participants had no experience of using Wii Fit.	Nintendo wii	Non-immersive VR (wii)	Unified Parkinson's Disease Rating Scale (UPDRS-II) that assess independent performance of activities of daily living. Dynamic balancewas assessed using the Berg Balance Scale and Static balancewas assessed using the Unipedal Stance Test.	Patients with Parkinson's disease were able to improve their performance in three groups of games; Wii-based motor and cognitive training improved the participants' independent performance of ADLs, balance and cognition, and this was maintained for 60 days after the end of training; the improvement was similar to that obtained by the participants who performed balance exercise therapy; and no training led to significant improvement in balance in the dual task. Improvement in the skills trained through Wii Fit was not restricted to games, but had a positive impact on independent performance of ADLs, balance and cognition.
Feasibility of an individually tailored virtual reality program for improving upper motor functions and activities of daily living in chronic stroke survivors: A case series Kim et al. (2016)	Investigate the feasibility and effectiveness of introducing a newly developed ITVRP on chronic stroke survivors with upper motor problems.	ITVRP for 40–50 min/day, 3 days/week for 8 weeks	chronic stroke survivors ITVRP	inclusion criteria: ischemic or hemorrhagic stroke at least 6 months previously; age 65 years or older.	A motion-capture sensor Kinect for Windows was connected to the main notebook computer by a USB 2.0 interface to create the individualised and tailored rehabilitation environment. A 50-inch PDP display monitor.	Non-immersive VR (Kinect for Windows)	Fugl-Meyer Assessment, Manual Function Test, Box and Block Test, and Modified Barthel Index. A custom made questionnaire was used to investigate satisfaction and safety of the ITVRP.	All participants' FMA scores improved after the ITVRP. Only 2 participants experienced negative outcomes according to the MFT, BBT, and MBI. They reported that the ITVRP would positively affect the upper-limb motor functions and ADL performance and be feasible for chronic stroke survivors. Improved MBI scores in chronic stroke survivors are interpreted as improved ADL performance. Repetitive and precise exercises of appropriate intensity are key factors for the recovery of motor functions and ADL performance in stroke survivors. Furthermore, the visual feedback mechanism used in the ITVRP continuously motivates participants

Table 5 Summary and Intervention of the Studies

Article	Addressing Study			Participants	Intervention		Tests	
Title	Objective Type	Trial Type	Comparisons	Criteria	Intervention type	Category	Evaluation	Results
Effects of virtual reality combined with balance training on upper limb function, balance, and activities of daily living in persons with acute stroke: a preliminary study Jeon et al. (2019)	Investigate the effects of virtual reality combined with balance training on upper limb function, balance, and ADLs in persons with acute stroke	Both groups performed the conventional rehabilitation therapy for 30 minutes a day, 5 times a week, for 4 weeks. Additionally, the experimental group conducted the VR training for 30 minutes each session, whereas the control group performed balance training for 30 minutes.	Experimental Group (non-immersive VR) vs control group (conventional rehabilitation therapy)	Inclusion criteria were as follows: clinically diagnosed stroke, stroke occurred within the last 30 days before the onset, a score of 24 or more on the Korean Mini-Mental Status Examination, and a stable medical condition. The exclusion criteria were as follows: a history of visual or hearing impairment and a history of orthopedic surgery.	Moto Cog (Cybermedic, Iksan, Korea) was used for the virtual reality rehabilitation program. To improve balance was used a balance pad (AIREX, Anaheim, CA, USA). Subjects in the control group conducted balance training on over-ground.	Non-immersive VR (Moto Cog).	The Manual Function Test (MFT) was used to measure upper limb function. To measure the balance was used The BBS, that is a dynamic balance test that scores functional tasks. The Korean version of the Modified Barthel Index (K-MBI) was used to assess the subject's ADL.	The results revealed that ADL focused virtual reality training is more effective for improving upper limb function, balance, and ADL for persons with acute stroke than that on a stable surface. Both the experimental and control groups showed significant improvement in all assessments after intervention. There was no statistically significant change, but the experimental group showed a greater decrease in fall risk after intervention than the control group. This result suggests that ADL-focused virtual reality combined with balance training can enhance balance ability compared to that without balance training.

2.3 DISCUSSION

Although there are only a few studies examining the effectiveness of VR-based program interventions for ADLs and IADLs in older adults, the results are encouraging. Only 3 studies showed non-significant improvements in ADLs and IADLs.

In most studies, VR was applied through HMD with simulations or video games due to its immersive aspect. Replicating ADLs from the real world to VRs and then conveying the benefits achieved from VR through repetitions to everyday activities. This type of technology, VR in conjunction with game development allows for extra motivation by adjusting difficulty levels (Oliveira et al., 2021), (Lee et al., 2015).

Only 4 articles specifically indicate improvements in the performance of IADLs, which indicates that in more complex activities VR is less efficient, as they depend more on a social context.

In the article (Eun and Kim, 2020), there is no real method to study the real impact of VR versus traditional methods. Since there is no such comparison, we cannot say that VR is better than traditional methods. The tests are also not specific in real ADLs, also no scales like BI were used to measure real life activities, only the EEG was used. So we don't know the real effect of these exercises in the improvement of ADLs in real life. On article (Liao et al., 2019), both groups showed improvement, although it was the VR group that showed significant improvement in the IADLs among older adults with MCI. The VR group had a 1.61 improvement on the Lawton Instrumental Activities of Daily Living scale while the CPC had a 0.44 improvement. Despite the improvements, more people should have been included in the study to understand the real impact of VR on IADLs. Both groups should have an equal number of people, which is not the case. There was also a lack of a long-term study to understand if these improvements were maintained over time. Most of the articles have the same problems as the ones mentioned above, few individuals in the studies, lack of long-term studies, in order to understand if these improvements are maintained over time. And some articles use EGG or the number of clicks and crashes against 3D structures and not scales like BI or LAWTON, in order to assess and see if the improvements have been transferred to ADLs. Most studies show significant improvements in ADL performance in the VR group compared to traditional methods.

2.4 COGNITIVE ABILITIES FROM A SCT PERSPECTIVE

One must first comprehend the relation between cognitive abilities and IADLs performance because it holds the foundation for the SCT (Structural Cognitive Training) methodology. Cognitive functions refer to mental processes that include the domains of perception, memory, learning, attention, decision-making, and language abilities Kiely (2014). These mental processes or mental activities, are associated with learning and problem solving performed by individuals. This ability to process information in complex ways is referred to as cognitive functioning. These processes may include verbal, spatial, psychomotor and processing-speed abilities on Measurement in Education (2017-07-22). Cognition is defined in Press and Dictionary.com (6 May 2020) as "the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses", which includes various cognitive functions Press and Dictionary.com (6 May 2020).

The human being is made up of 6 cognitive domains Association (2022) Sachdev et al. (2014), as shown in diagram 2.

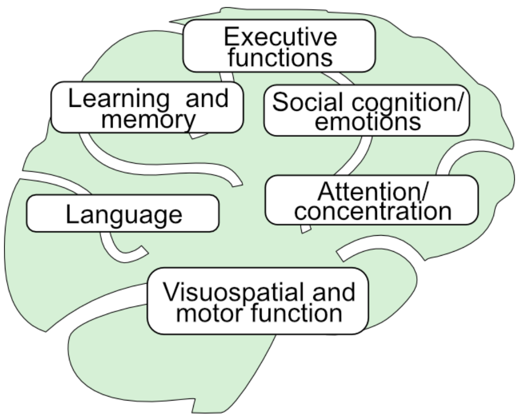


Figure 2: Cognitive functions

Executive functions consist in ten cognitive abilities, planning, integrated perception, decision making, working memory, reasoning, mental flexibility, flexible problem solving, metacognition, responding to feedback and overriding habit/inhibition. These functions allow us to "plan, focus attention, remember instructions, and juggle multiple tasks successfully" University.

The language dominion is composed by object naming, word finding, grammar, syntax and receptive language. This domain is fundamental to the acquisition of concepts and the view that language can serve for the formation of human thought processes Carruthers (2003).

Learning and memory functions are composed of several subcomponents such as, free recall, delayed memory, encoding memory, long-term memory, short-term memory, prospective memory, reasoning memory, verbal memory, information processing, and implicit learning. Usually this domain is conceptualised involving three phases: encoding, storage, and retrieval. Encoding is the initial recording and acquisition of information, storage is the maintenance of information over time, and retrieval is the process by which stored information is brought back into conscious awareness, this retrieval can be done in long-term memory and/or short-term memory Roediger and Karpicke (2005).

Social cognition emotion refers to a set of complex mental abilities underlying the perception, processing, interpretation and response to social stimuli. Together, these abilities support the development of appropriate social competence and adaptation Beaudoin and Beauchamp (2020). In order for the subject to acquire appropriate behaviour in a social environment, the individual must be able to interpret the social context and regulate his/her behaviour Aminoff and Daroff (2014) through cognitive self-monitoring and self-control. In addition to self-monitoring and and self-control, this cognitive domain is composed by the recognition of emotions, theory of mind, insight, and elf-evaluation.

The Attention/Concentration domain is described as the ability to choose and concentrate on a relevant stimulus. The ability to maintain attention on a stimulus for a long period of time is called sustained attention and the ability to choose a particular stimulus is called selective attention Cognifit. The rest of the abilities in this domain are divided attention and alternative attention.

The visuospatial and motor function refers to the cognitive processes required to "identify, integrate and analyse space, visual form, details of structures and spatial relationships" Dickerson (2014) in more than one dimension. These skills are necessary for the perception of depth and distance through visual perception and visuoconstruction. With the help of perceptual-motor coordination, that enables the subject's spatial navigation.

2.5 SCT METHODOLOGY

In the SCT methodology, it is necessary, to start by identifying the IADLs of the game mechanic. Then it is necessary to create cognitive tasks to train the IADLs for example, based on the tools Brainer, Captain's Log, CogniFit, COGPACK, FesKits, GRADIOR, NeuronUp, ComCog Irazoki et al. (2020). Then a gameplay example is presented, with minor variations in the game, but with the same IADLs and with different difficulty levels. Finally, a form of VR gameplay is proposed that combines the two proposals, cognitive exercises and IADLs, simplified in figure 3.

In the following, this methodology will be summarised into a list:

1. Identify which are the most important cognitive skills for the selected IADLs
2. Select the cognitive training tasks that best train the identified skills
3. Describe instances of simulations of the identified IADLs. That is, present concrete scenarios of IADLs.
4. To propose ways of coherent integration of cognitive training tasks with IADLs, which can be generic (for all instances) or specific for each instance.

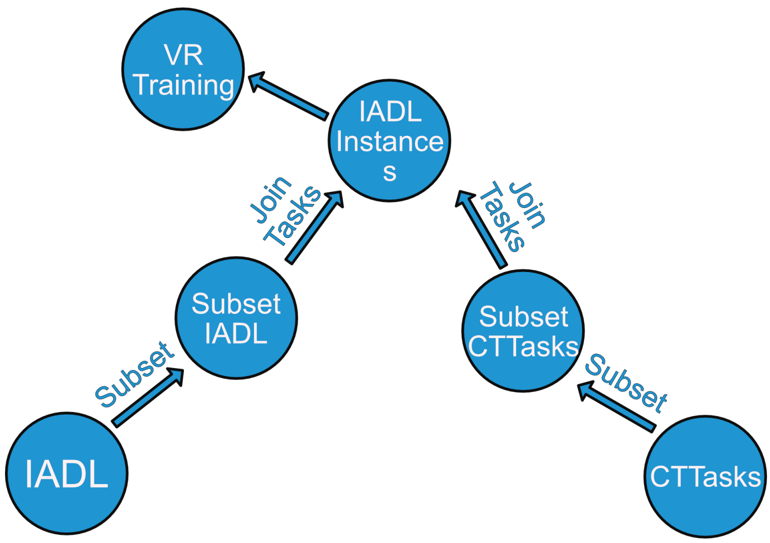


Figure 3: SCT Methodology

This proposal is elaborated in the VR GAMES SPECIFICATION section.

2.6 VR SPECIFICATION

The game developed over the semester was designed in Unity.

Unity is a cross-platform game engine created by Unity Technologies, which allows the creation of 2D and 3D games. For various platforms, such as windows, android, ios, Playstation, xbox, linux, switch, Oculus Quest, Microsoft HoloLens and etc..

A game in unity is constituted by GameObjects, which are objects that represent characters, props, scenery. They can also adopt any other type of behaviour depending on the components added.

Components, are functional parts of each GameObject, that contain properties, which can be edited in order to define the GameObject's behaviour. The user can also add their own developed scripts, in C#, that work as components.

To manage player interactions, a set of components and scripts are used.

The OpenXR library was used, which exists as a plugin for unity. This technology is an open, royalty-free standard developed by Khronos that aims to simplify AR/VR development, allowing developers to seamlessly develop a wide range of AR/VR devices. The reason this technology was chosen, is due to the fact that OpenXR allows applications to reach a wider variety of hardware, since it doesn't get tied to a single platform. Allowing a development, at a higher speed for various platforms, unlike other technologies that would require the use of different libraries for each device.

"OpenXR" has a set of very important and essential classes for developing a VR game.

The component "XR Controller (Action-based)" uses the class ActionBasedController. This component generates all controller commands. And the component "XR Ray Interactor", forms a raycast that allows the detection and interaction of all objects in the project that have the component "XR Grab Interactable" added. This new component controls the rotation and, what kind of movement the object makes when it is grabbed. These are GameObjects, or scripts, from the OpenXr library. In order to define and identify the type of behaviors that each object has, I created the script "TypeObject" and "PlayerManager".

2.7 CONCLUSION

In conclusion and according to the articles collected, VR is an innovative and feasible technique that supports and improves the performance of ADLs in community-dwelling older adults, thus allowing for better autonomy.

3

EVERYDAY GAMES

Over the years, the elderly decrease their performance in ADLs and as a result their independence as well. In order to prevent this decline and to improve the quality of life of the elderly, in the context of this Master's project, it is proposed in this chapter a game that uses virtual reality and that are within the cognitive domain in order to improve ADL. These ADLs are based on the ADLs of the article (Amini et al., 2014), and the exercises are based in the strucural Cognitive Training and its domains domains like visuospatial, reasoning, memory, problem solving and planning.

3.1 VR GAME SPECIFICATION

3.1.1 *Game brief description*

"Everyday games", is an adventure, puzzle and first person virtual reality game, which takes place in the house of the character. The objective of the protagonist, is to do a set of tasks. First our character has to find a notebook. This notebook has some of essential information, such as the weather, so that the player has information, about what to wear. It is also interactive, the player has to select a friend in the notebook, that he wants to visit. This notebook also describes the objects needed to collect, which are scattered around the house. Thus, the protagonist has the task of searching for all the objects. After finding the objects, the player has to go to the kitchen, to prepare two meals, with cognitive games. The recipes are all based on soups, and consists in grabbing an ingredient and put inside of the pot or cutting it up if necessary.

When all the ingredients are in the pot, we have to put the pot on top of the stove and heat it by clicking in the stove button, when the recipe is heated the player must press the button as quickly as possible in order to control the situation, this is a cognitive training called "Boiling".

Also, during the level, the player has the cognitive training "Patterns", which is done before the heating. And consists, in grabbing a set of ingredients with different patterns, than those needed to cook soup, from the current level and putting it, in the bag.

The third cognitive training is always called when the players finishes the recipe, an it is named as "Target sequence". This game comprises, a set of sequences, this sequences can be disordered recipes, represented as images, and the player has to tell if it the sequence is correct or wrong.

The last cognitive training is based on images. To cook, we have to follow the recipes that we have in the menu with the description and images, these images help the user in the task. The cognitive game, disables these images, in the second level of the kitchen, to make it harder for the player to make the dishes. This game is called "Twins".

3.1.2 *Gameplay synopsis*

The player starts in his house, where he will have to go through a series of puzzles, based on recipes and clothing, before completing the game.

The player will have movement mechanics that allowed the character to walk to all directions, for that the player can move with a joystick. As far as interactions go, the player simply puts his hand on top of the object to interact, press a button and selects it, to collect objects or leave pressed to move objects or open drawers and doors.

3.1.3 *Target Audience*

Our game is aimed at a more mature audience that is not used to games, so older adults with more or equal than 65 years. Who want to increase their performance in ADLs and improve their reasoning, memory, problem solving, planning, and visuospatial orientation.

3.1.4 *House exploration*

This game have of 2 compartments, the kitchen and the bedroom, in which the player has to collect some items, solve some puzzles and do some tasks.

We give the player a way here to set the pace and progress of the game, to make the game space larger than it is, so as not to bore the player while they practice the ADLs.

This 2 compartments have 3 main mechanics to interact with. This mechanics are as follows:

- **Bedroom mechanics:** Let the players engage with the main game mechanics. (explained in the 3.1.4 and 3.1.4).
- **Kitchen mechanics:** Let the players engage with the main game mechanics. (explained in the 3.1.4)

Closet

This is one of the core mechanics of the game. It can be accessed through the interaction with the closet, figure 4. In the interaction, the player will have to choose the clothes, depending on the weather and in the correct order. The weather can be checked in the notebook. If the player chooses a piece of clothing in the incorrect order or doesn't put on all the necessary clothes or puts on clothes for the wrong season, a warning appears and cannot select it. This involve several cognitive domains such memory, problem solving and reasoning.

The IADL of this mechanic is dressing.

It is necessary to identify the most important cognitive skills of the chosen IADL, which are the following: reasoning, problem solving, memory and short-term memory.

The player starts by checking the time on the notebook. If the notebook shows cold weather, the player has to put on a jumper and a jacket in order. Then or even before he or she can put on underwear, trousers and suitable shoes in that order.

Subsequently, reasoning need to be trained in the process of choosing clothes, in the cognitive process of problem solving, the player has to identify the problem, that is, what clothes he can wear for the current weather and where he can find the information about the weather. In memory the player has to know the order of the clothes to wear, and short-term memory to memorize the weather.

The reasoning, is used to choose the right clothes depending on the weather, and to get dressed in the right order. Problem solving is another cognitive process used, here the player has to identify the problem, which is, what clothes can he wear for the current weather and where can he find the information about the weather. Then it is needed to generate ideas for solving the problem, brain storming. Then the player has to select and evaluate the ideas in order to implement them. Like going to the notebook to check the weather, and choosing the dedicated clothes in order. Memory is also included in this mechanic, the player has to know the order of the clothes to wear, and short-term memory to memorize the weather.

Figure 4: Closet

Notebook

This is another core mechanic, and to access it, the player has to interact with the notebook. On interaction, the notebook opens, and shows the state of the weather and 3 names of 3 people. The player has to select one of them, and after that selection, the objects that the player has to pick up appear. The player can always view the notes in the notebook. This mechanic involve several cognitive domains such problem solving and reasoning.

The IADL for this mechanic is communication management, where the reader has to interpret the information in the notebook.

In the following we chose the most important cognitive functions by reverse engineering. That is, short-term memory, decision-making, reasoning and grammar & syntax.

The short-term memory is trained by the player, when memorising which objects he has to collect. In decision-making it is linked to the choice of the person the player wants to visit from the various options. To be able to perform all the previous activities the player needs the cognitive function grammar and syntax to understand what is written on the notebook. And problem solving, because the player needs to find specific object, that are hidden in in specific places that make sense.

The integration of cognitive training tasks with IADLs starts with short-term memory in the way the player has to memorise certain information, such as the objects he has to pick up at home. In addition, the player has to select one person among several, which includes the decision-making domain, because depending on the person, will change course of the bus and the price to pay to the bus driver. The grammar and syntax so the player can understand what is asked to do. And the problem solving, where the player has to find objects, for example, the umbrella, is stored in a specific location for umbrellas near the window, and the player has to find it.

Cooking

This mechanic is central to the game, it is a complex mechanic, involving several cognitive domains. This mechanic is divided into two levels, with an increasing level of difficulty in which in both levels, the player has to prepare a meal, this meal is a dish of soup. Additionally, during and after the preparation of the soup, we have cognitive training mini-games, in order to assess the player's cognitive domains.

Cooking: Level 1

In the first level we have the simplest preparation figure 5, we can see that all the instructions are written in a menu, and as the instructions are fulfilled, an "X" appears on the instruction, informing the player that he has fulfilled a specific task.

The simple preparation consists of filling the pot with water, for this, the player must turn on the tap and put the pot under the water, which is dripping from the tap. The player receives a visual warning, the subtitles, informing that the pot is full.

Then the player adds the ingredients described in the menu to the pot, the order in which the water and ingredients are placed has no effect on the gameplay.

While cooking the soup, the player can complete the cognitive game "Patterns". This game consists of adding the same ingredients but with different patterns in a bag, which is shown in figure 1 on the right.

During the heating, the player will have to stir the pot with a spoon.

After heating the meal, the player has to press the button as quickly as possible, to turn off the cooker and finish the dish, this action is also a cognitive training, called "Boiling".

Immediately after the previous training, the "Target sequence" training starts. This training consists of a set of meal preparation sequences represented in pictures, which

Figure 5: Cooking Level 1

are shown in a menu. The player has to press the right button if the sequence is right and wrong if the sequence is right.

Cooking: Level 2

At the second level, figure 6, we have the introduction of a new cognitive training, called "Twins". In this training, the images of the tasks are removed from the menu, thus increasing the level of difficulty. In addition, cutting mechanics are added in this level, so the player will have to take a knife to cut the food on a board and add it to the pot together with the water.

Two new foods for cutting will also be added, carrot and aubergine. The other cognitive training is maintained and based on the new instructions.

Cooking: IADL

The IADL of the "cooking" mechanic is meal preparation.

Following, the most important cognitive functions are identified, which are the following: attention, psychomotor speed, short-term memory. Visuospatial, motor function and reasoning.

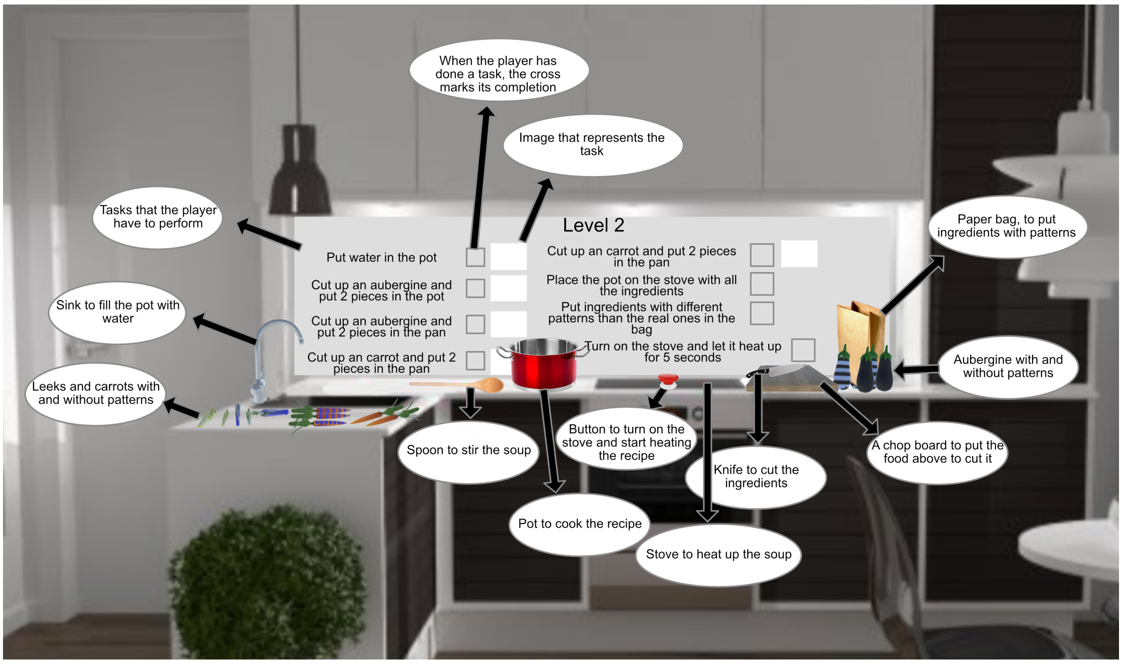


Figure 6: Cooking Level 2

The player starts by viewing the menu of the level with all the instructions he has to follow. Like adding water and food to the pot, the food has to be cut if asked in the instructions. The order of these two actions, therefore, the addition of the water and the food in the pan, has no relevance.

In the meantime, the player can look for the same foods that he put in the pot but with different patterns to the "real" foods and put them in the bag of patterns or put the pot on top of the cooker.

After completing these two tasks, press the stove button to heat up the soup and wait for 5 seconds for it to warm up.

After the soup has heated up, a smoke-like indication will appear coming out of the pot, and the soup water will change to a brownish colour, indicating that the soup is cooked.

Reasoning is trained by choosing which tasks the player can and cannot do first.

Psychomotor speed is trained by the speed the player turns off the stove button after receiving the smoke signal from the pot and the colour change of the soup.

The attention and reasoning is trained by the cognitive training "Target sequence", as the player confronted with a stimulus maintains his concentration and responds to a logic, which is the correct order of the preparation of the meal.

The cognitive training "Patterns", also works the attention part by adding the visuospatial cognitive domain. Here the player has to respond to a stimulus and maintain his concentration on the various patterns found in the kitchen, using the attention cognitive domain. Then he has to identify, integrate and analyze the visual form and structure of the patterns by the visuospatial cognitive domain. And finally reasoning is used to process all this information in a logical way and act to choose which foods go into the bag or pot.

Short term-memory is used in the cognitive training "Twins". Where the list of tasks has no images and the player has to solve all the tasks without any visual aid, relying on his reasoning and memory in order to identify the correct action for each task.

In level 1, the player starts by trying to figure out which of the tasks he has to do first, using reasoning. Here the player, when processing all the tasks, realises that logically the tasks of adding water and putting the food in the pot and in the bag, must be done first, but there is no order between them.

In level 1, the player starts by trying to figure out which of the tasks he has to do first, using reasoning. Here the player, while processing all the tasks, realizes that logically the tasks of adding water and putting the ingredients in the pot and in the bag, must be done first, but there is no order between them. Because it is not possible to make the recipe without the ingredients.

After adding the water and the 2 garlic in the pot, we can go to the task of adding the garlic with different patterns in the bag. More specifically 2 garlic with circular patterns drawn on the texture and another 2 with rectangular patterns drawn on the texture. This task trains the attention adding visuospatial cognitive domain and reasoning. Here the player has to respond to a single stimulus and not scatter, from the several patterns found in the kitchen, using the cognitive domain of attention. And finally, reasoning is used to process all this information in a logical way so that afterwards, the player chooses which foods go into the bag or the pot.

After this task, we turn on the stove to heat the pot and during heating we stir the soup with a spoon.

Then the pot emits a smoke signal and the colour of the soup changes. This smoke signal and change in the colour of the soup, allows the individual to identify and analyze the visual form which trains the visuospatial domain. And allows the training of reasoning, in order to have an analysis and structure of logic of thought, in order to promote an action. With the purpose, that the player understands that he has to press the button again. The psychomotor speed is also trained, which is the time that the individual takes to press the button.

Then the pot emits a smoke signal and the colour of the soup changes. This smoke signal and change in the colour of the soup, allows the individual to identify and analyze the visual form which trains the visuospatial domain. This allows the training of reasoning, in order to have an analysis and structure of logic of thought, to promote an action. Therefore the player, when analysing the change of colour of the soup and the emission of smoke, realises that the soup is already cooked. Consequently he realises that he has to press the button again. By pressing the button, he trains psychomotor speed, which is the time it takes for the individual to press the button.

And finally, attention and reasoning is also trained by the cognitive training "Target sequence", because the player before a stimulus keeps his concentration. He must also analyse and understand if the sequence is disordered or ordered, and before the player's reasoning he must press the correct button if the sequence is correct and the wrong button if the sequence is wrong.

In the second level the task of stirring the soup is removed and the 2 garlics are replaced by 2 aubergines and 2 carrots that will have to be cut up on a board. The cognitive training "twins" is added, which trains the short-term memory, since the images that are repeated in the previous exercise are removed. But it also trains reasoning, since not all ingredients, were present in the previous level, so the player really has to associate the name with the ingredient. The whole process after that, is the same as in level 1.

3.1.5 *Game elements*

Interactive elements are listed in Table 10

Interactive Elements		
Image	Name	Function
	Jack	Playable Character
	Wallet	Collectable Item
	Keys	Collectable Item
	Closet	Closet Mechanic
	Wine	Collectable Item
	Umbrella	Collectable Item

Figure 7: Interactive Elements

3.1.6 *Game elements*

Interactive elements are listed in Table 10

Interactive Elements		
Image	Name	Function
	Hat	Collectable Item
	Notebook	Collectable Item Notebook Mechanic
	Cake	Collectable Item
	Juice	Collectable Item
	Wine	Collectable Item
	Women's bag	Collectable Item

Figure 8: Interactive Elements

3.1.7 *Game elements*

Interactive elements are listed in Table 10

Interactive Elements		
Image	Name	Function
	Women's shoes	Collectable Item
	Beer	Collectable Item
	Knife	Interactable Item Cut Mechanic
	Leeks	Interactable Item
	Carrot	Interactable Item
	Aubergine	Interactable Item

Figure 9: Interactive Elements

3.1.8 *Game elements*

Interactive elements are listed in Table 10

Interactive Elements		
Image	Name	Function
	Pan	Interactable Item Cook Mechanic
	Spoon	Interactable Item
	Chop Board	Interactable Item
	Paper Bag	Interactable Item
	Sink	Interactable Item Water filling mechanic
	Stove	Interactable Item Heating Mechanic

Figure 10: Interactive Elements

3.1.9 *Punctuation and Assumptions*

Scoring Rules

The time it takes for the player to finish all tasks

Condition and victory

There is no victory condition, the player must complete as many tasks as possible. Since it is a game that tries to develop the ADLs and cognitive functions of older adults.

Defeat condition

there is no victory condition, the player must complete as many tasks as possible. Since it is a game that tries to develop the ADLs and cognitive functions of older adults.

3.2 EXAMPLE OF GAME PLAY

In this section the games and their features to be developed will be presented.

The game is called "Everyday Games". In this game the player starts inside his residence, more precisely in bed after waking up figure 11. He starts by looking for a notebook, this notebook contains information about the tasks, which he has to accomplish in the room.

Figure 11: Bedroom

After collecting it, the menu with all the tasks and room information becomes available. The first objective is to see the information about the weather state. This state, will influence the choices of the clothes the player will choose.

In the menu we have a set of options, where the player has to choose between Mary, John and Matilde. All these options exist for the same goal, to find objects, but each of the objects are specific to each person.

The player decides first, to dress his avatar. For that, he opens the menu and presses the notebook button, to check the weather. He verifies that it's a sunny day with 20ºc. In order, to dress the character, he opens the door of the wardrobe, figure 12, and collects some boxers, a t-shirt and trainers.

Figure 12: Closet Game

In the same menu, the player chooses Maud, and checks, that he has to find some women's shoes, a beer and a bag. Then you also check, that he has to collect 3 general items. Two of these items, do not depend on any choice, so they are always the same regardless of the gameplay. The remaining item depends on the weather. If it is a rainy weather he has to find an umbrella or if it is a sunny day he has to find a hat.

After completing all these tasks, the player moves on to the next and last room, the kitchen.

In the kitchen the player has to prepare two meals. The player starts by finding the preparation instructions on a menu in the same place as the preparation next to the wall figure 13.

Figure 13: Cooking Level 1

The player starts by checking what the first task is, which is to put water in the pot. Then the player takes the pot, puts it on the stand and turns on the tap. When it's full, a caption appears on the screen warning that the pot is full of water.

Then the player, collects the 2 leeks and places them in the pot. Following this, the player completes the cognitive training, "Patterns". In this game the player has to find the same type of food placed in the pot but with different patterns and place them in the bag. So the player takes the two garlic with circular blue patterns and another two with yellow striped patterns and puts them in the bag.

Then, the player takes the pot and places it on top of the cooker and presses the cooker button to heat the soup and stirs the soup with the spoon. After the 5 seconds, a steam starts coming out of the soup and the soup itself changes colour. With these warnings the player realises that he has to press the button again to normalise the situation.

Immediately afterwards, a menu with the cognitive game "Target Sequence" appears. In this game, an ordered set of images appears. The player has the goal, to press the correct button if the order is correct and the wrong button if the order is wrong. The context of the images is related to the tasks of the level that the player has just performed.

After finishing the cognitive game, the player moves to level 2, figure 14.

In this level, the player notices that he is no longer being assisted by the images in the task menu. This action is on purpose, it's a cognitive training called "Twins".

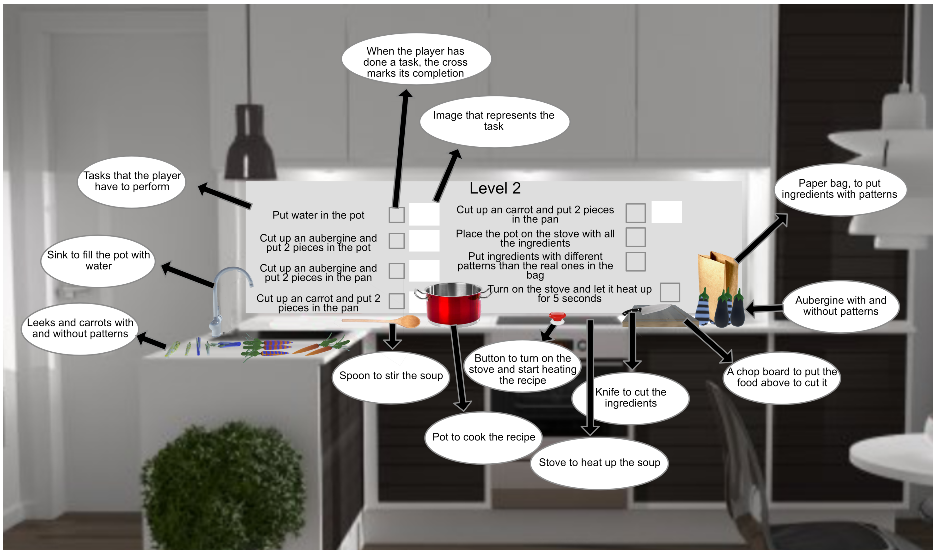


Figure 14: Cooking Level 2

The player starts by filling the pot with water in the sink.

Afterwards, the player takes a knife and cuts two aubergines until each one is divided into two aubergines. And place these 4 pieces in the pan. The same procedure applies to carrots.

Subsequently, the player completes the cognitive training "Patterns". To do so, he puts an aubergine with a blue circular pattern in the bag, and another two, but with blue striped patterns in the bag. He then places two carrots with blue striped patterns in the bag, and another with blue circular patterns in the bag.

After placing all these patterned foods in the bag, the player places the pot on the stove and presses the stove button, to heat up the soup.

After waiting 5 seconds, the player presses the button again in order to finish the meal. To finish the level, the player performs the game "Target Sequence", already explained above.

4

DEVELOPMENT

4.1 CONTROLLERS AND MENUS

The development of the game, started by coding the buttons of the controls. So that the players' hand movements are as natural as possible, to facilitate the player's experience in the game and not create barriers. In figure 15, we can see a generic description of the buttons.

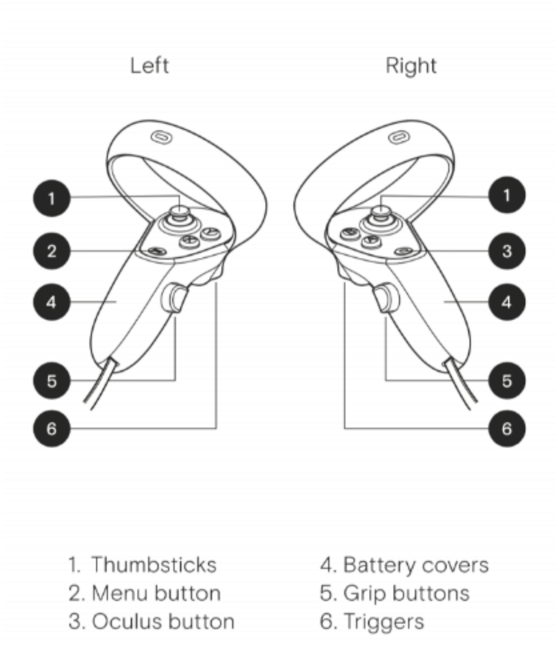


Figure 15: Controllers

And in the figure 16 are represented the commands and the descriptions of their functions.

Figure 16: Controller Instructions

To interact with the menus, the trigger buttons are used, both in the right and left control, which is identified by the number 6 of the figure 15 or 16. The menus are shown in the figure 17 and 18.

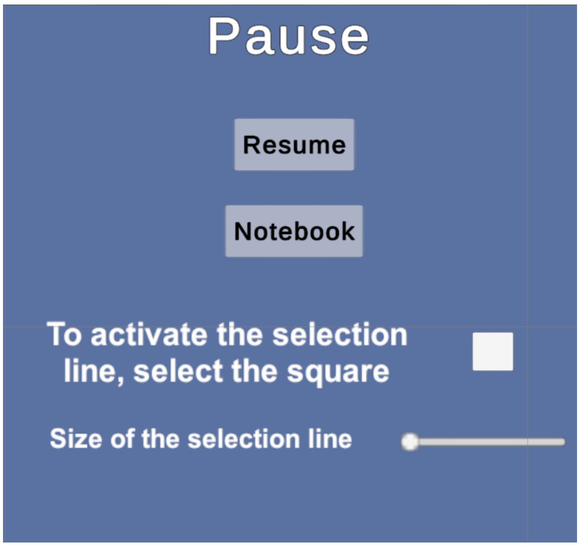


Figure 17: Menu Pause

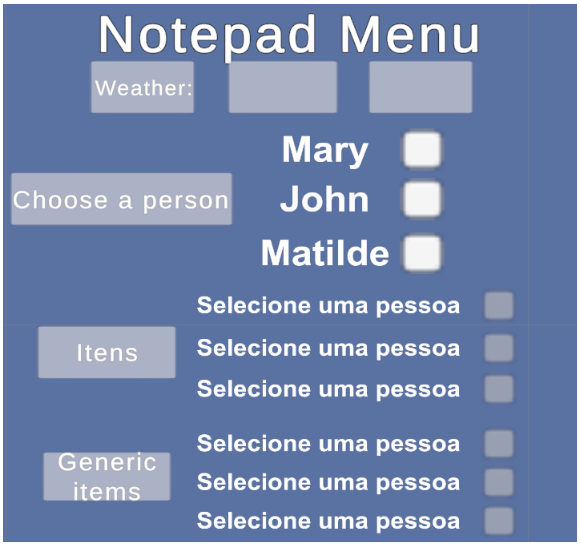


Figure 18: Menu Notebook

In the figure 17, the pause menu is the first menu that can be accessed by pressing the menu button, shown in the figure 15 as the button 2. In this pause menu, the line of selection can be increased or visibly shown. This line is an "XR Ray Interactor", which allows interaction with the objects of the game.

The notebook, from the figure 18, can be accessed from the previous menu by selecting the notebook button. In this menu there' s information about the weather, on the empty cells we have the weather information, Below we have the people that we can choose and the items that we have to collect.

4.2 VR DEVELOPMENT LOGIC

The "TypeObject" is a script that is in all the objects that the player can interact with, except the drawers and doors. This script, defines what type of object the player is interacting with, as shown in figure 19. So that, the script "PlayerManager" defines which action to take.

Before collecting any kind of objects, except the ones in the kitchen, the player has to find, the Notebook. The Notebook's "TypeObject_" is of type "Notebook", this type is represented in the first variable. Figure 19, shows a set of types that objects can acquire from the "TypeObject_" variable.

The object that contains this script, in figure 20, is the "Wine" object. The variable, "TypeObject_", in this case is of type "Mary", which means that if the player, in the menu, has chosen Mary, he can pick up the objects of type Mary. But not, the objects of other people, like john's or Matilde. The people to select are represented in the menu in figure 18. The generic objects like the umbrella or the hat, depend on the weather state represented in the variable "DayType". And the other two, the key and the wallet, are always required. These objects are of the "Collectible" type of the "TypeObject" variable, since they do not depend on any person, nor are they objects that the user can use.

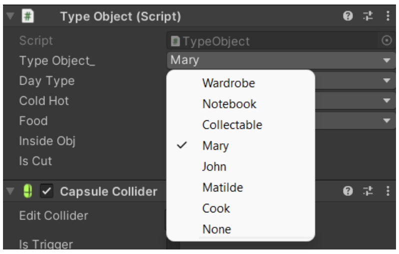


Figure 19: TypeObject Types

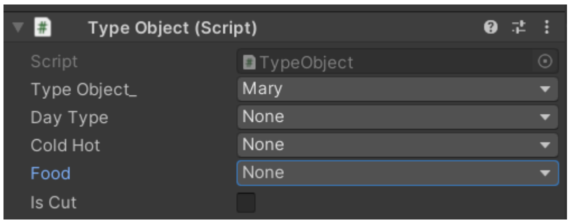


Figure 20: TypeObject

The objects in the wardrobe, are also represented in "TypeObject_", as being of type "Wardrobe", here the script changes from TypeObject to "TypeObjects", figure 21. Because these objects can have two different characteristics in the same variable. This figure represents, a "TypeObjects" of a jacket, which can be used for both a rainy and sunny day, but can only be used on a cold day.

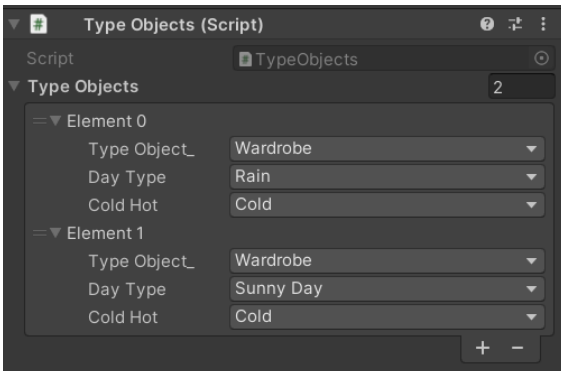


Figure 21: Menu Notebook

The variables "DayType" or "ColdHot" are only used for clothes in the wardrobe and some generic objects.

The "Daytype" variable defines if the object can be worn on a rainy day or on a sunny day. "ColdHot", determines if the clothes can be worn on a hot or cold day.

This information is created by the Notebook script, which randomly creates the weather. The information is then displayed in the menu in figure 22.

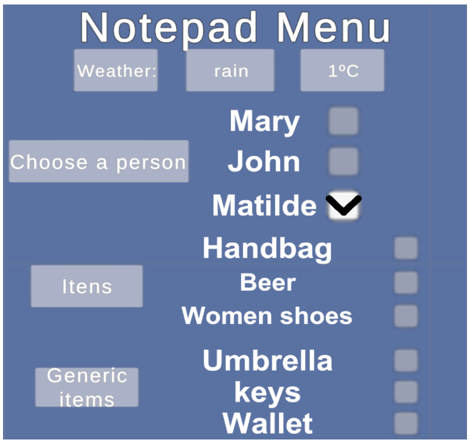


Figure 22: Menu Example

Any clothes from the wardrobe that the player collects have an index and a type, this index defines the order that the player collects the clothes and the type defines whether it is clothing from above or below the torso.

There are also predefined maximum indexes, so that the player can not wear more than allowed, or the same type. All this process is managed in the script "Wardrobemanager".

In the kitchen, any type of food also has the script "TypeObject", in order to indicate its type. All food is of type "Cook", in the "TypeObject" variable and in the "Food" variable the food is of type "Pan". Which means that it goes into the pan and also works as an id to be accepted in the pan.

Example of a "TypeObject" of an aubergine, figure 23, already with the properties of a food.

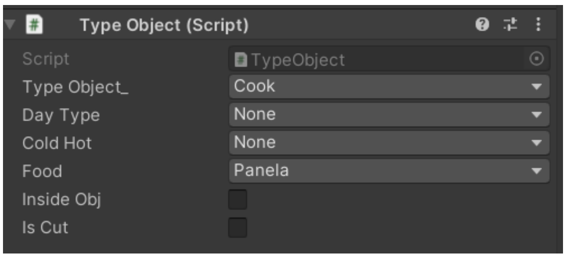


Figure 23: TypeObject Aubergine

The properties "InsideObj" and "IsCut" become true, when the object is inserted in the pan and the object is cut respectively. Regarding the creation of the kitchen levels, these are generated in the "Levels" script.

The "Levels" script inherits the "Pan" class, which gives us a set of properties needed to build the levels, showed in the figure 24, 25 and 26.

Then, in order to build the levels, the objects, therefore the food, are added to the variable "Objects" in the script "Levels", as shown in figure 24.

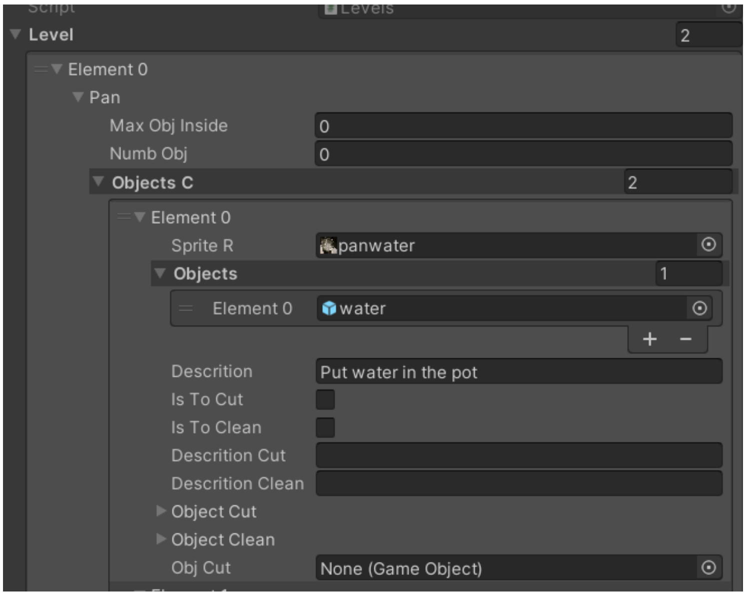


Figure 24: Example of the addition of a alimentary

Next in figure 25, there is an example of the addition of an aubergine to the level. The difference to other foods, is that this object is cut on a board.

Next in figure 25, there is an example of the addition of an aubergine to the level. The difference to other foods, is that this object is cut on a board. In the variable "Objects" are added two final objects of the aubergine already cut and in the "ObjectCut" is added the "Parent" aubergine, therefore the object not yet cut. This is because the "cuttable" objects have a hierarchy in which the parent, has the whole aubergine and is active, while the children are deactivated. But because they are children, they have properties that are transferred from parent to child such as position and scale. So the children will always have the position of the parent before the parent is cut. The parent has other essential information like the object type and how many cuts the object has and the maximum cuts it can have.

When the object is placed on top of the chop board it checks which is the parent and sends the information to the "CutManager" script. This script is added to the knife and only manages food cuts.

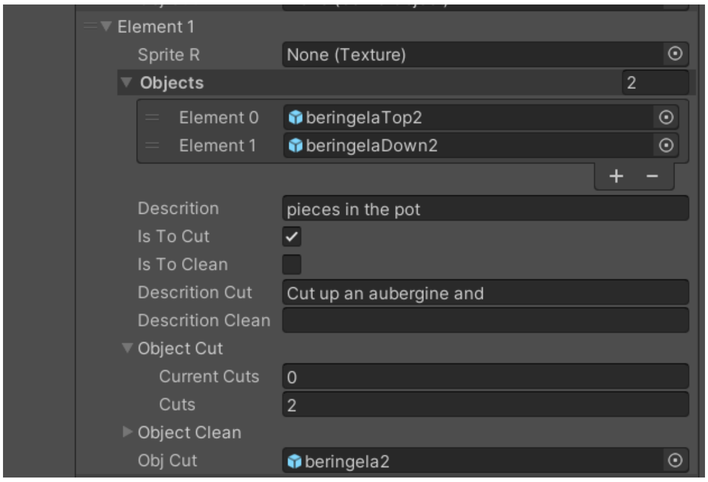


Figure 25: Example of the addition of a food for cutting

Following that, there are generic descriptions, showed in the figure 26, these are additional or informative tasks and are necessary to complete the levels. Each one with its tag in the variable "DescriptionCook", and at the end there is the "CookingTime" which is the time needed to heat the dish on the stove. Warming up is only possible if all the food is in the pot. Checking, and adding the food is done by the pan script the "PanManager". The heating of the pan is managed by the stove script "PlacaManager".

The game ends when the player reaches a task that has the variable "FinishedGame" set to true. Which as can be seen in figure 26, is the last task in the variable "DescriptionCook" with the tag "Aquecer no fogao". In this case it means that the player has just heated up the food, and finished the level.

And finally the time of each level is stored in a txt.

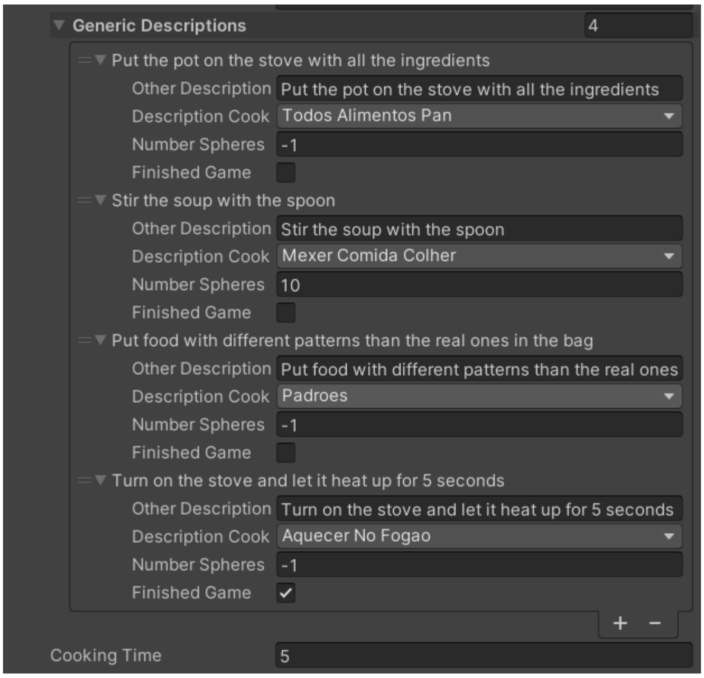


Figure 26: Generic Descriptions

4.3 3D MODELS

All models were incorporated from websites such as https://sketchfab.com/feed, https://www.cgtrader.com/free-3d-models and https://archive3d.net/.

It was checked if some of the models had parts that could be separated in gameplay, such as closet, doors or drawers in the character's room.

Before they were incorporated, it was also checked if the polygons could be reduced without the models losing too much quality, so that the game would be playable at a high frame rate. For this the blender tool called decimate was used. Other objects, such as eggplants and carrots, had to undergo simple changes, so basically they were cut in half and in the leaf part, so that the cutting mechanics was possible.

4.4 RESULTS

The Vr game was tested with 4 participants, 3 females and 1 male, aged between 75 and 82.

The game was divided into 4 levels in the kitchen. The first consisted of turning the stove on and off. The second was putting a carrot in the pot. The third was to cut up an aubergine and put it in the pot, and the fourth was to fill the pot with water. Only a small part of the game was used, so that it can be tested.

A Mini Mental Examination (MMSE) was initially completed on all participants accompanied by a psychologist.

This test consists of a set of 11 questions, performed by doctors or other health professionals, Direct. These questions verify the existence of cognitive deficiencies in various cognitive areas such as:

- orientation to time and place;
- Attention and concentration;
- short-term memory (recall);
- language skills;
- Visuospatial abilities;
- Ability to understand and follow instructions.

These questions usually take between 5 and 10 min and consist of the following tasks:

- Memorising a few objects and then repeating the list back later;
- Copying a drawing;
- writing a short sentence that is grammatically correct;
- Language skills;
- Correctly identifying the current day of the week, followed by the date, the month, the season and the year;
- Correctly identifying where you are.

The results of the MMSE and the tests are represented in the table 6, and the tests can be seen in the appendix A.

Table 6: VR Exercise Test

VR Exercise				
	1º Atenpt			
Age	82	75	79	79
Race	White	White	White	white
Educational Level	Unqualified	Fourth grade	Unqualified	Third grade
Gender	Female	Female	Female	Male
Performance in the game	Made it through the first level with 1:02 min Could not pass the following levels	Could not clear any levels	Could not clear any levels	Could not clear any levels
MMSE Score	21 Is considered to be normal Maria machado	24 Is considered to be normal maria de fatima	27 Is considered to be normal Maria luisa	28 Is considered to be normal Antonio

Throughout the game, the older adults often wandered around the kitchen instead of doing the tasks asked of them and were distracted by the virtual environment. Therefore in the next sessions the movement and rotation commands will be blocked, the player's position adjusted and the font size of the tasks increased. The position, so that the players don't have to gesticulate so much and the size and position of the letters, because the players couldn't read certain tasks.

After the session is completed, the System Usability Scale test is performed.

In the table 7 the System Usability Scale test is showed.

This test is a tool that allows the evaluation of the system usability usability.gov. It consists of a questionnaire with 10 questions, each with 5 answer options from 1 to 5. These range from Strongly agree to Strongly disagree. All the testes are showed in the A.

Table 7: System Usability Scale

	VR Exercise - System Usability Scale (SUS)			
	Antonio	Maria Machado	Maria Luisa	Maria de Fatima
Question 1	4	3	4	3
Question 2	4	4	5	5
Question 3	2	2	2	2
Question 4	4	5	4	5
Question 5	3	2	4	4
Question 6	3	3	3	3
Question 7	3	2	3	4
Question 8	3	3	3	3
Question 9	2	1	2	3
Question 10	3	3	3	4

As shown in table 7, the older adults had difficulties in the Vr game, the solutions were already presented.

In the next sessions, a visual monitoring of the game will be done in real time, therefore streaming the game to the PC. In order to check in detail which errors are causing older adults difficulties in the game.

In the second session a test was conducted with 6 older adults, all different from the previous session. And as in the last session, 2 tests were performed. The MMSE before the session and the SUS after the session. We can see the result of the exercises in table 8.

Table 8: VR Exercise Test 2

VR Exercise						
	1º Atenpt					
Age	63	80	70	60	71	66
Race	White	White	White	white	White	White
Educational Level	Fourth grade	Fourth grade	Second grade	Fourth grade	Fourth grade	Fourth grade
Gender	Female	Female	Female	Female	Male	Female
Performance in the game	1º level - Not completed 2º level - 29 seconds 3º level - 01:17 min 4º level - Not completed	1º level -58 seconds 2º level - 1:04 min 3º level - 16 seconds 4º level - Not completed	Could not clear any levels Can't see properly	1º level - 50 seconds 2º level - 25 seconds 3º level - 27 seconds 4º level - Not completed	1º level - 46 seconds 2º level - 23 seconds 3º level - 55 seconds 4º level - 01:41 min	1º level - Not completed 2º level - 12 seconds´ 3º level - 40 seconds 4º level - 01:29 seconds
MMSE Score	30 Is considered to be normal Maria Irene	27 Is considered to be normal Maria Augusta	25 Is considered to be normal Maria do Céu	29 Is considered to be normal Conceição	29 Is considered to be normal Domingos	28 Is considered to be normal Maria Ortelinda

During the game, players had difficulty seeing the button because they had to turn their heads downwards, so the player's position will have to be adjusted. They also had difficulty pressing the button to turn on the stove, so the solution will be to increase the size. And finally, players randomly threw objects to the ground when they touched them, taking the collisions out of the player's hand should solve this problem.

After the session is completed, the System Usability Scale test is performed. In the table 9 the System Usability Scale test is showed.

Table 9: System Usability Scale test 2

VR Exercise - System Usability Scale (SUS)						
	Maria Irene	Maria Augusta	Ortelinda	Maria do Céu	Conceição	Domingos
Question 1	2	1	3	5	1	3
Question 2	3	3	3	4	4	1
Question 3	2	5	3	3	4	3
Question 4	3	3	4	5	1	3
Question 5	5	4	5	3	5	5
Question 6	4	3	3	3	3	5
Question 7	3	2	3	5	3	3
Question 8	1	3	4	3	3	5
Question 9	3	4	5	3	3	5
Question 10	4	4	2	3	2	4

5

CONCLUSION

Before starting the conclusion, just to clarify, that part of the work that was not included in the proposal, due to reworks in the game. For, came across too extensive game and decided to focus on developing the kitchen mechanics and polishing them to create a better experience for the players.

I will therefore explain what has been removed.

After the player has finished all the house chores, the player heads to the city.

In the city The player will have, a minimap and an arrow, which will guide him to the bus stop, figure 27. The player has to cross several times the street, for this, the player will have to cross the crosswalk. For the crossing, the player should be careful and check if there are cars near the crosswalk. If you cross and a car is too close, you will be run over and lose the game. So, the player must manage his position and speed with that of the car. There are also crosswalks with traffic lights, here the difference will be that with a red light the car will be at a higher speed than with a yellow and green light. The velocity of a car in the crosswalk with green light is slower than just a crosswalk without traffic lights. If you cross in a place without a crosswalk the speed of the car will be greater than a place with a crosswalk. This mechanics include reasoning, problem solving and planning of cognitive domains.

To get inside the bus, we have to interact with the bus. Once inside the bus we have two core mechanics:

- **Interaction with the bus driver:** The beginning of the interaction with the bus driver (Explained in 5).
- **Ring the bus bell:** Ring the bell for the bus to stop (Explained in 5).

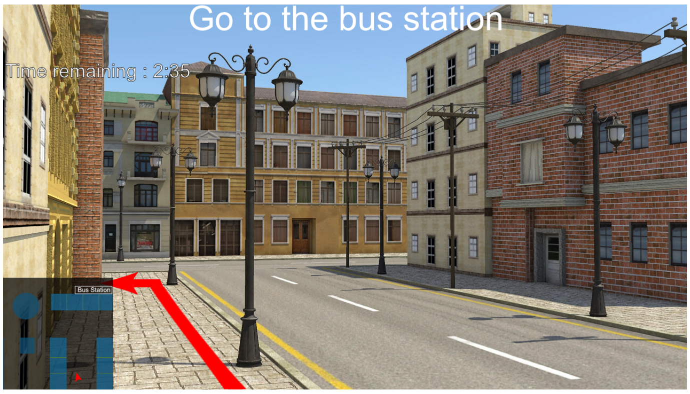


Figure 27: Outside

Interaction with the bus driver

Here the player interacts with the driver to choose which location he wants figure 28, this location depends on the person he selected on the notebook. After choosing the destination, the driver tells you the amount to pay.

Figure 28: Select your destination

And a pay menu opens and the player has to choose the coins and notes until he makes the correct amount. The selection is done by dragging, so the player has to drag the coins from the first menu to the second as shown in figure 29. If the amount is wrong, the pay button turns red for a while. If the player wants to hear the amount again, he has to go back on the arrow and choose the desired destination again.

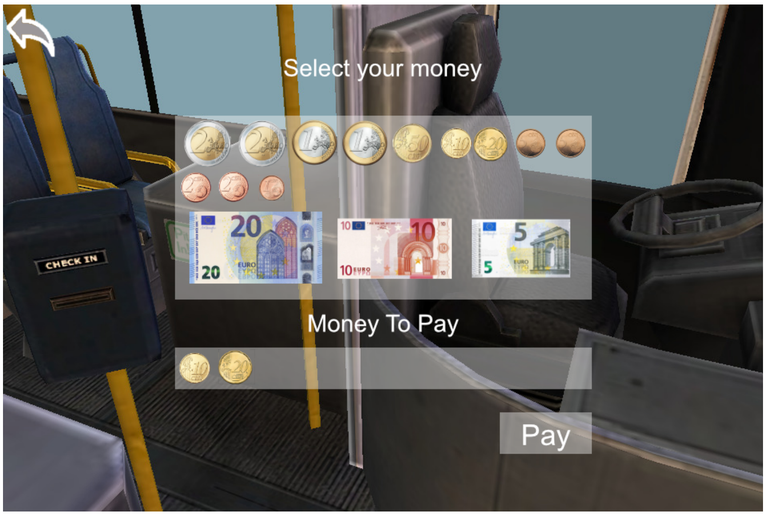


Figure 29: Payment

Ring the bus bell

After the player chooses a place to sit, the player has to keep an eye on the town sign, if the player sees the town sign is the same as the desired destination and spots the bus stop, the player should press the red bus button. When the bus stops, the player must get off the bus. If you get off at the wrong stop you lose the game. If you touch the bus too far from the stop the bus won't stop, if you don't get off at the bus stop and wait a certain amount of time the bus will continue. If the bus reaches the end of the route and the player has not got off at the correct stop, the game is lost. This mechanics include reasoning, problem solving, planning and memory of cognitive domains.

In this thesis document, the topic of the difficulties experienced by older people to perform their Activities of Daily Life (ADL) was presented and deeply discussed. The need to created modern resources to train their abilities to do the referred activities and the use of Immersive Virtual Reality (IVR) games for that purpose was described and explored through an extensive literature review. In this context and according to the studies surveyed, it is possible to affirm that VRS are technologies with a great potential and that they already make a difference and that good results are obtained in the present studies related to ADLs and rehabilitation in older adults. Not only do we obtain better results than traditional exercises, but we also increase motivation with the development of VR games in the people involved in the activities.

A game was created with 2 types of levels in two different rooms of the house. The first one in the player's room. Where the player has various tasks from dressing appropriately for the type of weather, to finding objects described in the notebook. The kitchen compartment is quite different from the bedroom compartment. This is divided into 2 levels and is less mobile, as less movement is required, as, the objects needed to complete the tasks, are all close to each other. Initially an introduction of the thesis was given, in order to explain, what the aim of the thesis is. Therefore, the aim is to achieve the far transfer and improve the performance of IADLs, by the junction of cognitive training and IADLs, with the use of the SCT methodology, using immersive virtual reality with an HMD. In this case the Oculus Quest 2.

Next, in the state of the art, a systematic literature was made, in order to be able to validate, the VR technology, and its use in improving the performance of ADLs. We can observe that in the studies, there was mostly an improvement in the performance of ADLs using virtual reality oculus or other immersive technology.

Then, the methodology used to create the IADLs present in the game was explained. This methodology called Structural Cognitive Training, consists briefly in joining the IADLs and cognitive training tasks, which best train the IADLs. So that afterwards, both can be integrated in a coherent manner.

In the "VR specification" section, the components of VR are specified, therefore, the technologies used, hardware and a bit of unity logic.

In the chapter "Everyday games", the game is presented, therefore, its description, target audience, score, game elements, victory condition, defeat condition, gameplay example and all its mechanics, along with the SCT methodology in the game.

The following chapter, the Development chapter, explains how the game was developed. Therefore, the mapping of the controllers and the menus constitution were initially explained. And lastly, the logic of the game development.

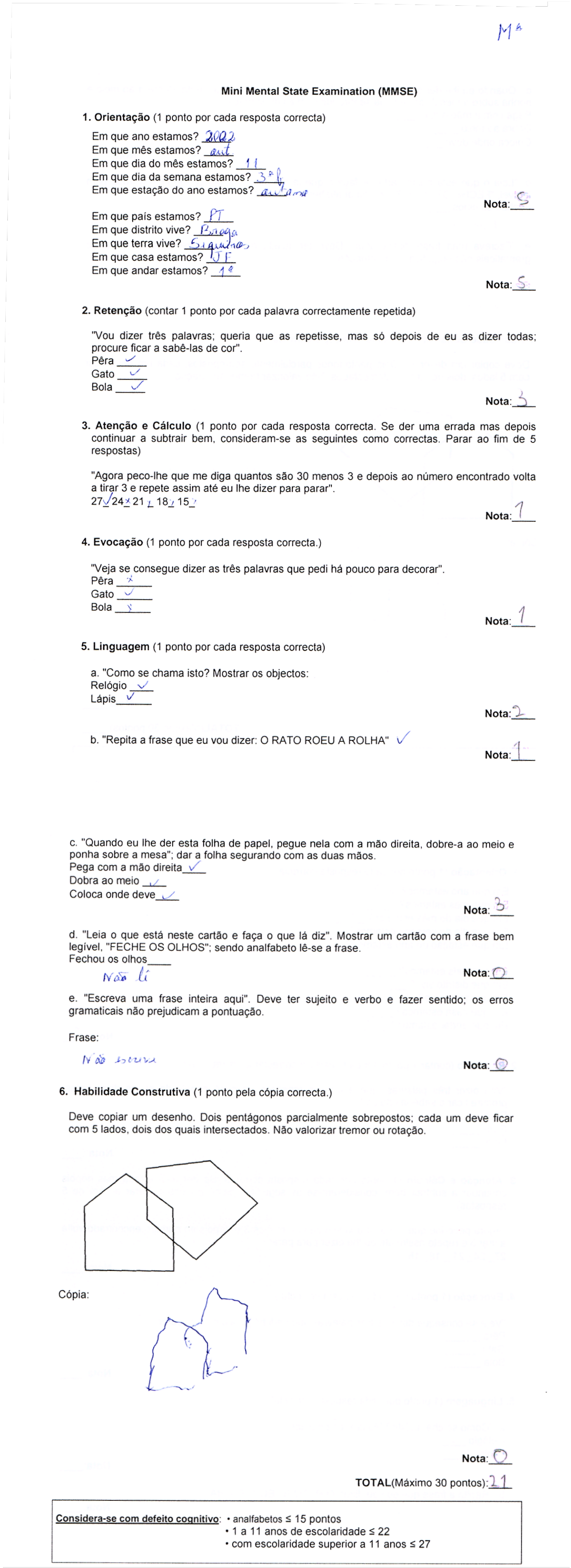
The "Models" section describes the process of obtaining the models and how the polygons of each model were reduced to allow the game to run smoothly at a high frame rate.

The "Results" chapter, two sessions were held, the first with four participants. In this session several problems, described in this chapter, were identified and discussed. The second session was tested with 6 people, not the same as in the first session. The results were better than in the first session. One person managed to do all the levels whereas in the first session only one player managed to complete only the first level. Only one person could not complete any level due to vision difficulties. The rest had difficulty doing the first level, due to the size of the button and the difficulties of the fourth level, is due to the need for the use of the joystick on the controller.

It is possible to conclude that with improvements in the game and with some training of the players, there is an improvement in the playing technique, and consequently the game will become easier for the players.

A

QUESTIONNAIRE



M^a

Mini Mental State Examination (MMSE)

1. Orientação (1 ponto por cada resposta correcta)

Em que ano estamos? 2022
Em que mês estamos? out
Em que dia do mês estamos? 11
Em que dia da semana estamos? 3ª f
Em que estação do ano estamos? outono

Nota: 5

Em que país estamos? PT
Em que distrito vive? Braga
Em que terra vive?
Em que casa estamos?
Em que andar estamos? 1º

Nota: 5

2. Retenção (contar 1 ponto por cada palavra correctamente repetida)

"Vou dizer três palavras; queria que as repetisse, mas só depois de eu as dizer todas; procure ficar a sabê-las de cor".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

3. Atenção e Cálculo (1 ponto por cada resposta correcta. Se der uma errada mas depois continuar a subtrair bem, consideram-se as seguintes como correctas. Parar ao fim de 5 respostas)

"Agora peco-lhe que me diga quantos são 30 menos 3 e depois ao número encontrado volta a tirar 3 e repete assim até eu lhe dizer para parar".
27 ✓ 24 ✗ 21 ✗ 18 ✗ 15 ✗

Nota: 1

4. Evocação (1 ponto por cada resposta correcta.)

"Veja se consegue dizer as três palavras que pedi há pouco para decorar".
Pêra ✗
Gato ✓
Bola ✗

Nota: 1

5. Linguagem (1 ponto por cada resposta correcta)

a. "Como se chama isto? Mostrar os objectos:
Relógio ✓
Lápis ✓

Nota: 2

b. "Repita a frase que eu vou dizer: O RATO ROEU A ROLHA" ✓

Nota: 1

c. "Quando eu lhe der esta folha de papel, pegue nela com a mão direita, dobre-a ao meio e ponha sobre a mesa"; dar a folha segurando com as duas mãos.
Pega com a mão direita ✓
Dobra ao meio ✓
Coloca onde deve ✓

Nota: 3

d. "Leia o que está neste cartão e faça o que lá diz". Mostrar um cartão com a frase bem legível, "FECHE OS OLHOS"; sendo analfabeto lê-se a frase.
Fechou os olhos____
Não lê

Nota: 0

e. "Escreva uma frase inteira aqui". Deve ter sujeito e verbo e fazer sentido; os erros gramaticais não prejudicam a pontuação.

Frase:
Não escreve

Nota: 0

6. Habilidade Construtiva (1 ponto pela cópia correcta.)

Deve copiar um desenho. Dois pentágonos parcialmente sobrepostos; cada um deve ficar com 5 lados, dois dos quais intersectados. Não valorizar tremor ou rotação.

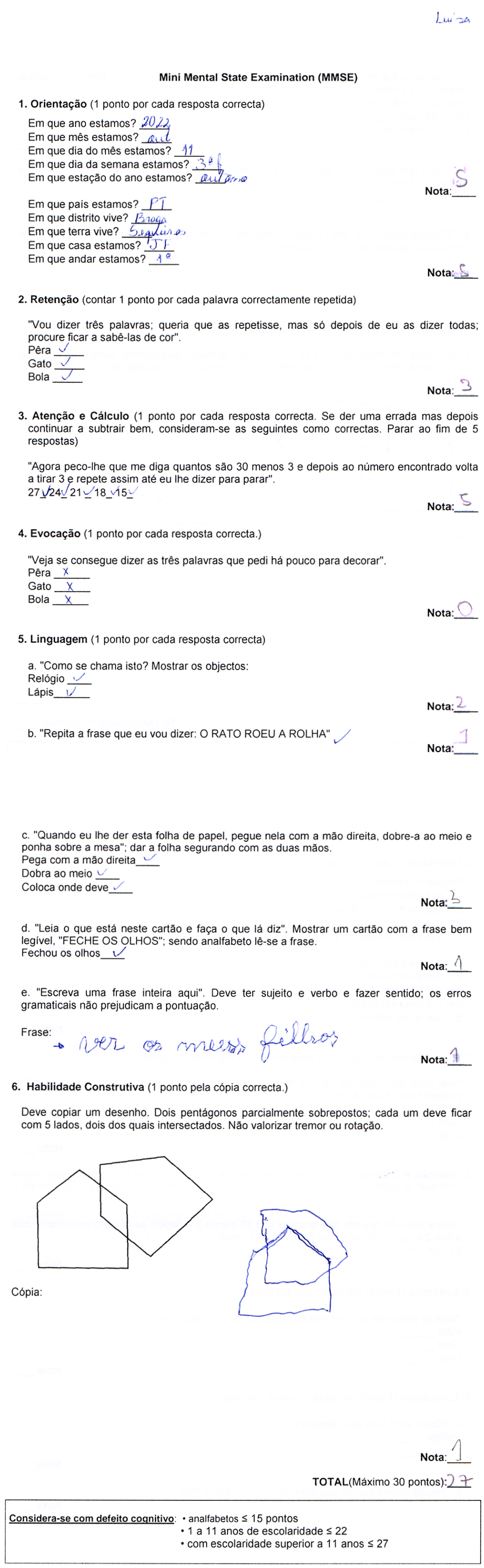
Cópia:

Nota: 0

TOTAL(Máximo 30 pontos): 21

<u>**Considera-se com defeito cognitivo**</u>:
- analfabetos ≤ 15 pontos
- 1 a 11 anos de escolaridade ≤ 22
- com escolaridade superior a 11 anos ≤ 27

Figure 30: MMSE Test Maria Machado



Luisa

Mini Mental State Examination (MMSE)

1. Orientação (1 ponto por cada resposta correcta)

Em que ano estamos? 2022
Em que mês estamos? abril
Em que dia do mês estamos? 11
Em que dia da semana estamos? 3ª f
Em que estação do ano estamos? outono

Nota: 5

Em que país estamos? PT
Em que distrito vive? Braga
Em que terra vive?
Em que casa estamos?
Em que andar estamos? 1º

Nota: 5

2. Retenção (contar 1 ponto por cada palavra correctamente repetida)

"Vou dizer três palavras; queria que as repetisse, mas só depois de eu as dizer todas; procure ficar a sabê-las de cor".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

3. Atenção e Cálculo (1 ponto por cada resposta correcta. Se der uma errada mas depois continuar a subtrair bem, consideram-se as seguintes como correctas. Parar ao fim de 5 respostas)

"Agora peço-lhe que me diga quantos são 30 menos 3 e depois ao número encontrado volta a tirar 3 e repete assim até eu lhe dizer para parar".
27 ✓ 24 ✓ 21 ✓ 18 ✓ 15 ✓

Nota: 5

4. Evocação (1 ponto por cada resposta correcta.)

"Veja se consegue dizer as três palavras que pedi há pouco para decorar".
Pêra X
Gato X
Bola X

Nota: 0

5. Linguagem (1 ponto por cada resposta correcta)

a. "Como se chama isto? Mostrar os objectos:
Relógio ✓
Lápis ✓

Nota: 2

b. "Repita a frase que eu vou dizer: O RATO ROEU A ROLHA" ✓

Nota: 1

c. "Quando eu lhe der esta folha de papel, pegue nela com a mão direita, dobre-a ao meio e ponha sobre a mesa"; dar a folha segurando com as duas mãos.
Pega com a mão direita ✓
Dobra ao meio ✓
Coloca onde deve ✓

Nota: 3

d. "Leia o que está neste cartão e faça o que lá diz". Mostrar um cartão com a frase bem legível, "FECHE OS OLHOS"; sendo analfabeto lê-se a frase.
Fechou os olhos ✓

Nota: 1

e. "Escreva uma frase inteira aqui". Deve ter sujeito e verbo e fazer sentido; os erros gramaticais não prejudicam a pontuação.

Frase: ver os meus filhos

Nota: 1

6. Habilidade Construtiva (1 ponto pela cópia correcta.)

Deve copiar um desenho. Dois pentágonos parcialmente sobrepostos; cada um deve ficar com 5 lados, dois dos quais intersectados. Não valorizar tremor ou rotação.

Cópia:

Nota: 1

TOTAL(Máximo 30 pontos): 27

Considera-se com defeito cognitivo:	• analfabetos ≤ 15 pontos • 1 a 11 anos de escolaridade ≤ 22 • com escolaridade superior a 11 anos ≤ 27

Figure 31: MMSE Test Maria Luisa

Fátima

Mini Mental State Examination (MMSE)

1. Orientação (1 ponto por cada resposta correcta)

Em que ano estamos? 2022
Em que mês estamos? out
Em que dia do mês estamos? –
Em que dia da semana estamos? 3ªf
Em que estação do ano estamos? outono

Nota: 4

Em que país estamos? PT
Em que distrito vive? Braga
Em que terra vive? Sequinas
Em que casa estamos? JF
Em que andar estamos? 1º

Nota: 5

2. Retenção (contar 1 ponto por cada palavra correctamente repetida)

"Vou dizer três palavras; queria que as repetisse, mas só depois de eu as dizer todas; procure ficar a sabê-las de cor".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

3. Atenção e Cálculo (1 ponto por cada resposta correcta. Se der uma errada mas depois continuar a subtrair bem, consideram-se as seguintes como correctas. Parar ao fim de 5 respostas)

"Agora peço-lhe que me diga quantos são 30 menos 3 e depois ao número encontrado volta a tirar 3 e repete assim até eu lhe dizer para parar".
27 ✓ 24 ✓ 21 x 18 x 15 x

Nota: 2

4. Evocação (1 ponto por cada resposta correcta.)

"Veja se consegue dizer as três palavras que pedi há pouco para decorar".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

5. Linguagem (1 ponto por cada resposta correcta)

a. "Como se chama isto? Mostrar os objectos:
Relógio ✓
Lápis ✓

Nota: 2

b. "Repita a frase que eu vou dizer: O RATO ROEU A ROLHA" ✓

Nota: 1

c. "Quando eu lhe der esta folha de papel, pegue nela com a mão direita, dobre-a ao meio e ponha sobre a mesa"; dar a folha segurando com as duas mãos.
Pega com a mão direita ✓
Dobra ao meio ✓
Coloca onde deve ✓

Nota: 3

d. "Leia o que está neste cartão e faça o que lá diz". Mostrar um cartão com a frase bem legível, "FECHE OS OLHOS"; sendo analfabeto lê-se a frase.
Fechou os olhos ✓

Nota: 1

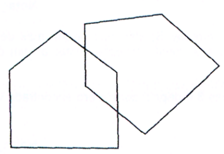
e. "Escreva uma frase inteira aqui". Deve ter sujeito e verbo e fazer sentido; os erros gramaticais não prejudicam a pontuação.

Frase: → [illegible]

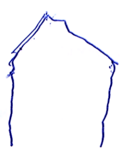
Nota: 0

6. Habilidade Construtiva (1 ponto pela cópia correcta.)

Deve copiar um desenho. Dois pentágonos parcialmente sobrepostos; cada um deve ficar com 5 lados, dois dos quais intersectados. Não valorizar tremor ou rotação.



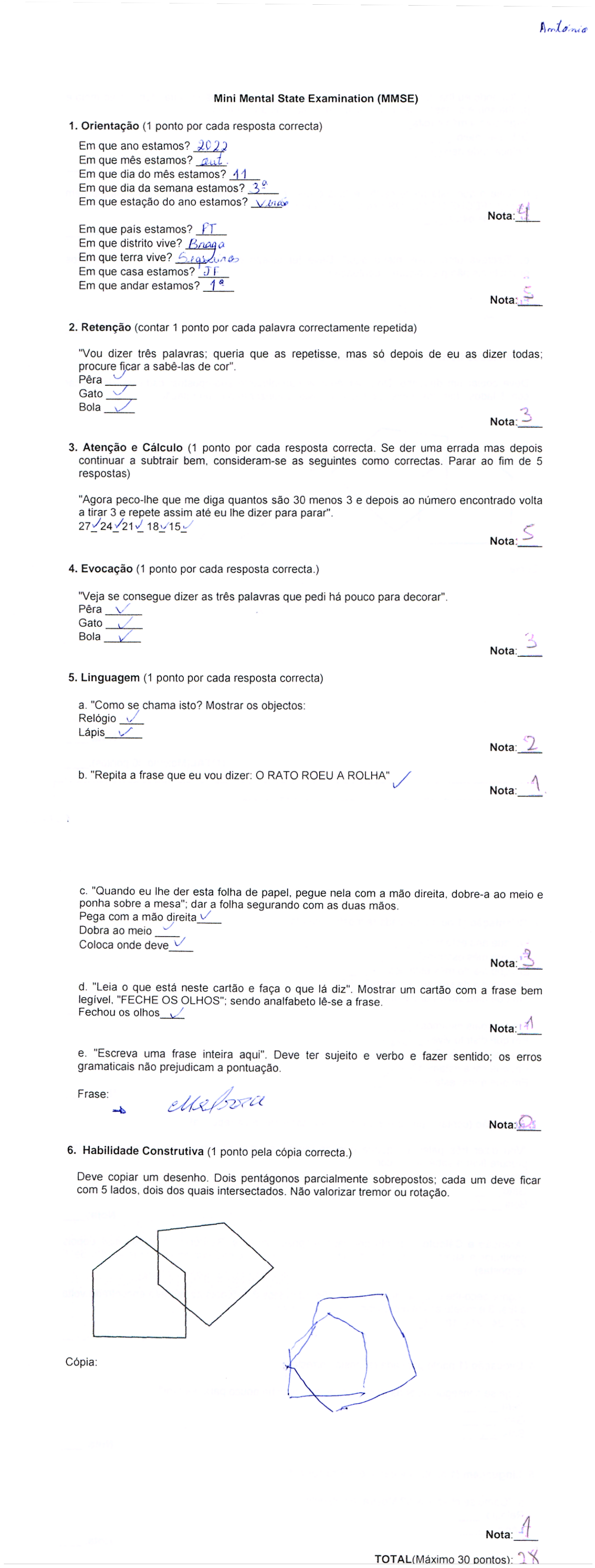
Cópia:



Nota: 0

TOTAL(Máximo 30 pontos): 24

<u>Considera-se com defeito cognitivo</u>:	• analfabetos ≤ 15 pontos • 1 a 11 anos de escolaridade ≤ 22 • com escolaridade superior a 11 anos ≤ 27



Antónia

Mini Mental State Examination (MMSE)

1. Orientação (1 ponto por cada resposta correcta)

Em que ano estamos? 2022
Em que mês estamos? out.
Em que dia do mês estamos? 11
Em que dia da semana estamos? 3ª
Em que estação do ano estamos? verão

Nota: 4

Em que pais estamos? PT
Em que distrito vive? Braga
Em que terra vive? Sequeiros
Em que casa estamos? JF
Em que andar estamos? 1º

Nota: 5

2. Retenção (contar 1 ponto por cada palavra correctamente repetida)

"Vou dizer três palavras; queria que as repetisse, mas só depois de eu as dizer todas; procure ficar a sabê-las de cor".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

3. Atenção e Cálculo (1 ponto por cada resposta correcta. Se der uma errada mas depois continuar a subtrair bem, consideram-se as seguintes como correctas. Parar ao fim de 5 respostas)

"Agora peco-lhe que me diga quantos são 30 menos 3 e depois ao número encontrado volta a tirar 3 e repete assim até eu lhe dizer para parar".
27✓ 24✓ 21✓ 18✓ 15✓

Nota: 5

4. Evocação (1 ponto por cada resposta correcta.)

"Veja se consegue dizer as três palavras que pedi há pouco para decorar".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

5. Linguagem (1 ponto por cada resposta correcta)

a. "Como se chama isto? Mostrar os objectos:
Relógio ✓
Lápis ✓

Nota: 2

b. "Repita a frase que eu vou dizer: O RATO ROEU A ROLHA" ✓

Nota: 1

c. "Quando eu lhe der esta folha de papel, pegue nela com a mão direita, dobre-a ao meio e ponha sobre a mesa"; dar a folha segurando com as duas mãos.
Pega com a mão direita ✓
Dobra ao meio ✓
Coloca onde deve ✓

Nota: 3

d. "Leia o que está neste cartão e faça o que lá diz". Mostrar um cartão com a frase bem legível, "FECHE OS OLHOS"; sendo analfabeto lê-se a frase.
Fechou os olhos ✓

Nota: 1

e. "Escreva uma frase inteira aqui". Deve ter sujeito e verbo e fazer sentido; os erros gramaticais não prejudicam a pontuação.

Frase:

Nota: 0

6. Habilidade Construtiva (1 ponto pela cópia correcta.)

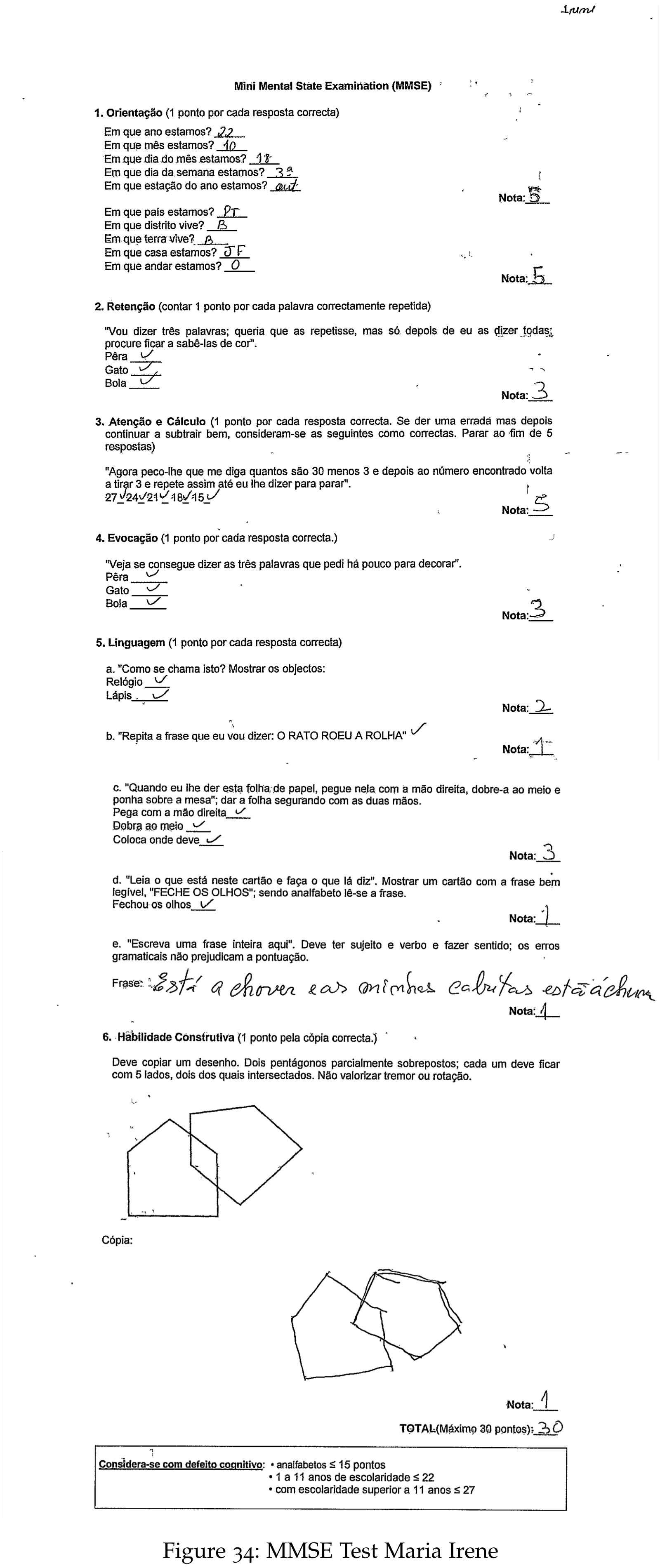
Deve copiar um desenho. Dois pentágonos parcialmente sobrepostos; cada um deve ficar com 5 lados, dois dos quais intersectados. Não valorizar tremor ou rotação.

Cópia:

Nota: 1

TOTAL(Máximo 30 pontos): 28

Figure 33: MMSE Test Ántónio



1num

Mini Mental State Examination (MMSE)

1. Orientação (1 ponto por cada resposta correcta)

Em que ano estamos? 22
Em que mês estamos? 10
Em que dia do mês estamos? 18
Em que dia da semana estamos? 3ª
Em que estação do ano estamos? out

Nota: 5

Em que país estamos? PT
Em que distrito vive? B
Em que terra vive? B
Em que casa estamos? JF
Em que andar estamos? 0

Nota: 5

2. Retenção (contar 1 ponto por cada palavra correctamente repetida)

"Vou dizer três palavras; queria que as repetisse, mas só depois de eu as dizer todas; procure ficar a sabê-las de cor".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

3. Atenção e Cálculo (1 ponto por cada resposta correcta. Se der uma errada mas depois continuar a subtrair bem, consideram-se as seguintes como correctas. Parar ao fim de 5 respostas)

"Agora peço-lhe que me diga quantos são 30 menos 3 e depois ao número encontrado volta a tirar 3 e repete assim até eu lhe dizer para parar".
27 ✓ 24 ✓ 21 ✓ 18 ✓ 15 ✓

Nota: 5

4. Evocação (1 ponto por cada resposta correcta.)

"Veja se consegue dizer as três palavras que pedi há pouco para decorar".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

5. Linguagem (1 ponto por cada resposta correcta)

a. "Como se chama isto? Mostrar os objectos:
Relógio ✓
Lápis ✓

Nota: 2

b. "Repita a frase que eu vou dizer: O RATO ROEU A ROLHA" ✓

Nota: 1

c. "Quando eu lhe der esta folha de papel, pegue nela com a mão direita, dobre-a ao meio e ponha sobre a mesa"; dar a folha segurando com as duas mãos.
Pega com a mão direita ✓
Dobra ao meio ✓
Coloca onde deve ✓

Nota: 3

d. "Leia o que está neste cartão e faça o que lá diz". Mostrar um cartão com a frase bem legível, "FECHE OS OLHOS"; sendo analfabeto lê-se a frase.
Fechou os olhos ✓

Nota: 1

e. "Escreva uma frase inteira aqui". Deve ter sujeito e verbo e fazer sentido; os erros gramaticais não prejudicam a pontuação.

Frase: Está a chover e as minhas cabritas estão à chuva

Nota: 1

6. Habilidade Construtiva (1 ponto pela cópia correcta.)

Deve copiar um desenho. Dois pentágonos parcialmente sobrepostos; cada um deve ficar com 5 lados, dois dos quais intersectados. Não valorizar tremor ou rotação.

Cópia:

Nota: 1

TOTAL (Máximo 30 pontos): 30

Considera-se com defeito cognitivo:
• analfabetos ≤ 15 pontos
• 1 a 11 anos de escolaridade ≤ 22
• com escolaridade superior a 11 anos ≤ 27

Figure 34: MMSE Test Maria Irene

M3

Mini Mental State Examination (MMSE)

1. Orientação (1 ponto por cada resposta correcta)

Em que ano estamos? 22
Em que mês estamos? 10
Em que dia do mês estamos? 17
Em que dia da semana estamos? 3ª
Em que estação do ano estamos? out

Nota: 5

Em que país estamos? PT
Em que distrito vive? B
Em que terra vive? B
Em que casa estamos? UF
Em que andar estamos? 0

Nota: 5

2. Retenção (contar 1 ponto por cada palavra correctamente repetida)

"Vou dizer três palavras; queria que as repetisse, mas só depois de eu as dizer todas; procure ficar a sabê-las de cor".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

3. Atenção e Cálculo (1 ponto por cada resposta correcta. Se der uma errada mas depois continuar a subtrair bem, consideram-se as seguintes como correctas. Parar ao fim de 5 respostas)

"Agora peco-lhe que me diga quantos são 30 menos 3 e depois ao número encontrado volta a tirar 3 e repete assim até eu lhe dizer para parar".
27✓24✓21✓18✓15✓

Nota: 5

4. Evocação (1 ponto por cada resposta correcta.)

"Veja se consegue dizer as três palavras que pedi há pouco para decorar".
Pêra ✓
Gato ✓
Bola ✗

Nota: 2

5. Linguagem (1 ponto por cada resposta correcta)

a. "Como se chama isto? Mostrar os objectos:
Relógio ✓
Lápis ✓

Nota: 2

b. "Repita a frase que eu vou dizer: O RATO ROEU A ROLHA" ✓

Nota: 1

c. "Quando eu lhe der esta folha de papel, pegue nela com a mão direita, dobre-a ao meio e ponha sobre a mesa"; dar a folha segurando com as duas mãos.
Pega com a mão direita ✗
Dobra ao meio ✓
Coloca onde deve ✓

Nota: 2

d. "Leia o que está neste cartão e faça o que lá diz". Mostrar um cartão com a frase bem legível, "FECHE OS OLHOS"; sendo analfabeto lê-se a frase.
Fechou os olhos ✓

Nota: 1

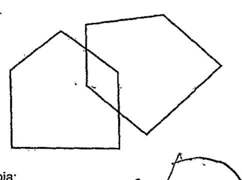
e. "Escreva uma frase inteira aqui". Deve ter sujeito e verbo e fazer sentido; os erros gramaticais não prejudicam a pontuação.

Frase: Boas férias

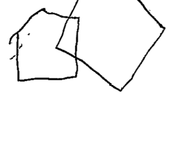
Nota: 0

6. Habilidade Construtiva (1 ponto pela cópia correcta.)

Deve copiar um desenho. Dois pentágonos parcialmente sobrepostos; cada um deve ficar com 5 lados, dois dos quais intersectados. Não valorizar tremor ou rotação.



Cópia:



Nota: 1

TOTAL(Máximo 30 pontos): 27

Considera-se com defeito cognitivo:	• analfabetos ≤ 15 pontos • 1 a 11 anos de escolaridade ≤ 22 • com escolaridade superior a 11 anos ≤ 27

Mª (?)

Mini Mental State Examination (MMSE)

1. Orientação (1 ponto por cada resposta correcta)

Em que ano estamos? 22
Em que mês estamos? 10
Em que dia do mês estamos? 18
Em que dia da semana estamos? 3ª
Em que estação do ano estamos? out

Nota: 5

Em que país estamos? PT
Em que distrito vive? B
Em que terra vive? Bico
Em que casa estamos? JF
Em que andar estamos? 0

Nota: 5

2. Retenção (contar 1 ponto por cada palavra correctamente repetida)

"Vou dizer três palavras; queria que as repetisse, mas só depois de eu as dizer todas; procure ficar a sabê-las de cor".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

3. Atenção e Cálculo (1 ponto por cada resposta correcta. Se der uma errada mas depois continuar a subtrair bem, consideram-se as seguintes como correctas. Parar ao fim de 5 respostas)

"Agora peço-lhe que me diga quantos são 30 menos 3 e depois ao número encontrado volta a tirar 3 e repete assim até eu lhe dizer para parar".
27 ✓ 24 x 21 x 18 x 15 x

Nota: 1

4. Evocação (1 ponto por cada resposta correcta.)

"Veja se consegue dizer as três palavras que pedi há pouco para decorar".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

5. Linguagem (1 ponto por cada resposta correcta)

a. "Como se chama isto? Mostrar os objectos:
Relógio ✓
Lápis ✓

Nota: 2

b. "Repita a frase que eu vou dizer: O RATO ROEU A ROLHA" ✓

Nota: 1

c. "Quando eu lhe der esta folha de papel, pegue nela com a mão direita, dobre-a ao meio e ponha sobre a mesa"; dar a folha segurando com as duas mãos.
Pega com a mão direita x
Dobra ao meio ✓
Coloca onde deve ✓

Nota: 2

d. "Leia o que está neste cartão e faça o que lá diz". Mostrar um cartão com a frase bem legível, "FECHE OS OLHOS"; sendo analfabeto lê-se a frase.
Fechou os olhos ✓

Nota: 1

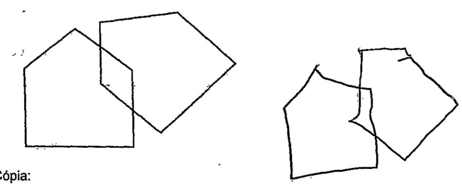
e. "Escreva uma frase inteira aqui". Deve ter sujeito e verbo e fazer sentido; os erros gramaticais não prejudicam a pontuação.

Frase: hoje esta a chuver

Nota: 1

6. Habilidade Construtiva (1 ponto pela cópia correcta.)

Deve copiar um desenho. Dois pentágonos parcialmente sobrepostos; cada um deve ficar com 5 lados, dois dos quais intersectados. Não valorizar tremor ou rotação.



Cópia:

Nota: 1

TOTAL(Máximo 30 pontos): 23

Considera-se com defeito cognitivo: • analfabetos ≤ 15 pontos • 1 a 11 anos de escolaridade ≤ 22 • com escolaridade superior a 11 anos ≤ 27

Mini Mental State Examination (MMSE)

1. Orientação (1 ponto por cada resposta correcta)

Em que ano estamos? 22
Em que mês estamos? 10
Em que dia do mês estamos? 18
Em que dia da semana estamos? 3ª
Em que estação do ano estamos? out

Nota: 5

Em que país estamos? PT
Em que distrito vive? Braga
Em que terra vive? Bika
Em que casa estamos? JF
Em que andar estamos? 0

Nota: 5

2. Retenção (contar 1 ponto por cada palavra correctamente repetida)

"Vou dizer três palavras; queria que as repetisse, mas só depois de eu as dizer todas; procure ficar a sabê-las de cor".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

3. Atenção e Cálculo (1 ponto por cada resposta correcta. Se der uma errada mas depois continuar a subtrair bem, consideram-se as seguintes como correctas. Parar ao fim de 5 respostas)

"Agora peço-lhe que me diga quantos são 30 menos 3 e depois ao número encontrado volta a tirar 3 e repete assim até eu lhe dizer para parar".
27 ✓ 24 ✓ 21 ✓ 18 ✓ 15 ✓

Nota: 5

4. Evocação (1 ponto por cada resposta correcta.)

"Veja se consegue dizer as três palavras que pedi há pouco para decorar".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

5. Linguagem (1 ponto por cada resposta correcta)

a. "Como se chama isto? Mostrar os objectos:
Relógio ✓
Lápis ✓

Nota: 2

b. "Repita a frase que eu vou dizer: O RATO ROEU A ROLHA" ✓

Nota: 1

c. "Quando eu lhe der esta folha de papel, pegue nela com a mão direita, dobre-a ao meio e ponha sobre a mesa"; dar a folha segurando com as duas mãos.
Pega com a mão direita ✓
Dobra ao meio ✓
Coloca onde deve ✓

Nota: 3

d. "Leia o que está neste cartão e faça o que lá diz". Mostrar um cartão com a frase bem legível, "FECHE OS OLHOS"; sendo analfabeto lê-se a frase.
Fechou os olhos ✓

Nota: 1

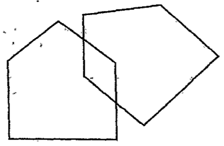
e. "Escreva uma frase inteira aqui". Deve ter sujeito e verbo e fazer sentido; os erros gramaticais não prejudicam a pontuação.

Frase: Muita chuva

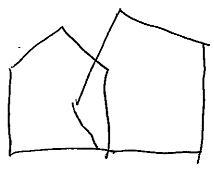
Nota: 0

6. Habilidade Construtiva (1 ponto pela cópia correcta.)

Deve copiar um desenho. Dois pentágonos parcialmente sobrepostos; cada um deve ficar com 5 lados, dois dos quais intersectados. Não valorizar tremor ou rotação.



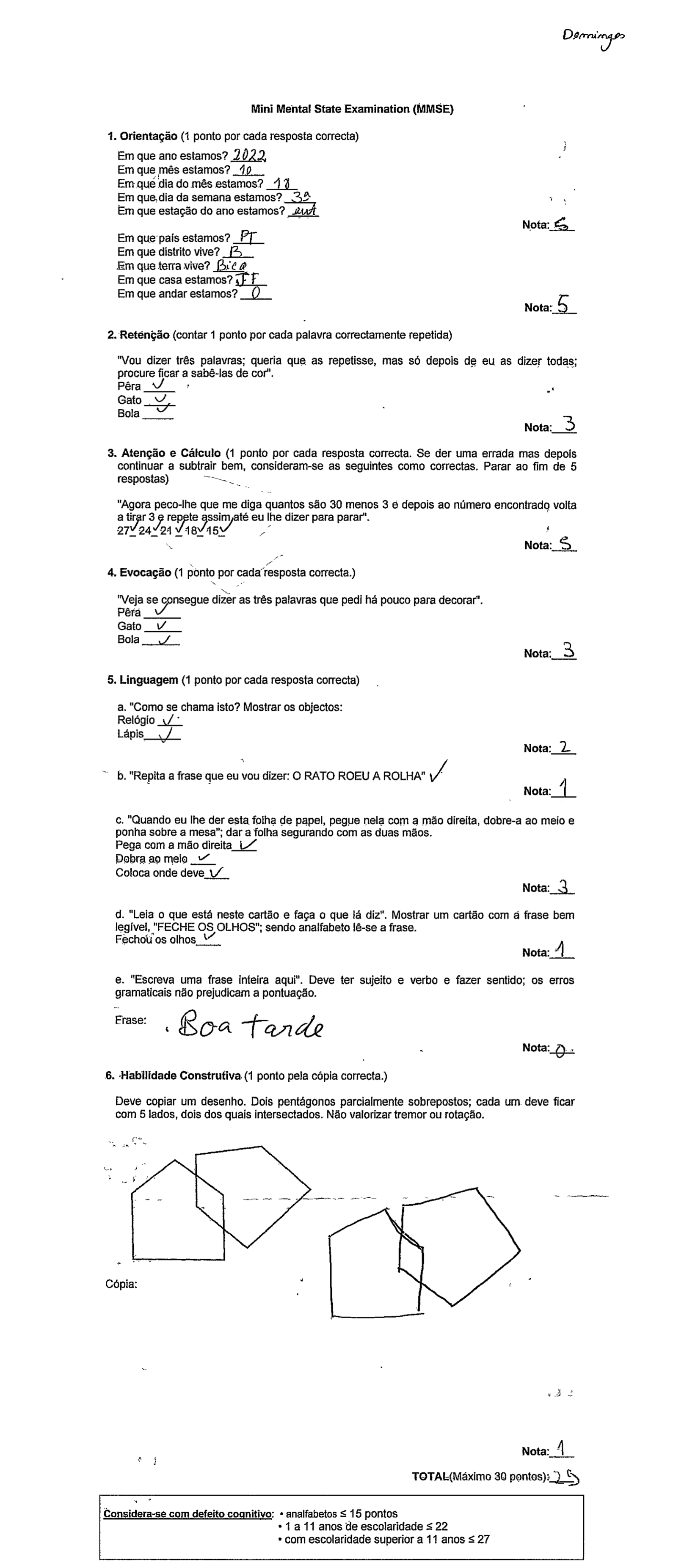
Cópia:



Nota: 1

TOTAL (Máximo 30 pontos): 29

<u>Considera-se com defeito cognitivo</u>: • analfabetos ≤ 15 pontos • 1 a 11 anos de escolaridade ≤ 22 • com escolaridade superior a 11 anos ≤ 27



Domingos

Mini Mental State Examination (MMSE)

1. Orientação (1 ponto por cada resposta correcta)

Em que ano estamos? 2022
Em que mês estamos? 10
Em que dia do mês estamos? 18
Em que dia da semana estamos? 3ª
Em que estação do ano estamos? out

Nota: 5

Em que país estamos? PT
Em que distrito vive? B
Em que terra vive? Bica
Em que casa estamos? JF
Em que andar estamos? 0

Nota: 5

2. Retenção (contar 1 ponto por cada palavra correctamente repetida)

"Vou dizer três palavras; queria que as repetisse, mas só depois de eu as dizer todas; procure ficar a sabê-las de cor".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

3. Atenção e Cálculo (1 ponto por cada resposta correcta. Se der uma errada mas depois continuar a subtrair bem, consideram-se as seguintes como correctas. Parar ao fim de 5 respostas)

"Agora peço-lhe que me diga quantos são 30 menos 3 e depois ao número encontrado volta a tirar 3 e repete assim até eu lhe dizer para parar".
27 ✓ 24 ✓ 21 ✓ 18 ✓ 15 ✓

Nota: 5

4. Evocação (1 ponto por cada resposta correcta.)

"Veja se consegue dizer as três palavras que pedi há pouco para decorar".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

5. Linguagem (1 ponto por cada resposta correcta)

a. "Como se chama isto? Mostrar os objectos:
Relógio ✓
Lápis ✓

Nota: 2

b. "Repita a frase que eu vou dizer: O RATO ROEU A ROLHA" ✓

Nota: 1

c. "Quando eu lhe der esta folha de papel, pegue nela com a mão direita, dobre-a ao meio e ponha sobre a mesa"; dar a folha segurando com as duas mãos.
Pega com a mão direita ✓
Dobra ao meio ✓
Coloca onde deve ✓

Nota: 3

d. "Leia o que está neste cartão e faça o que lá diz". Mostrar um cartão com a frase bem legível, "FECHE OS OLHOS"; sendo analfabeto lê-se a frase.
Fechou os olhos ✓

Nota: 1

e. "Escreva uma frase inteira aqui". Deve ter sujeito e verbo e fazer sentido; os erros gramaticais não prejudicam a pontuação.

Frase: Boa tarde

Nota: 0

6. Habilidade Construtiva (1 ponto pela cópia correcta.)

Deve copiar um desenho. Dois pentágonos parcialmente sobrepostos; cada um deve ficar com 5 lados, dois dos quais intersectados. Não valorizar tremor ou rotação.

Cópia:

Nota: 1

TOTAL (Máximo 30 pontos): 25

Considera-se com defeito cognitivo:	• analfabetos ≤ 15 pontos • 1 a 11 anos de escolaridade ≤ 22 • com escolaridade superior a 11 anos ≤ 27

Figure 38: MMSE Test Domingos

Ortelinda

Mini Mental State Examination (MMSE)

1. Orientação (1 ponto por cada resposta correcta)

Em que ano estamos? 22
Em que mês estamos? 10
Em que dia do mês estamos? 12
Em que dia da semana estamos? 3ª
Em que estação do ano estamos? out

Nota: 5

Em que país estamos? PT
Em que distrito vive? B
Em que terra vive? B
Em que casa estamos? JF
Em que andar estamos? 0

Nota: 5

2. Retenção (contar 1 ponto por cada palavra correctamente repetida)

"Vou dizer três palavras; queria que as repetisse, mas só depois de eu as dizer todas; procure ficar a sabê-las de cor".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

3. Atenção e Cálculo (1 ponto por cada resposta correcta. Se der uma errada mas depois continuar a subtrair bem, consideram-se as seguintes como correctas. Parar ao fim de 5 respostas)

"Agora peco-lhe que me diga quantos são 30 menos 3 e depois ao número encontrado volta a tirar 3 e repete assim até eu lhe dizer para parar".
27 ✓ 24 ✓ 21 ✓ 18 ✓ 15 ✓

Nota: 5

4. Evocação (1 ponto por cada resposta correcta.)

"Veja se consegue dizer as três palavras que pedi há pouco para decorar".
Pêra ✓
Gato ✓
Bola ✓

Nota: 3

5. Linguagem (1 ponto por cada resposta correcta)

a. "Como se chama isto? Mostrar os objectos:
Relógio ✓
Lápis ✓

Nota: 2

b. "Repita a frase que eu vou dizer: O RATO ROEU A ROLHA" ✓

Nota: 1

c. "Quando eu lhe der esta folha de papel, pegue nela com a mão direita, dobre-a ao meio e ponha sobre a mesa"; dar a folha segurando com as duas mãos.
Pega com a mão direita x
Dobra ao meio ✓
Coloca onde deve ✓

Nota: 2

d. "Leia o que está neste cartão e faça o que lá diz". Mostrar um cartão com a frase bem legível, "FECHE OS OLHOS"; sendo analfabeto lê-se a frase.
Fechou os olhos ✓

Nota: 1

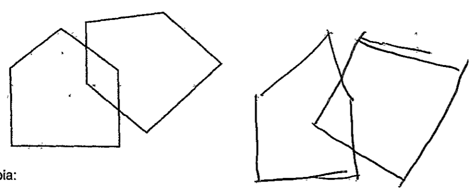
e. "Escreva uma frase inteira aqui". Deve ter sujeito e verbo e fazer sentido; os erros gramaticais não prejudicam a pontuação.

Frase: Eu gosto muito da ginástica da Valoriza.

Nota: 1

6. Habilidade Construtiva (1 ponto pela cópia correcta.)

Deve copiar um desenho. Dois pentágonos parcialmente sobrepostos; cada um deve ficar com 5 lados, dois dos quais intersectados. Não valorizar tremor ou rotação.



Cópia:

Nota: 0

TOTAL (Máximo 30 pontos): 28

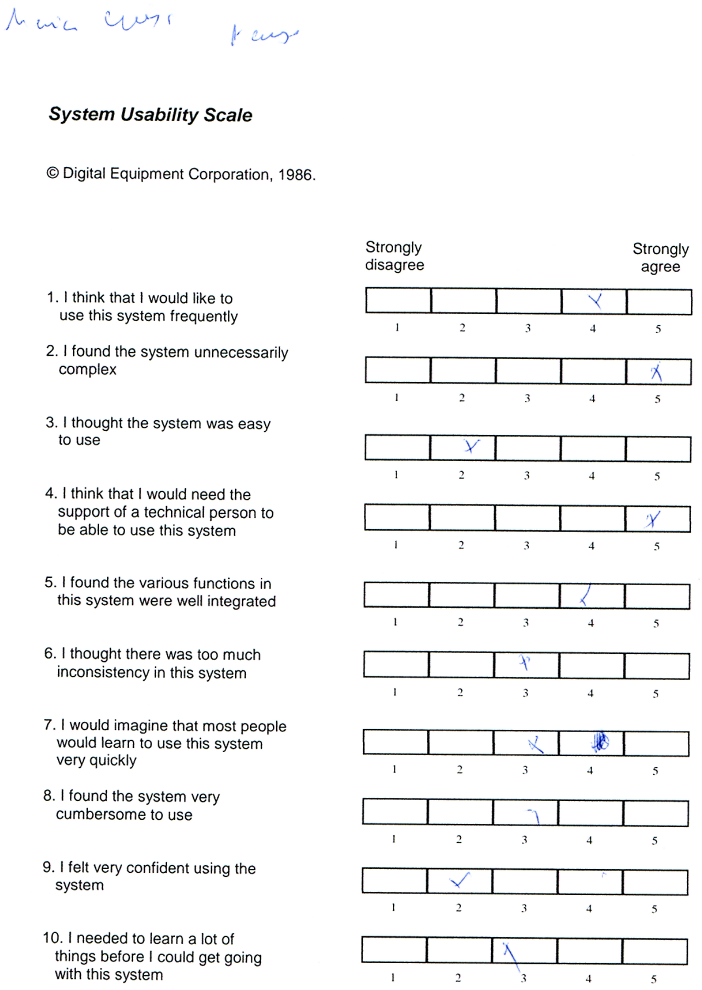
Considera-se com defeito cognitivo:
- analfabetos ≤ 15 pontos
- 1 a 11 anos de escolaridade ≤ 22
- com escolaridade superior a 11 anos ≤ 27

Figure 39: MMSE Test Ortelinda

System Usability Scale

	Strongly disagree 1	2	3	4	Strongly agree 5
1. I think that I would like to use this system frequently			X		
2. I found the system unnecessarily complex					X
3. I thought the system was easy to use		X			
4. I think that I would need the support of a technical person to be able to use this system					X
5. I found the various functions in this system were well integrated				X	
6. I thought there was too much inconsistency in this system			X		
7. I would imagine that most people would learn to use this system very quickly				X	
8. I found the system very cumbersome to use			X		
9. I felt very confident using the system			X		
10. I needed to learn a lot of things before I could get going with this system				X	

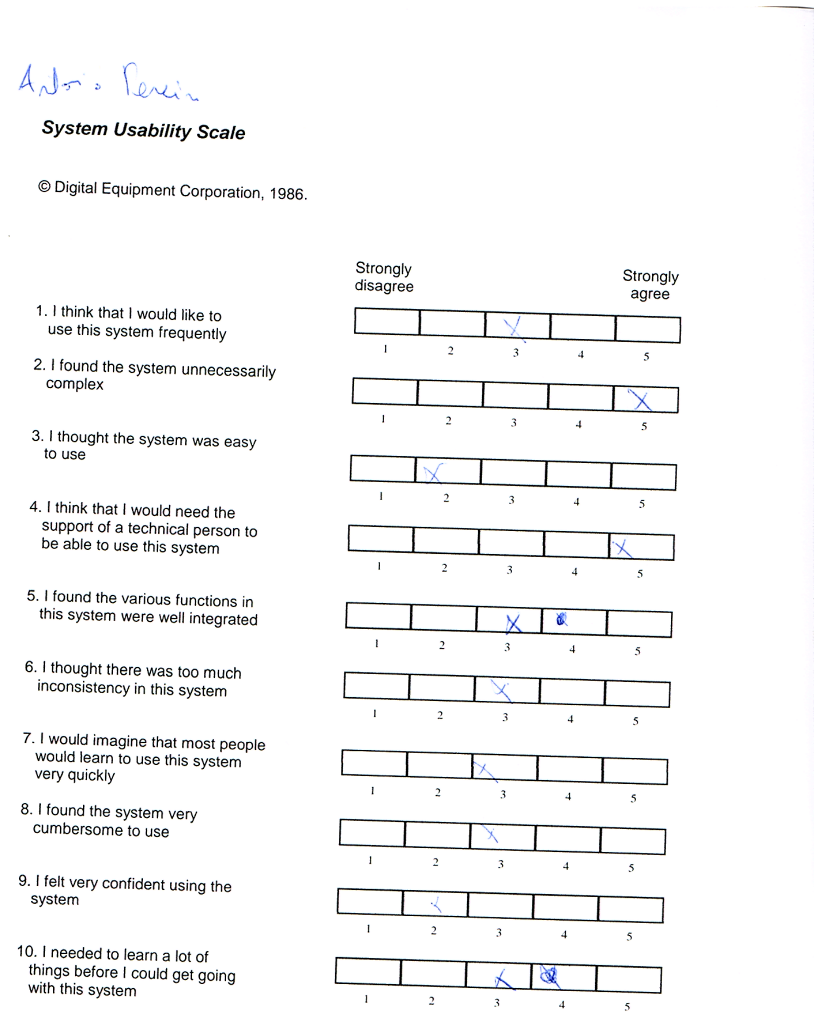
Figure 40: SUS Test Maria de Fatima



System Usability Scale

	Strongly disagree				Strongly agree
1. I think that I would like to use this system frequently	1	2	3	4	5
2. I found the system unnecessarily complex	1	2	3	4	5
3. I thought the system was easy to use	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5. I found the various functions in this system were well integrated	1	2	3	4	5
6. I thought there was too much inconsistency in this system	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8. I found the system very cumbersome to use	1	2	3	4	5
9. I felt very confident using the system	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system	1	2	3	4	5

Figure 41: SUS Test Maria Luisa

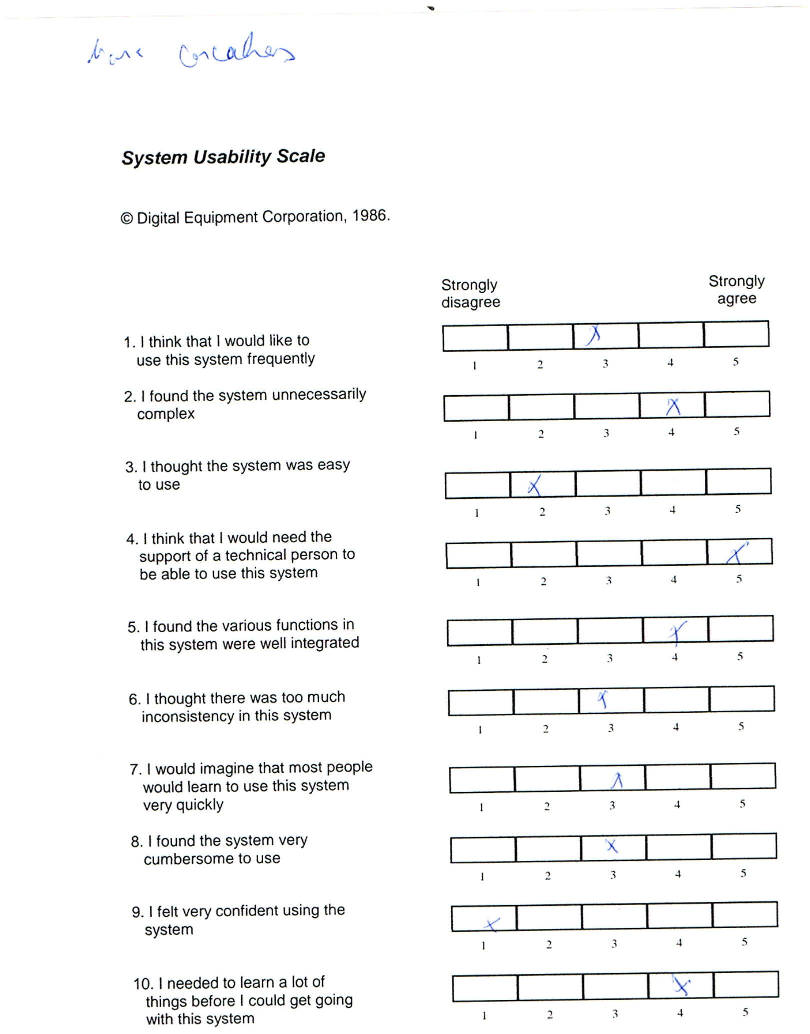


System Usability Scale

© Digital Equipment Corporation, 1986.

	Strongly disagree 1	2	3	4	Strongly agree 5
1. I think that I would like to use this system frequently					
2. I found the system unnecessarily complex					
3. I thought the system was easy to use					
4. I think that I would need the support of a technical person to be able to use this system					
5. I found the various functions in this system were well integrated					
6. I thought there was too much inconsistency in this system					
7. I would imagine that most people would learn to use this system very quickly					
8. I found the system very cumbersome to use					
9. I felt very confident using the system					
10. I needed to learn a lot of things before I could get going with this system					

Figure 42: SUS Test Antonio

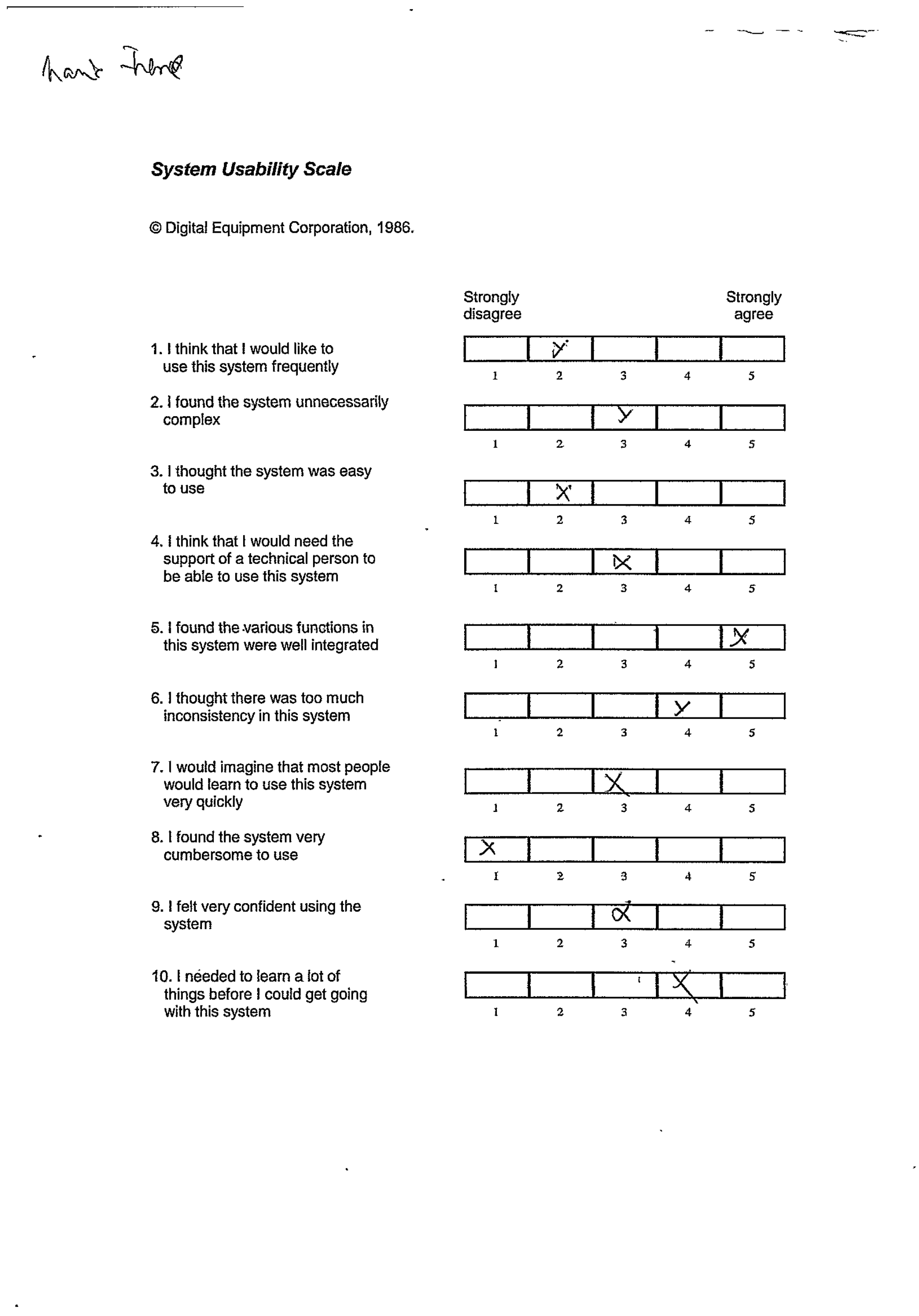


System Usability Scale

© Digital Equipment Corporation, 1986.

	Strongly disagree 1	2	3	4	Strongly agree 5
1. I think that I would like to use this system frequently			X		
2. I found the system unnecessarily complex				X	
3. I thought the system was easy to use		X			
4. I think that I would need the support of a technical person to be able to use this system					X
5. I found the various functions in this system were well integrated				X	
6. I thought there was too much inconsistency in this system			X		
7. I would imagine that most people would learn to use this system very quickly			X		
8. I found the system very cumbersome to use			X		
9. I felt very confident using the system	X				
10. I needed to learn a lot of things before I could get going with this system				X	

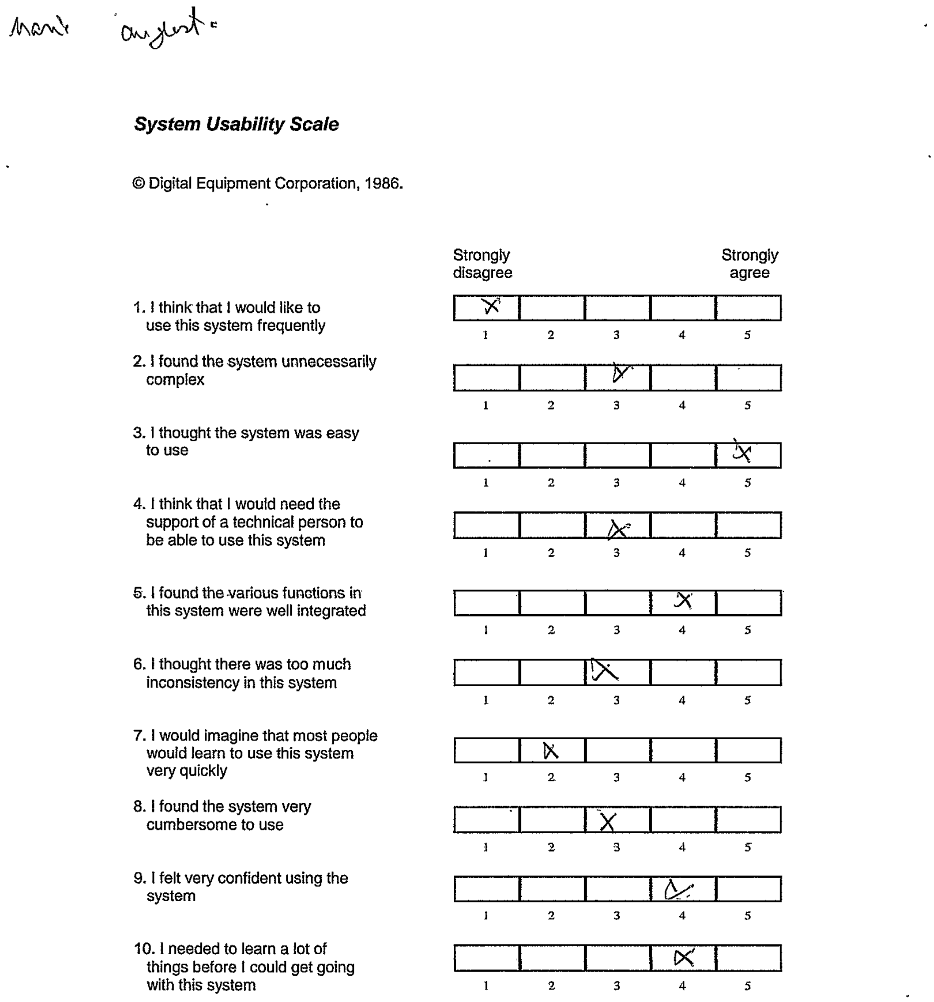
Figure 43: SUS Test Maria Machado



System Usability Scale

	1 (Strongly disagree)	2	3	4	5 (Strongly agree)
1. I think that I would like to use this system frequently		X			
2. I found the system unnecessarily complex			X		
3. I thought the system was easy to use		X			
4. I think that I would need the support of a technical person to be able to use this system			X		
5. I found the various functions in this system were well integrated					X
6. I thought there was too much inconsistency in this system				X	
7. I would imagine that most people would learn to use this system very quickly			X		
8. I found the system very cumbersome to use	X				
9. I felt very confident using the system			X		
10. I needed to learn a lot of things before I could get going with this system				X	

Figure 44: SUS Test Maria Irene



System Usability Scale

	Strongly disagree 1	2	3	4	Strongly agree 5
1. I think that I would like to use this system frequently	X				
2. I found the system unnecessarily complex			X		
3. I thought the system was easy to use					X
4. I think that I would need the support of a technical person to be able to use this system			X		
5. I found the various functions in this system were well integrated				X	
6. I thought there was too much inconsistency in this system			X		
7. I would imagine that most people would learn to use this system very quickly		X			
8. I found the system very cumbersome to use			X		
9. I felt very confident using the system				X	
10. I needed to learn a lot of things before I could get going with this system				X	

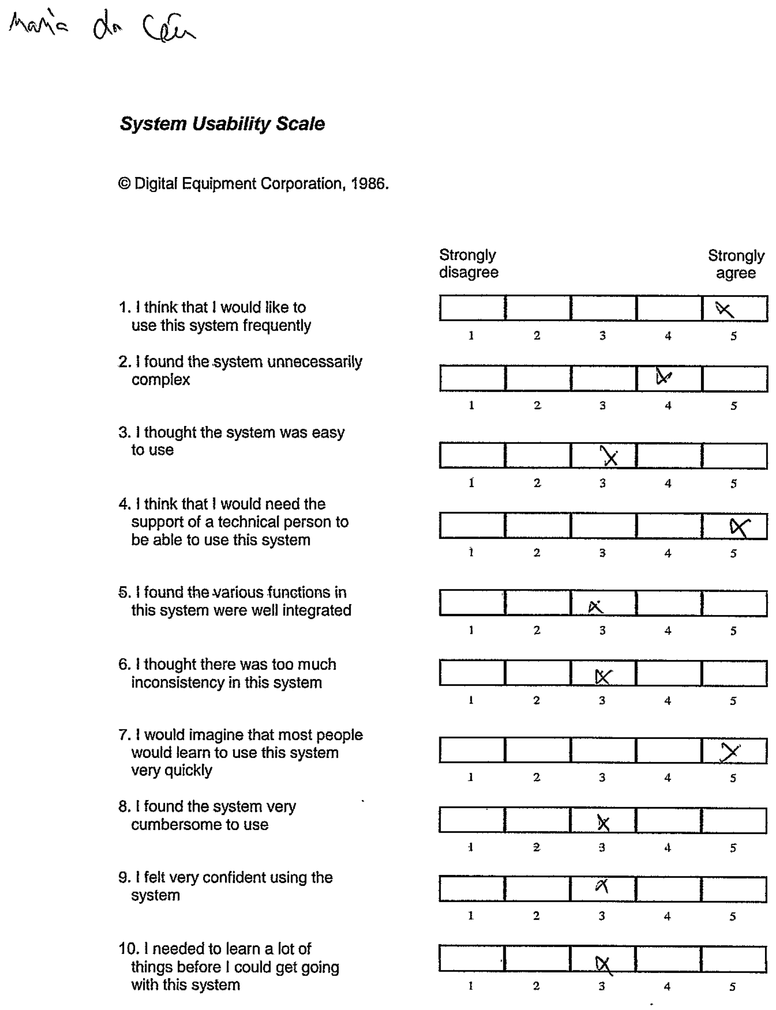
Figure 45: SUS Test Maria Augusta

Ortelinda Pinheiro

System Usability Scale

	1 (Strongly disagree)	2	3	4	5 (Strongly agree)
1. I think that I would like to use this system frequently			X		
2. I found the system unnecessarily complex			X		
3. I thought the system was easy to use			X		
4. I think that I would need the support of a technical person to be able to use this system				X	
5. I found the various functions in this system were well integrated					X
6. I thought there was too much inconsistency in this system			X		
7. I would imagine that most people would learn to use this system very quickly			X		
8. I found the system very cumbersome to use				X	
9. I felt very confident using the system					X
10. I needed to learn a lot of things before I could get going with this system		X			

Figure 46: SUS Test ortelinda



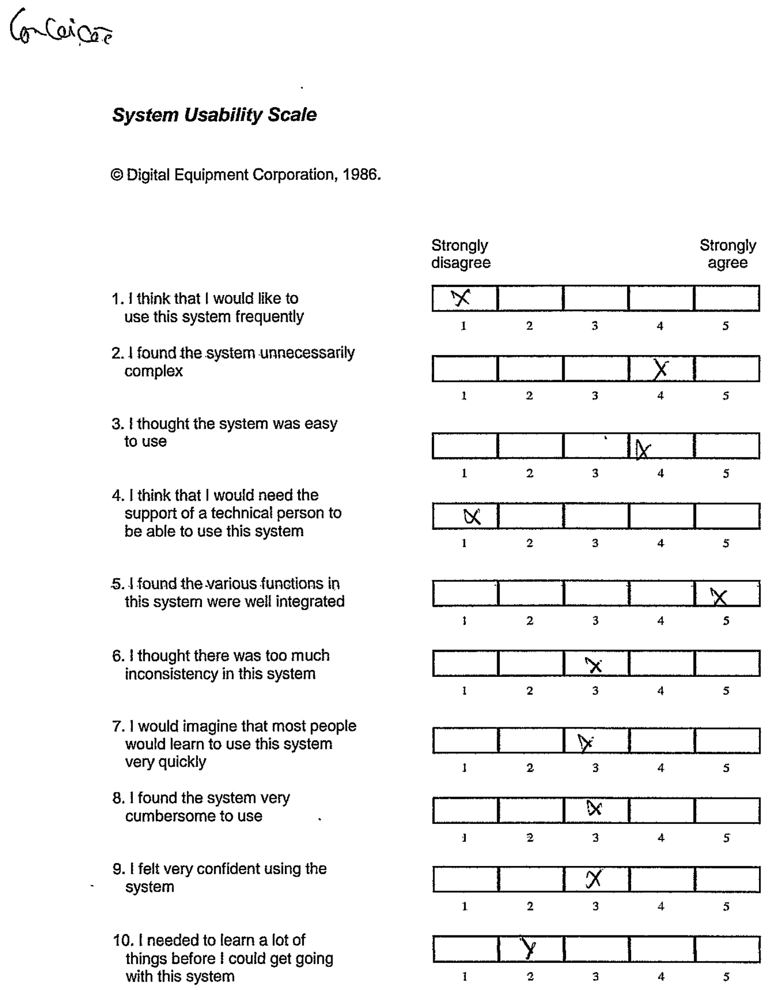
Maria do Céu

System Usability Scale

© Digital Equipment Corporation, 1986.

	1 (Strongly disagree)	2	3	4	5 (Strongly agree)
1. I think that I would like to use this system frequently					X
2. I found the system unnecessarily complex				X	
3. I thought the system was easy to use			X		
4. I think that I would need the support of a technical person to be able to use this system					X
5. I found the various functions in this system were well integrated			X		
6. I thought there was too much inconsistency in this system			X		
7. I would imagine that most people would learn to use this system very quickly					X
8. I found the system very cumbersome to use			X		
9. I felt very confident using the system			X		
10. I needed to learn a lot of things before I could get going with this system			X		

Figure 47: SUS Test Maria do Céu

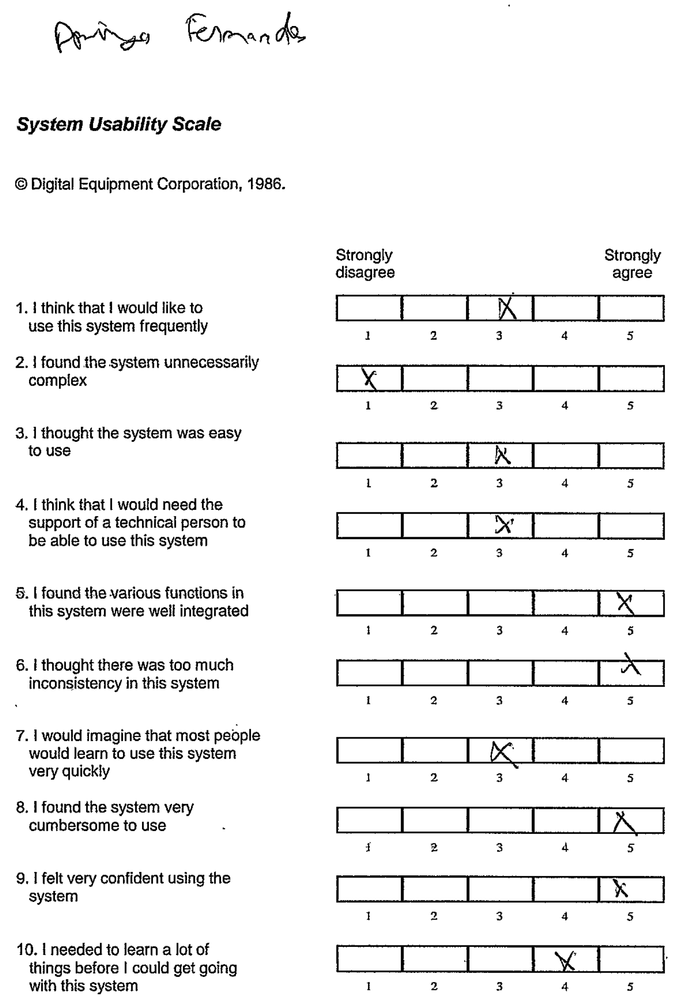


Conceição

System Usability Scale

	Strongly disagree 1	2	3	4	Strongly agree 5
1. I think that I would like to use this system frequently	X				
2. I found the system unnecessarily complex				X	
3. I thought the system was easy to use				X	
4. I think that I would need the support of a technical person to be able to use this system	X				
5. I found the various functions in this system were well integrated					X
6. I thought there was too much inconsistency in this system			X		
7. I would imagine that most people would learn to use this system very quickly			X		
8. I found the system very cumbersome to use			X		
9. I felt very confident using the system			X		
10. I needed to learn a lot of things before I could get going with this system		X			

Figure 48: SUS Test Conceição



Domingos Fernandes

System Usability Scale

© Digital Equipment Corporation, 1986.

	1 (Strongly disagree)	2	3	4	5 (Strongly agree)
1. I think that I would like to use this system frequently			X		
2. I found the system unnecessarily complex	X				
3. I thought the system was easy to use			X		
4. I think that I would need the support of a technical person to be able to use this system			X		
5. I found the various functions in this system were well integrated					X
6. I thought there was too much inconsistency in this system					X
7. I would imagine that most people would learn to use this system very quickly			X		
8. I found the system very cumbersome to use					X
9. I felt very confident using the system					X
10. I needed to learn a lot of things before I could get going with this system				X	

Figure 49: SUS Test Domingos

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