VR Game Development for OCD Therapy

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Resumo Alargado

O seguinte texto tem como objetivo apresentar sumariamente o conteúdo deste relatório de projeto em Lingua Portuguesa.

Introdução

Hoje em dia, o desenvolvimento dos videojogos e realidade virtual, a par da sua difusão na população em geral têm impulsionado a utilização destes em áreas tão diversas do seu objetivo lúdico como a educação e a saúde.
No tratamento de transtornos do foro psicológico são já usadas ferramentas reais e técnicas diversas com os pacientes, para a sua reabilitação. A realidade virtual pode vir a ser uma nova forma de abordagem nestes casos, deixando o paciente/utilizador interagir com um mundo próximo da realidade onde é exposto às suas fobias. Com este projeto, pretendeu-se criar um protótipo para proporcionar uma experiência próxima da realidade vivida pelo paciente/utilizador, desafiando a Pertubação Obsessivo-Compulsiva (POC), tão comum no tempo em que vivemos, com a imersão do paciente num ambiente acolhedor do interior de uma casa, supervisionado pelo profissional de saúde que o acompanha.

Trabalho relacionado

Segundo pesquisas realizadas, constatou-se que a implementação de videojogos e realidade virtual na área da saúde psiquiátrica tem sido crescente e direcionada maioritariamente a um público infantil e sobretudo ligado à educação e ensino.
Não tendo encontrado videojogos destinados ao tratamento de adultos com POC, o que se justifica pelo facto da normal associação das crianças ao jogo lúdico, pretende

este projeto criar uma simulação com alto nível de imersão em que a realidade virtual pode cativar todas as faixas etárias, pois atualmente encontram-se em todas as idades fãs dos jogos digitais.
A inovação deste projeto consiste na criação de um jogo de realidade virtual destinado a ser aplicado em pacientes com POC, em sessões terapêuticas, por especialistas, com a finalidade de desritualizar a compulsão do paciente de uma forma lúdica.

Conceito de game design

É descrita a concetualização do vídeojogo criado: mundo virtual modelado e ações a desenvolver.
Devido à situação pandémica que vivemos houve alterações que são referidas no final deste capítulo.
Foi possível concretizar este trabalho, promovendo reuniões e encontros informais com profissionais de saúde (Psiquiatras e Psicólogos) a fim de apurar as compulsões mais comuns nestes subtipos, a saber, ordem e simetria, limpeza e contaminação, dúvida e verificação e taboo. Sendo o subtipo taboo impossível de generalizar foi imediatamente descartada concentrando-se a conceção do jogo nas restantes.
Este videojogo foi desenvolvido em parceria, por dois estudantes, devido às especificidades da sua construção e abrangência de duas áreas; programação e game design de um jogo em Realidade Virtual.
VR-POC (nome do jogo) é um jogo de puzzles e exploração, jogado na perspetiva da primeira pessoa que utiliza os pontos fortes da realidade virtual para ajudar na reabilitação de pacientes com POC. O jogo permite ao jogador, utilizando comandos e capacete de realidade virtual, interagir com diferentes objetos utilitários do dia a dia e realizar as tarefas propostas no interior da casa de forma a ir desritualizando as suas compulsões. No mapa do jogo foi desenhado um apartamento T1 compacto. Os puzzles desenhados destinam-se ao tratamento do subtipo ordem e simetria, focando-se nas sequências e padrões.
No decurso deste projeto foram encontradas dificuldades intransponíveis para a sua concretização como inicialmente previsto. O contexto da pandemia mundial (a partir de março de 2020) impossibilitou a continuação do trabalho de equipa e dinâmica do trabalho, obrigou à alteração dos três níveis projetados para um só nível com várias tarefas e não permitindo a realização de testes em pacientes levou à elaboração de

inquéritos digitais a profissionais da área e consequente tratamento de dados.

Desenvolvimento do projeto

O quarto capítulo apresenta informação sobre todos os componentes do protótipo desenvolvido: indica as ferramentas necessárias para o desenvolvimento do projeto, enumera e detalha as localizações do mundo virtual do jogo; explica os controlos do jogo no equipamento de realidade virtual, descreve as interações possíveis do jogador com o mundo virtual e finalmente explica a sequência de progresso do jogo.

Testes e resultados

Neste quinto capítulo são apresentados os resultados da aplicação de um inquérito anónimo a profissionais de saúde mental com o objetivo de verificar as potencialidades terapêuticas do protótipo criado.
No inquérito após a identificação profissional, foram feitas perguntas sobre o conhecimento e acesso a videojogos e ferramentas de realidade virtual, foi disponibilizada ligação para um vídeo demonstrativo do protótipo e em seguida foram questionados sobre diferentes aspetos do videojogo.
Da análise das respostas de psicólogos e psiquiatras a este inquérito, detalhadas neste capítulo, concluímos que todos os inquiridos demonstraram interesse na possível utilização do videojogo nas suas sessões terapêuticas.
Esta foi a única forma possível que se encontrou para obter validação deste projeto em situação de pandemia, devido ao impedimento de acesso às clínicas e hospitais psiquiátricos.

Conclusões

Neste último capitulo são apresentadas as conclusões do desenvolvimento deste projeto assim como possíveis formas de o melhorar.
Apesar de não ter sido possível a realização de testes com pacientes como previsto no início deste projeto, os dados obtidos no inquérito já mencionado foram extremamente positivos vindo assim comprovar a potencialidade terapêutica da realidade virtual em

tratamento de POC. Como trabalho futuro fica a realização de testes com pacientes como uma forma de demostrar que este tipo de jogo pode ser uma ferramenta terapêutica útil.

Palavras Chave

Realidade Virtual, Medicina, Perturbação Obsessivo-Compulsiva, Video Jogos, Psicoterapia, Psicologia

Abstract

With video games becoming more and more advanced, being pushed to their absolute limits in terms of Graphics, Performance, Gameplay and Narrative. It should come at no surprise when video games began to be used for more than just entertainment, and with Virtual Reality (VR), this notion has never been more widespread. From virtual reality movies being put into production, to musical and artistic experiences being brought into the virtual world, it was just a matter of time that video games would foray into the world of medical science, to be more exact, to the psychological field. In mental health, various toys and gimmick devices are used to distract and aid in treatments of many patients all around the globe. Using a VR game, one can give the player the ability to interact with an area that can be tailored to be as authentic as possible. This project aimed to create a prototype to deliver an experience that is grounded in a similar reality to the one the patient already knows, taking their Obssessive Compulsive Disorder (OCD) and challenging it in a controlled environment, asking the player to dissimulate their compulsions around a warm and inviting home. This prototype was reviewed by medical professionals, through video format due to the restrictions of the global pandemic in 2020.

Keywords

Virtual Reality, Medicine, Obsessive Compulsive Disorder, Video Games, Psychotherapy, Psychology

Contents

List of Figures

List of Tables

Acronyms

VR Virtual Reality

OCD Obssessive Compulsive Disorder

CBT Cognitive Behavioral Treatment

VRET Virtual Reality Exposure Therapy

PDT Prescription Digital Therapeutics

UI User Interface

NPC Non-Playable Character

Chapter 1

Introduction

The first chapter of this document presents the project, the scope of the game in section 1.1. The motivation behind the project in section 1.2. The objectives and methodology in section 1.3. Section 1.4. closes off the chapter with a brief description of the structure of the report.

1.1 Scope of the Project

Presently, in an increasingly globalized world, technology has become a very important part of our daily lives. This technological integration resulted in a rapid development of new technology like VR. This category of equipment is most used in the video game industry; however, it has various uses in other areas such as: Medicine, Science, Defense and Engineering. This project intends to aid in the rehabilitation and treatment of OCD through the medium of video games. Making use of a controlled virtual environment, to supply the therapist with a tool to make psychotherapy sessions more engaging, effective and efficient.

1.2 Motivation

This project was designed with an idea in mind: the area of Psychology is a field that could use this technology and the examples of working products are still very few to get a proper grasp on its effectiveness. Using a VR system, a technology said to enhance the user's immersion in the experience, it should be possible to have very

positive results when dealing with problems related with psychological disorder, further advancing quality of treatments and patient's quality of life.

1.3 Objectives and Methodology

The goal of this project is to create a prototype for a game that can be used in OCD therapy sessions with the intent of creating an engaging experience for the patient. This work intends to prove a correlation between the use of video games through VR technology and the well-being of a patient during therapy, regulating stress levels and recovering through exposure of the obsession within a virtual environment over multiple therapy sessions. To achieve this objective, two students, one with a computer science background and the other with a game design background, set out to create a VR video game with customisable levels of exposure so the therapist can adapt the simulation to the current patient. While they go through the levels under proper supervision their vital signs are measured for comparison with ones of patients going through normal treatment procedures in order to prove if this type of project has a positive effect on the patient and is effective.

1.4 Report Structure

This report will have the following structure:

- Chapter 1, Introduction, starts by explaining the subject of the project, it's scope, the motivation that led to choosing this topic, the objectives and methodology used to achieve the goals of the project and a description of the structure of this report;
- Chapter 2, Related Work, reports some related works to this project in the area of Psychology and deliberates on their different characteristics, comparing them to this project's expected product and focusing on what can be innovated from them;
- Chapter 3, Game Design Concept, delves into the thought process behind the design choices for this game, ranging from controls and gameplay, to world setting and possible restrictions;

- Chapter 4, Prototype Development, describes the creation process, going into more detail about the game world and the programming behind the current status of the game;
- Chapter 5, Tests and Results, shows the results of a small inquiry done to mental health professionals about this project and their willingness to support it;
- Chapter 6, Conclusions and Future Work, reveals the conclusions brought about by this project, noting some improvements that can be made to better the quality of the application;
- Appendix A, Scripts, shows the scripts used for the development of the game along with a small explanation of each one;
- Appendix B, Survey and Test Results, has the full survey and a summary of all answers in graphs and charts.

Chapter 2

Related Work

2.1 Introduction

A serious game is a game designed with a different primary purpose in mind other than just entertainment, using the allure of video games as a tool to capture the attention and interest of the player, to try and teach or change some sort of behavior.
Section 2.2. discusses some examples of serious games and articles related to OCD, psychology and VR. The target audience is defined and justified on section 2.3. In section 2.4. the innovative values of the work are presented.

2.2 Related Work

Serious games are made with the intent of helping a large number of people, trying to generalize on common problems, so finding work related to OCD is harder, but at the same time that means there is a current gap in the market for a working video game like this project. There have also been articles that detail different work done with OCD patients using VR

2.2.1 Ricky and The Spider

Ricky and the Spider[1] is a game made for children between the ages of 6 and 12, with the purpose of incentivizing both children and therapists to fight the OCD with Cognitive Behavioral Treatment (CBT) tactics. The characters of this game are Ricky,

Lisa, Dr Owl and the Spider. The game exposes the children to the story of Ricky and Lisa, living in the forest and being bullied by a bad spider that represents the disorders. Here the OCD is being personified as the villain of the story and the player's job is to help Ricky and Lisa overcome the spider's psychological grasp. Alongside the character of Dr Owl who guides the protagonists the player is led to do these "Courage Tasks" that help the disseminate the ritualization of OCD. Ricky is a grasshopper and Lisa is a lady bug, both of them having very cartoons-like designs in order to appeal to younger audiences, as can be seen on figure 2.1.

Figure 2.1: Ricky and the Spider website banner, taken from [1]

2.2.2 Treasure Hunt

Treasure Hunt[2] introduces itself as a behavioral computer game aimed for children between the ages of 9 and 13, as seen on figure 2.2. It's focused as an aid to the therapist when introducing young patients to CBT. In treasure hunt, the player goes through six levels, each one representing a step in CBT, masked with a narrative of a pirate treasure hunt with Captain Jones, Felix the ship's cat and Polly the ship's parrot. To find the treasure, the player must go through a series of tasks that help understand and internalize the CBT process.
Just like this project, Treasure Hunt is not a self-help game, so it should only be played by children who are in psycho therapeutic treatment, the true benefits come from playing it with supervision from a therapist.

Figure 2.2: Treasure Hunt image taken from [2]

2.2.3 Limbix

Limbix[3] is a company focused on the creation of VR experiences for mental health. The company actively researches and produces therapies for the new therapeutic class: Prescription Digital Therapeutics (PDT). Limbix is working to have PDTs that can be paired with existing pharmaceutical treatments and some as standalone treatments. They have a library of over 20 experiences ranging from education and entertainment to exposure therapy and mindfulness, like the figure 2.3 shows. Through small experiences they manage to reach a bigger group of people with different needs.

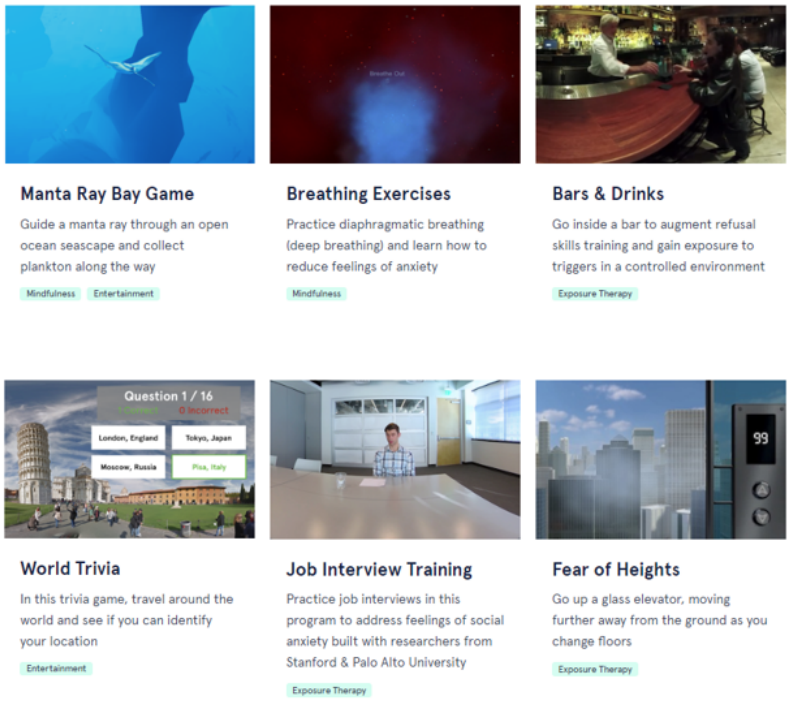


Figure 2.3: Caption of the Limbix VR Library, taken from [3]

2.2.4 Virtual reality exposure for OCD: Is it feasible?

The article [6] refers the trial that experimented Virtual Reality Exposure Therapy (VRET), in patients with OCD. The author describes that the most CBT failures are due to a lack of engagement in exposure and response prevention, most patients being reluctant on self-exposure or due to the strict regimen needed for this type of treatment. This article defends the use of exposure in a virtual world, claiming that it is considered a safer environment, letting users experience treatment on a less physical level.
It reports the results of testing this type of technology on four women with OCD, whose sub-type was *Cleaning and Contamination*. Each person had to go through four different tasks all revolving around their common OCD sub-type, afterwards assessing their levels of presence, emotional engagement, reality judgment, anxiety and disgust. These tests were made using a television connected to a laptop and a Kinect [7] device. The results showed that the anxiety and disgust levels increased as the simulation progressed, becoming more and more contaminated. This rise was connected to the sense of presence and emotional engagement of the user, showing potential in the use of this technology to ease the patient's adherence to live therapy or to just use it as it's own therapy tool.

2.3 Target Audience

The target audience for a serious health game will always be the people who are affected by the condition that's being focused on. After deliberation on the related games found when searching for serious games related the psychological therapy, it was easy to see a lack of content for a more adult crowd. This is mostly because of the stigma that video games are meant for children, but VR opens a door for a virtual simulation with a very high level of immersion that can amaze both kids and adults.

2.4 Project Innovation

This project is a VR game for aiding the treatment of OCD, which is something that currently does not exist, it's a tool being provided in a present where the capabilities of VR are constantly being tested and limits being pushed, so it's the perfect time to pioneer such a project. With the use of a realistic virtual world, one can more easily

be immersed in a digital setting, where therapists can more easily present triggers to compulsions that the patient might have.

2.5 Conclusions

In this chapter, games related to both VR and psychological therapy were analyzed. In doing so, a gap for this project was revealed, detailing the guidelines for possible development and details on where it should stand out. The lack of a proper VR simulation game for patients with OCD is something this project can capitalize on, using game design techniques to dissimulate the compulsions of the disorder and provide an escape or simply a relaxation tool for the patient.

Chapter 3

Game Design Concept

3.1 Introduction

This project was made possible with the help of several mental health professionals. In order to accurately define what could and could not be translated into gameplay, there was a need for a specialist's opinion. With that, the creation process of the therapeutic VR game for OCD can begin.
Section 3.2. reports the result of meetings with psychologists with the objective of identifying compulsions that can be translated into a game. In section 3.3. the game concept is explained, describing the details, specifications and general idea of focus. Section 3.4. describes the creation of the game world's different nuances according to the therapeutic actions selected. Section 3.5. goes into detail about the puzzles the player has to solve during the game, and where are the hints to help the player reach a correct solution. In section 3.6. the challenges and impediments to the development of the concepts defined in this chapter, brought by the global pandemic, are detailed.

3.2 Pathology-to-Game Discussion

During the first stages of the project, meetings were held with different psychologists to understand more about the sub-types of OCD and strategise how they would be adapted into a video game:

- **Order and Symmetry:** Symmetry, ordering and exactness;

- **Cleaning and Contamination:** Excessive cleaning or washing;
- **Doubt and Verification:** Checking and rechecking;
- **Taboo:** Forbidden thoughts.

The sub-type immediately discarded was *Taboo*. It was very specific and hard to generalize in a single action or with a single type of gameplay. With that in mind a lot of different tasks were pondered on for the other sub-type, the most common ones always involving the person's home. These can be seen on table 3.1.

Bathroom	**Kitchen**
Shampoo (Order)	Cutlery (Order)
Shower (Cleaning or Doubt)	Plates (Cleaning)
Towel Closet (Order)	Cooking Ingredients (Order)
Bidet (Cleaning)	Bidet (Cleaning)
Faucet (Doubt)	Faucet (Doubt)
Lights (Doubt)	Lights (Doubt)
Floor (Cleaning)	Floor (Cleaning)
Living room	**Bedroom**
Chairs (Order)	Desk (Order)
Sofas (Order or Cleaning)	Computer (Doubt)
Dining Table (Cleaning)	Bed (Order or Cleaning)
Bookshelf (Order)	Wardrobe (Order)
Windows(Doubt)	Windows(Doubt)
Lights (Doubt)	Lights (Doubt)
Floor (Cleaning)	Floor (Cleaning)

Table 3.1: Possible gameplay actions in each room

3.3 Game Concept

Like previously mentioned in section 1.3, two students teamed up to create a concept for a VR video game for OCD patient rehabilitation. This game was titled VR-POC, in allusion to the Portuguese translation of OCD (Perturbação Obsessivo-Compulsiva), it was made with a VR headset and two controllers as the main interaction device, by

letting the patient interact with the digital world with a set of digital arms and eyes, one can achieve a much deeper level of immersion than with a normal keyboard or controller.

3.3.1 Game Description

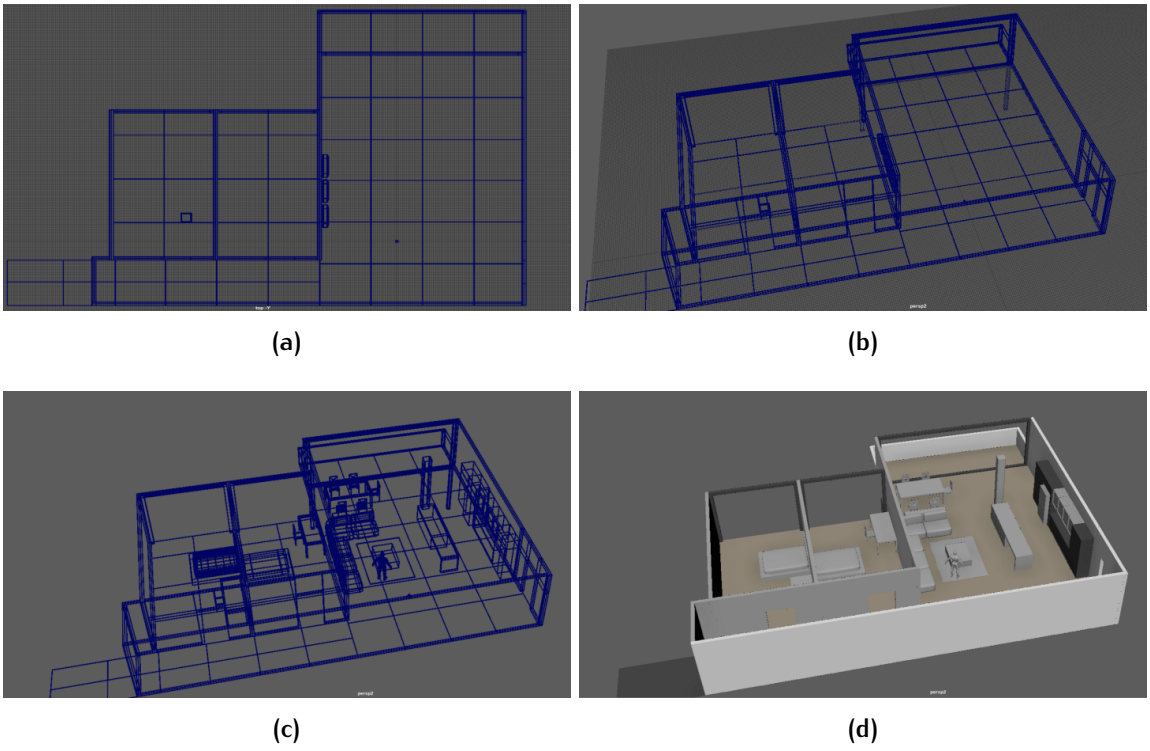
VR-POC is a first person, puzzle exploration game that makes use of the strengths of VR to aid in the rehabilitation of patients suffering from OCD. It allows the player to use VR controllers and interact with items in a cozy apartment to solve puzzles and de-ritualize compulsions.
In VR-POC, the patient takes the role of themselves, as they explore a house with multiple rooms, to solve various short and easy puzzles, where the real challenge is their own condition. The player spawns into the game in a nice three room house area, a warm and inviting living quarters that is easily recognizable as a safe environment. They are then met with a text prompt guiding them to the chalkboard, a sort of notice board that informs them of their current randomized objective after they interact with it. Following the board's instructions, the player solves various puzzles, where they must wander the house in search of items ranging from articles of clothing to drinking glasses, to ultimately arrange them in a non-conventional order. Alongside the objective information is a small timer to let the player know how long they've been inside the simulation.

3.3.2 Hardware Overview

The integration of VR is an essential element, as the player needs to feel as connected to the game world as they possibly can be. Making use of the Oculus Rift S's [4] headset, which boasts a very high refresh rate, to keep the player experience as smooth and seamless. VR-POC uses the VR controllers's unique controls to allow the player to interact with the environment in much a similar way as they would in real life, pinching and grabbing at objects within their reach. The VR headset and controllers will be presented in detail in chapter 4.

3.4 Game World Concept

Bearing in mind that this game was being made with the intent of appealing to both younger and older audiences, alongside the fact that this was a serious game with a primary focus on helping with patient therapy, a layout was made for an apartment in order to let the patients feel enter a safe, yet modern looking environment. Figure 3.1 shows the evolution of the apartment concept.



(a) (b)

(c) (d)

Figure 3.1: Evolution of the Game World Concept

After doing the ground work for the possible types of actions and having to prepare the game world for a different set of levels, each one representing a type of OCD, it was decided to make a compact design with small, easy to reach rooms, while making sure it wasn't too restrictive. In order to help the player not feel constricted, the kitchen and living room were fused into a larger room, giving the user more ample space to walk around.

3.5 Gameplay Concept

The first goal of the development team was to focus on the development of a level that suited the needs of a patient with OCD regarding *the Order and Symmetry* sub-type. Taking the actions mentioned above in table 3.1:

- Shampoo;
- Towel Closet;
- Cutlery;
- Cooking Ingredient;
- Chairs;
- Sofas;
- Bookshelf;
- Desk;
- Bed;
- Wardrobe.

The actions selected were "Cutlery"(Cups), "Wardrobe" and "Bookshelf". All these actions had a similar focus, to force the player to break what would be the aesthetically pleasing solution. Ordering and sorting in each of these situations would subject the player into performing a task that could trigger anxiety in order to progress in the game.

3.5.1 Wardrobe

The first task to be thought of was the wardrobe one. The initial plan was to create a musical instrument with the wardrobe, where different colored pieces would strum different notes. The goal of the player was to create a melody by placing colors that didn't match into randomly generated positions. This idea was later discarded so all the different places of the house had similar gameplay, which was done to familiarize

the patient with the controls and the flow of the game. The computer in front of the wardrobe contained the hint to help the player place the shirts, an example is shown on figure 3.2.

Figure 3.2: Example of a hint for the wardrobe challenge

3.5.2 Cups

For the cup task, a different order measuring tool was needed. In order to differentiate this task from the last, the cup sizes are the key to solving this puzzle. The cups are scattered throughout the house and the player must put them in the kitchen tray, but in the order that shows on the television screen, where each number represents the cup's size (1 being the smallest and 6 being the tallest), like what's seen on figure 3.3.

Figure 3.3: Example of a hint for the cup challenge

3.5.3 Bookshelf

The books were similar to the shirts, but instead of color order, it was made with color matching. Each shelf will have the color of the corresponding book that needs to go there, yet there will always be at least 2 shelves with books that don't match color wise, as seen on figure 3.4. This puzzle intends to trick the player into putting the books next to their respective colored books, instead of following the hint, which leads the player to look at the bookshelf color instead of the books themselves. This will create aesthetically displeasing images that might trigger anxiety in the patient.

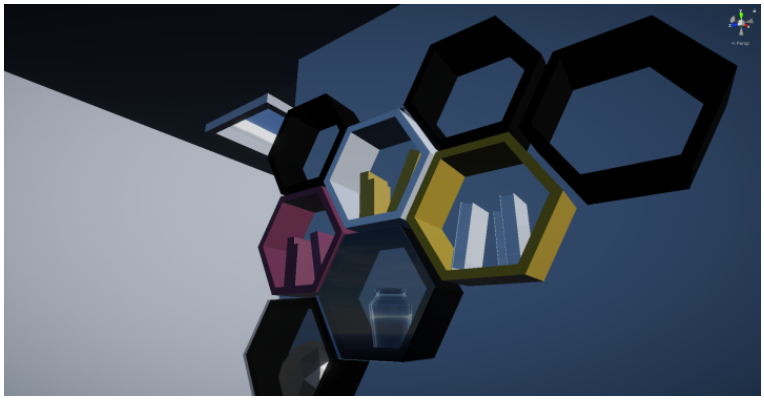


Figure 3.4: Example of a hint for the bookshelf challenge

3.6 Consequences of COVID-19

With the global changes brought by COVID-19, there were a lot of objectives and plans that had to change in order to accommodate for the new regulations and rules.

1. Be forced to work from home, having a negative impact on teamwork and work dynamic;
2. Change from three levels to one level with various tasks;
3. Change from in-person testing to medical professional survey.

At the beginning all usable sub-types were considered but as the game's development became more difficult due to the challenges brought by the global pandemic, it was decided that it would be best to focus on a single type of OCD. *Order and symmetry* is a disorder with compulsions that can be characterized as mostly involving

organization, placement and sorting, something that can be easily translated into a video game format, so it was chosen as the sub-type to focus on.
It was impossible to conduct in-person tests, which was the main reason why there needed to be three levels, so there could be a section for each usable sub-type, helping with finding more possible test subjects for the game. In the end, after the adaptation and focus shift to a single sub-type, the prototype was able to progress faster and with better quality.

3.7 Conclusions

This chapter exposed the thought process behind the making of the prototype, explaining what was thought of and for what purpose. After exposing the conceptualization and description of the main game, it went into detail about the impact of the global pandemic on the project. Focus had to shift and a lot of work ended up being discarded for the final version, to fit the new conceptualized version of a testable prototype.

Chapter 4

Prototype Development

4.1 Introduction

Through the development of this project, adaptation was necessary at every step due to unforeseen circumstances like the global pandemic, this chapter will detail what was settled on and developed. Section 4.2. explains the more important development tools necessary for this project, justifying some of the choices made when selecting them. In section 4.3. a more in depth look into the game world can be found, showing the items present in each room. Section 4.4. details the controls of the game on the VR equipment. The interactions between the player and the world are described in section 4.5. Lastly, section 4.6. goes through the game's progress route, explaining what happens to the player and the game world.

4.2 Development Tools

This section details the development tools and programs that have been used in the making of this project, justifying the choices made when picking them.

4.2.1 Oculus Rift S

The VR equipment selected for this work was the Oculus Rift S. It comes with a headset and two wireless controllers, as can be seen on figure 4.1.

Figure 4.1: Oculus Rift S headset and controllers, taken from [4]

The Oculus Rift S was chosen due to the camera tracking on the headset, unlike most devices that need extra cameras to setup. Not every consultation office is the same, which means the proper space for a VR experience might not be possible every time. By selecting a device with motion tracking without needing more equipment, it's guaranteed to work on most offices, regardless of space. One Oculus Rift S comes with the headset, 2 ergonomic controllers, cables, video output adapters and batteries, in short it doesn't need any extra equipment besides the base computer in order to be used.

4.2.2 Unity Game Engine

Unity [8] is a game engine created by Unity Technologies. This engine allows the creation of video games for a wide variety of systems, in both 2D and 3D, in a more intuitive and simplified way. Some of its most prominent characteristics are:

- **Editor:** Unity's editor includes a multitude of user-friendly tools so both artists and programmers can get quick grasp of the basics and begin developing their games.

- **2D and 3D:** Supports development for many genres and in both dimensions.

- **Path-finding AI:** It includes a navigation system that creates Non-Playable Character (NPC). These move efficiently through the game world, using navigation

meshes created from the scene's geometry and they react to dynamic objects, altering their course in real time.

- **Physics Engine:** It supports both Box2D [9] and NVIDIA PhysX [10] for a realistic, high performance game.

- **Custom Add-on Tools:** Unity has a vast community that works on plugins to help with the creation process, User Interface (UI), modeling and scripting. Using both official and unofficial plugins, one can hasten the speed of their project and the quality of their final product.

4.2.3 Blender

Blender [11] is a 3D tool to create models and animations. It was used to model different household items that are present in the game world. Blender is released under the General Public License, giving the user free reign on what they want to do with the application and the models made in it. This made for a great tool to build the game's 3D models.

4.2.4 Google Forms

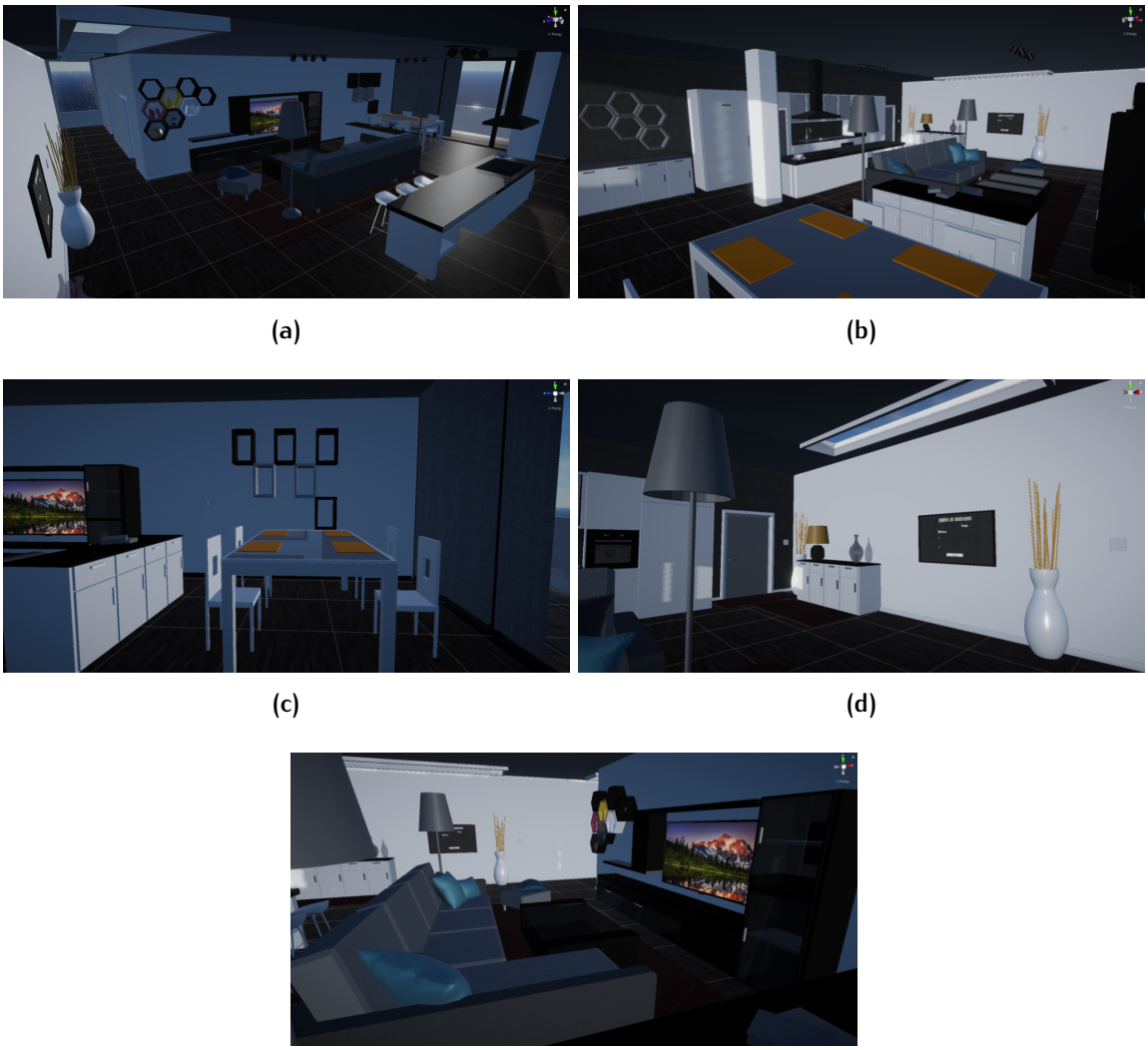
Google Forms [12] is a free tool to create forms and surveys. With it, it was possible to create a survey in order to properly get feedback on the prototype and draw conclusions from it. This tool also summarizes data, making the analysis faster.

4.3 Game World Development

As mentioned in section 3.4, the game world is an apartment with three rooms, a fusion between a kitchen and a living room, a bedroom and a bathroom. These had the purpose to transport the player into a cozy location, letting them feel safe and incentivize exploration in each room. Each room has a different set of interactive objects, depending on the level the player is currently in.

4.3.1 Living Room/Kitchen

The living room is the biggest of section of the game, fusing all aspects of a kitchen with a lounge(seen on figure 4.2 (a and b) and having a small dining section as well (seen on figure 4.2 (c)). Since the other two rooms were small, a bigger section of the house was needed in order to help the player not feel restricted or anxious. With the player's reaction to the world in mind, it was essential to have this room as the center of the game, which is why the chalkboard was placed here, as we can see in figure 4.2 (d). The lounge section of this room is home to the book puzzle, as referenced in section 3.5. The bookshelves that change color can be seen in figures 4.2 (a and e)



(a) (b)

(c) (d)

(e)

Figure 4.2: In-engine images of the living room

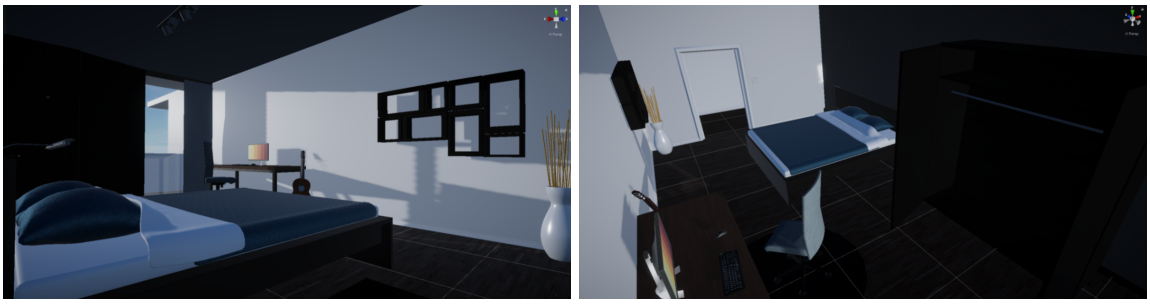
The kitchen section of this room had a lot of work put into the drawers, having to stabilize them and making every cabinet usable and making the faucet function based on lever intensity. These two features were cut from the main course of the game, however they can still be interacted with, as shown on figure 4.3 (a). This section of the room is where the tray for one of the puzzles is located. The kitchen island (seen on figure 4.3 (b)) acts as a base for the player to put down the cups while gathering them, and is placed in a way that gives clear view of the television (mentioned in section 3.5.2), when standing from the kitchen side, as can be seen on the previous figure 4.2 (a).

(a) (b)

Figure 4.3: In-engine images of the kitchen

4.3.2 Bedroom

When entering the room, the player is greeted with a simple, yet welcoming sight. A small room with a large bed, simplistic decoration, a desk, a guitar and a wardrobe (seen on figure 4.4 (a)). The wardrobe and computer are the focal pieces of one of the puzzles. The wardrobe is empty and standing right in front of the monitor in order to give the player ease of access to the hint (mentioned in section 3.5.1).

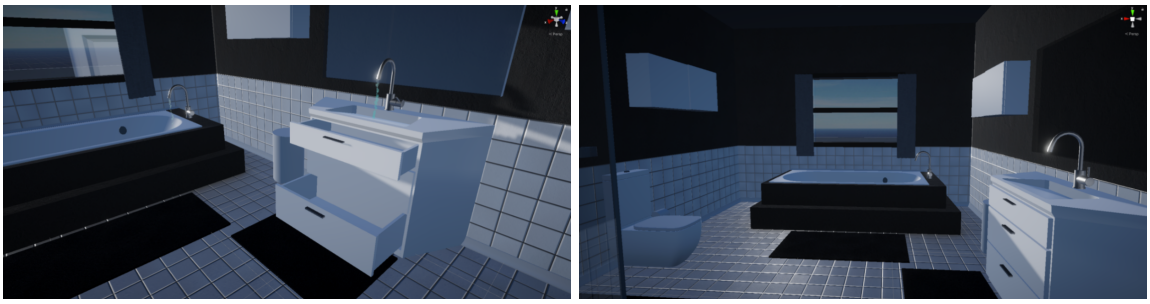


(a) (b)

Figure 4.4: In-engine images of the bedroom

4.3.3 Bathroom

The house wouldn't be complete without a bathroom. It's integration helps sell the idea that this is a realistic apartment. Although there are no puzzles related to this room, it still acts as a section of the home where the key objects can be scattered to and it still had some leftover interactive items (shown on figure 4.5 (a)). The bathtub, toilet and shower (seen on figure 4.5 (b)) were supposed to have contamination puzzles related to them but it was cut when switching the focus of the game.



(a) (b)

Figure 4.5: In-engine images of the bathroom

4.4 Game Controls

VR-POC is a video game made to be played solely in VR, so to engage with the world, the player needs to have a proper grip on the controller and understand the finger placement for the buttons required to play. The controller being shown on figure 4.6

is the left version of the pair that this game was tested on.

Figure 4.6: Image of the Oculus Rift S left Controller, taken from [5]

This device presents two normal buttons, a home button, an analog stick, a trigger in the front and a side button. The controller is ergonomic and the mapping of the buttons is mirrored on the second controller, so it fits nicely in the player's hand, leaving their fingers on the necessary buttons if held naturally. The mapping for VR-POC is:

- The left analog sticks control movement;
- The right analog sticks control rotation;
- Trigger in the front controls chalkboard interactions;
- Side button controls grab interactions.

Since this game is targeted towards a more general audience, it was decided that controls should be as close as possible to intuitive motions of the hand. Not everyone is used to holding a controller or remember to move analog sticks, so the ease on controls and basic gameplay try to give everyone a simple yet engaging way to interact with the world.

4.5 Game Interactions

When starting to create this project, one had to undergo the learning process on how to properly handle and implement VR headsets and controllers in a game development setting. In order to learn more, a lot of initial tests were made and various tutorials were used. After a proper grasp of the basics and a clear idea of what type of interaction would be beneficial to the game, the different points of interaction were created:

- Picking up and letting go of objects;
- A board to guide the player;
- A zone for important objects to snap into place;
- Opening doors and drawers;
- A working faucet.

Each one of these had a lot of thought and work put in, but only some of them were used later on for the puzzle creation.

4.5.1 Object Grab Interaction

The most important interaction in the game is the grab function. The VR headsets are always usually accompanied by controllers, making the hands the most important tool to work with when designing a game for this device.

Figure 4.7: Grabbing Objects

Players are allowed to grab certain objects, like the cup figure 4.7, if they reach or at a distance, being able to swap from hand to hand and walk around while holding them. These objects can be freely moved to any part of the house, depending on the player's inclination.

4.5.2 Guide Board

Normally, conventional video games have an easy way to portray objectives to the player. Through UI elements like maps, quests or any other text based methods. Some games have taken a different approach, to let the player explore and find the objectives on their own. Considering the nature of this game and the fact that every consultation is timed, the use of a chalk board was thought of as the way to communicate with the player.

With the objective of the game focusing on helping with the rehabilitation of the patient, it was imperative that the player was as immersed as they could possibly be. This would mean to lower the amount of information displayed to the player or alternatively to display the information in a way that would not break the immersion of reality. In this case, the UI had to be presented in a way where it wouldn't be connected to the player's sight to, as was previously mentioned, keep the player as immersed as they could be. This was achieved by displaying the information instead onto the chalk board present in the starting room. The only information directly fed onto the visor is the directions to the chalkboard, as seen on figure 4.8.

Figure 4.8: Gameplay image showing the first text in the player's field of vision

Figure 4.9 shows how the board looks after it's been interacted with. This can serve

as guidance, for the player to visit when they feel stuck, or when they want to know what is the next task they have to perform. Starting off with a small message in the middle of the screen when the player starts, that guides them to the board. After the player starts the game, a small timer begins counting their time, so they can have a reference of how long they've been in the simulated world. The board gives task after task, including a hint to help the player figure out how to beat the puzzle.

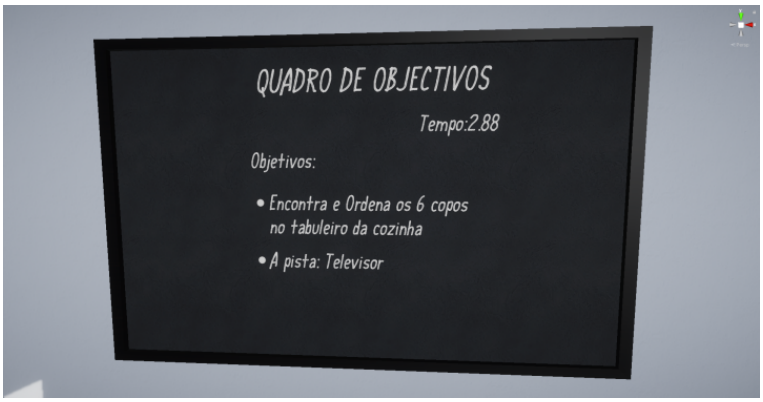


Figure 4.9: Chalkboard text to guide the player and timer

4.5.3 Object Snapping

In order for events to happen, they needs something to act as trigger. For that purpose, and also to help the player correctly set objects down in their designed place, points were created where the player could leave an object and it would snap into position.

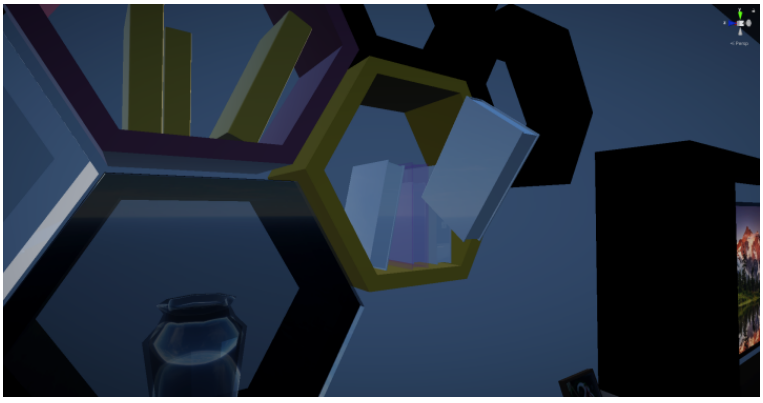


Figure 4.10: Book with snap zone outlined

These points, as showed on figure 4.10, make it possible to create puzzles, mixing

orders and sequences, compelling players to figure out the less aesthetically pleasing solution.

4.5.4 Doors and Drawers

Doors and drawers and some of the most common places in households. They can be found in various room in almost every house, since every room has at least a door. In the early stages of the project, the player had to open doors to move between rooms and some cups would be in drawers or cupboards, like the ones in figure 4.11, but the bigger doors kept making troublesome errors appear where the player could move them at a distance.

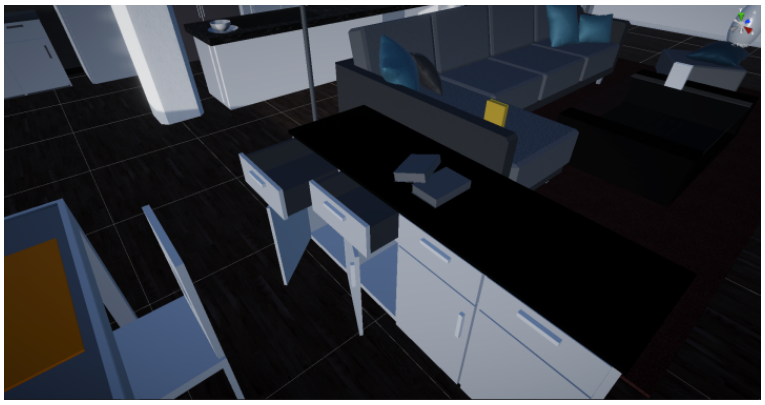


Figure 4.11: Open drawers in the dining area

The drawers didn't present a problem at first, however if the player wanted to break the immersion, they could easily start pulling on the drawer and move back, causing collision issues. This was fixed and the drawers were functional, however there were too many so they just adorn the background, they can still be interacted with.

4.5.5 Faucet and Water

While still trying to fit every OCD subtype in the game, a small water source was added to the game. The small faucet was present in both the kitchen and the bathroom, with a controllable pressure system that let out more water the lower the handle, as figure 4.12 shows.

Figure 4.12: Faucet with water effects coming out

The water was supposed to be a crucial element in the *Cleaning and Contamination* mini games, while also playing a part in the *Doubt and Verification* as well. While it ended up serving no gameplay purpose, it still contributes to make the environment more realistic to the player.

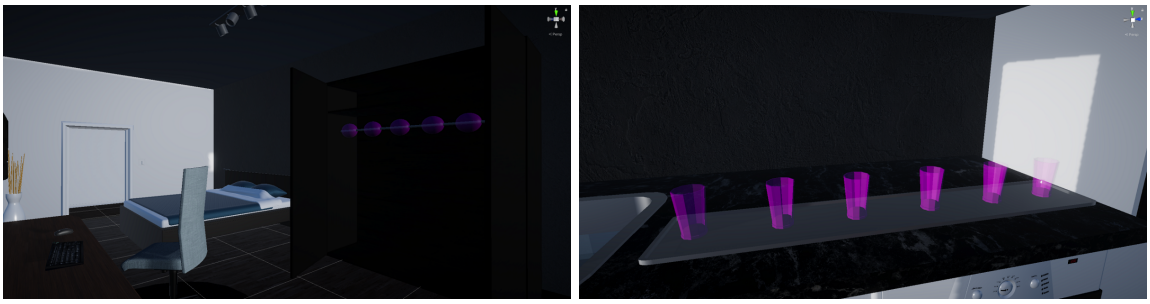
4.6 Game Logic

All the important scripts that made the game functional are available in Appendix A with a small description for each. This section will start by going into more detail about the game overview that was conceptualized in section 3.3. The game's progress route is:

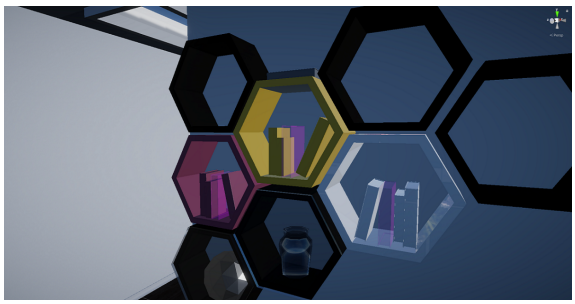
1. The player enters the virtual world and is greeted with a message telling them to find the chalkboard in the living room;
2. After finding the chalkboard and interacting with it, the timer begins counting up and the player is met with their first randomized task;
3. The game will pick the order of the 3 puzzles that will be presented, and gives directions to the player's first objective along with a hint;
4. The key objects in the game appear and are scattered throughout the apartment, with semi-randomized locations;
5. After the player completes a task, the world around him changes and text on the chalkboard will reflect the directions and hint of the new puzzle;

6. When all tasks are finished, the board will give the player the option to leave the game, stopping the timer and showing them how long they took to complete their tasks.

The puzzles presented in the game all involve snapping objects into a correct place. When an object intersects a possible zone where it's supposed to go on, the player can see a uniform pink outline, as shown in the figures 4.13 (a,b and c). All the objects are allowed to go on each zone, yet only the proper solution will let the player continue to progress. This solution will never be the properly ordered one, which is guaranteed by the scripts running in the background, because the main objective of the game is to de-ritualize these patterns.



(a) (b)



(c)

Figure 4.13: In-engine images of the snap zones turned on in each puzzle

Each one of the puzzles presented to the player has been randomized dynamically by the game. These puzzles are randomized in order, in object position and solution. Which means that the player must play a very huge amount of times to find the same sequences and solutions. This was made so the game can be utilized during more than just a single consultation, since the goal of this prototype was to serve as a tool for therapy sessions, not just a diagnosis or one time exposure experience.

4.7 Conclusions

With this chapter, concludes the explanation of VR-POC and the work that went into creating the prototype for it. The main aim of the development was to create a semi-realistic, yet simple game world. This world would house simple to understand gameplay with a focus on replayability, so that the patient could go through the compulsion triggering events again and again, with the help and supervision of the medical professional, so that they can begin the de-ritualization process.

Chapter 5

Tests and Results

5.1 Introduction

Due to the current global pandemic, it was impossible to test this prototype directly with patients. The original plan was to conduct tests during therapy, using a heart rate monitor to measure stress levels in patients, in order to figure out if the application was working as intended. With the constant challenges posed by confinement and necessary restrictions, a quality assurance survey was made. This survey and it's answers are included in Appendix B, as well as the graphs with the results. It was answered only by mental health specialists to obtain professional validation on the serious game prototype.
In section 5.2. each person that took part in the survey is separated into different groups, depending on their job, workplace and years of experience. Section 5.3. details their general knowledge of video games and VR. Finally, in section 5.4. the questions are related to the video of example gameplay, in order to try and get a measurement of success.

5.2 Medical Background

This section was filled with questions regarding the specialist's profession, place of work, years of experience and the most common sub-type present in their patients. Both parties that had experience and inexperience with the mental disorder were queried, that allowed for a broader look on how this specific therapy would be judged by

psychologists and psychiatrists overall.

5.2.1 Field of Expertise

Psychologist	Psychiatrist	Total
7	3	10

Table 5.1: What's your field of expertise?

Analyzing the answers to the first question, as seen on table 5.1, it can be seen that most of the participants were psychologists, with only a small part of the control group being psychiatrists. In order to be able to reach a good number of participants, it was decided to target both psychologists and psychiatrists. They were separated into groups to better analyze the data.

5.2.2 Workplace

Expertise	Hospital	Clinic	Private Consultation	University
Psychologists	1	3	1	2
Psychiatrists	3	0	0	0

Table 5.2: Where do you work?

The data on table 5.2 shows that the people who took part on this survey are from varied places of work, with only one of them being self employed. People working in different areas might have different degrees of acceptance to a new type of therapy. Considering the formalities of legalizing and getting licenses and equipment, it was pertinent to observe if that would impact the decision to try it in a real setting with patients.

5.2.3 Years of Experience

Expertise	1-5 years	5-10 years	+10 years
Psychologists	0	0	7
Psychiatrists	3	0	0

Table 5.3: How many years have you been working in your field?

In table 5.3, it's shown that the psychologists that answered have more experience working in the field with patients for a longer period of time, averaging around 10 years, which is more then the psychiatrists whom worked for 1 to 5 years. However, psychiatrists typically have an extended formal medical education for around 5 years, so whilst they may not have the practical experience the psychologists did, their input was still highly valued.

5.2.4 Frequent Patient Pathology

Expertise	Order	Cleaning	Doubt	None of the above
Psychologists	1	2	3	4
Psychiatrist	1	2	1	0

Table 5.4: Which pathology is more frequent in your patients?

This checkbox question, detailed in table 5.4, shows an elevated number of participants with no frequent sub-type. That can be explained by not all psychologists directly dealing with OCD patients. Their opinion on the game is still validated through their extensive knowledge on the human mind. Cleaning and Doubt both had 4 answers, while Order only had 2 which ended up being the least common sub-type, which came as a surprise, seeing that OCD is mostly known for being related to symmetry and organization. Cleaning is an easier sub-type to work with game wise, when compared to Doubt, so it can be seen as the next step to take in video game development for OCD therapy.

5.3 Video game and VR Headset Knowledge

These questions will help notate any correlation between level of understanding towards the concepts of video games, VR and their current experience with them. This sets an important flag for where their final and concurrent stances on the experience fall and the following data may intersect.

5.3.1 Devices Used

Devices	Psychologists	Psychiatrists
Playstation 4	0	0
Playstation 5	0	0
Xbox One	0	0
Xbox Series X	0	0
PC	2	3
Nintendo Switch	0	0
Android Phone	6	1
Apple Iphone	0	1

Table 5.5: Please check which devices you have used.

Table 5.5 shows the most common devices that medical professionals use, the only ones selected being mobile phones and computers. In order to make a video game to help medical professionals, the system selected must be one that's familiar and easy to grasp. So the creation of supervision through the computer part of the game will most likely be easy to adapt to.

5.3.2 Video game Familiarity and Exposure

Familiarity Level	Psychologists	Psychiatrists
5	0	0
4	1	0
3	3	2
2	2	1
1	1	0

Table 5.6: Are you familiar with video games? (1 being not familiar at all and 5 being extremely familiar)

Exposure Level	Psychologists	Psychiatrists
5	0	0
4	0	0
3	2	1
2	2	1
1	2	1
0	1	0

Table 5.7: How often have you had contact with video games? (0 being not at all and 5 being extremely often)

The selected group of participants seems to have a basic grasp of video games, as shown on table 5.6 and table 5.7, although with very little contact as the data portrays. With only 1 participant with above average knowledge and exposure, and most participants with barely any contact and familiarity with video games, this can mean a low level of acceptance towards video games as something else than just as an entertainment media.

5.3.3 Experience with Immersion in VR

Familiarity Level	Psychologists	Psychiatrists
5	0	0
4	3	0
3	2	2
2	2	0
1	0	1
0	0	0

Table 5.8: How familiar are you with the concept of Immersion and Virtual Reality? (0 being not familiar at all and 5 being extremely familiar)

Expertise	Has tried VR	Hasn't tried VR
Psychologists	1	6
Psychiatrists	2	1

Table 5.9: Have you had any hands-on experience with Virtual Reality?

Expertise	Can access VR	Can't access VR
Psychologists	2	5
Psychiatrists	0	3

Table 5.10: Do you own, or know anyone who owns a VR device?

In the topic of VR, data was gathered through three questions, in table 5.8, table 5.9 and table 5.10. These show a lack of access to a VR Headset and a lot of answers where the participant hasn't even tried it once, but the familiarity question had relatively positive results, with over seventy percent being confidently familiar with the concept of immersion in virtual reality. Nowadays, information is obtained at a much faster rate due to the facilitation of internet and everyone being globally connected. Even though a lot of the participants haven't tried a VR Headset by themselves, it seems to

not impair them from grasping it's concepts and being able to foresee the effects of it's immersion level.

5.4 VR Tool Gameplay Example and Feedback

In this area, a video sample[1] of gameplay is provided, the specialist is asked to view it and then answer the questions pertaining the quality of the prototype as a therapeutic tool. The video only shows the gameplay that can be seen in the computer screen, it does not show the previous setup needed to get the headset and controllers working, as that is a one time thing that shouldn't bother the user after the first time they use the headset, even without playing the game.

5.4.1 OCD Therapy Methodology

Expertise	Provoking the patient	Soothing the patient
Psychologists	6	1
Psychiatrists	2	1

Table 5.11: Do you think that a video game built to help OCD should be:

In this question, the table 5.11 shows that eighty percent of the participants, across both fields of expertise, believe that a game made for OCD patients should be provoking the patient's thoughts. The data gathered in this question coincides with the meetings had with the various medical professionals, mentioned in section 3.1 of chapter 3. The overwhelming majority agrees that in order to treat the patient, one must expose them and provoke the compulsions so they can be analyzed and dissimulated.

[1] Video sample available: http://y2u.be/L3pNDLfbbV8

5.4.2 Game World and Gameplay Feedback

Game World Quality	Psychologists	Psychiatrists
10	0	0
9	1	0
8	3	1
7	2	1
6	0	0
5	0	1
4	0	0
3	0	0
2	1	0
1	0	0
0	0	0

Table 5.12: Where would you classify the game world shown in the video? (0 being not adequate to the experience and 10 being very adequate)

Gameplay Quality	Psychologists	Psychiatrists
10	0	0
9	1	1
8	1	1
7	2	0
6	2	0
5	0	1
4	0	0
3	0	0
2	1	0
1	0	0
0	0	0

Table 5.13: Where would you classify the gameplay shown in the video? (0 being not therapeutic at all and 10 being very therapeutic)

This question tackles the therapeutic potential of the video of gameplay. The table 5.12 and the table 5.13 reveal the participant's thoughts on both the game world and the gameplay shown. With eight answers above the average of, one average and one low. Overall, the data collected here shows a positive majority that believes the game has therapeutic potential. The lowest grade given to the project was from a participant who had marked that serious video games for OCD should soothe the patient instead of the agreed upon methodology for the creation of this prototype.

5.4.3 Interest on the Project

Expertise	Wants to try	Doesn't want to try
Psychologists	2	0
Psychiatrists	3	0

Table 5.14: Would you be interested to try a game like this out with patients as a possible therapy method? (This question is only for those who work with OCD patients, feel free to skip if that doesn't apply to you)

The penultimate inquiry regards hypothetical future tests, in a post pandemic world. This section of the survey had less responses due to only being targeted to those that work with OCD patients. This question had an unanimous positive response as we can see in table 5.14, regardless of their score before, even the more neutral and negative ones showed interest to trying this type of treatment. Coming from the entertainment industry, video games have a natural ability to capture the attention of the users, this type of appeal can be use to motivate patients to frequent therapy more often and not lose hope on rehabilitation.

5.4.4 Thoughts and Suggestions

The last question was open-ended, asking for suggestions and other activities that could be added to the game. This question had very few answers.

- One asking for continued development of the game, focusing on the other subtypes in order to create a tool that covered most common possibilities for therapists;

- One commenting on the randomness of the shirts, wanting more colors and different pieces of clothing;
- One agreeing that the game can invoke the anxiety in OCD patients, letting the therapists then work on it during consultation, adding that it is a tool for early consultations, but can be developed into a work tool.

5.5 Conclusions

After reviewing all answers to the survey, there was an overall positive response to the gameplay shown and the idea of a video game that works as a tool to help the medical professional during the consultation. It served as the best way to get validation for this project, and helped motivate future work that can be done to better the quality of this new type of therapy tool.

Chapter 6

Conclusions and Future Work

This chapter will present the conclusions taken from this project in section 6.1. To finish off this project, in section 6.2, there is a list of future work activities that focus on the bettering the quality of the project.

6.1 Conclusions

This project had a normal start, however halfway through it was hit with the catastrophe that is the global pandemic. One of the main objectives of this project was to collect vital sign data of patients that were using the prototype and compare it with normal patients, in order to conclude if the prototype was better at triggering those feeling that the medical professional helps the patient with.
After the global pandemic struck, these tests became impossible. The VR headset and controllers involve heavy physical contact, putting patients at risk and turning the headset into a possible infection device. In good faith, the project kept being developed, yet it quickly became easy to see that the state of the world at that time wasn't going to change. The measures to deal with it had a heavy toll on all Humanity, confining tons of people in their homes.
With the sea of restrictions and impediments, a new approach was thought of. The best way to get confirmation on the therapeutic potential of the game was to try and get feedback from mental health professionals, this had to be done in a way that didn't break confinement and complied with regulations. So with all of this in mind, the survey was created in order to see what a person with experience would think and if

they would be willing to try this type of therapy with their own patients. Overall the response was positive, with every professional showing interest in trying this prototype for their sessions.
It can be concluded that the project, even if it had deviated from the original objective, showed promise and potential. The initial objectives were impossible to complete, but the new objective of getting feedback turned out positive, showing that there is potential in the area of VR for mental health treatments in OCD.

6.2 Future Work

After reading the survey responses and deliberating on what could be done to improve the project, the following plans were decided upon:

- As soon as it's allowed and safe, proceed with live presentations to professionals and testing on real patients;
- Continue the development of the game, including the two different sub-type that had been cut;
- Create new puzzles;
- Add a body and shadow for the player character;
- Add item moving animations;
- Improve the overall performance of the game.

The future goal of this project is to fully develop the conceptualized game and make it available to mental health professionals, to justify and incentivize the use of video games in other areas as more than just entertainment.

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Appendix A

Scripts

This appendix presents each script that helps the game function, with a brief introduction and explanation of what each one does. The scripts are in alphabetical order.

A.1 Board Script

This script controls the timer on the chalkboard, being turned on and off by the Game Controller, shown in section A3.

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using TMPro;

public class BoardController : MonoBehaviour
{
    public TextMeshProUGUI textTimerUI;
    public float timeT;
    private bool stop = false;
    public void Starttime()
    {
        stop = true;
    }

    public void Stoptime()
```

```
    {
        stop = false;
    }

    // Update is called once per frame
    void Update()
    {
        if (stop)
        {
            timeT += Time.deltaTime;
            timeT = Mathf.Round(timeT * 100f) / 100f;
            textTimerUI.SetText("" + timeT);
        }
    }
}
```

Listing A.1: BoardController.cs Script

A.2 Continuous Movement

This script controls the player's movement, taking the input from the analog sticks and turning it into a vector for the player character to move. It also controls the camera following the players head and gives the player gravity.

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.XR;
using UnityEngine.XR.Interaction.Toolkit;

public class ContinuousMovement : MonoBehaviour
{
    public float speed = 1;
    public XRNode inputSource;
    public float gravity = -9.81f;
    public LayerMask groundLayer;
    public float additionalHeight = 0.2f;
```

```
private float fallingSpeed;
private XRRig rig;
private Vector2 inputAxis;
private CharacterController character;

void Start()
{
    character = GetComponent<CharacterController>();
    rig = GetComponent<XRRig>();
}

void Update()
{
    InputDevice device =
       InputDevices.GetDeviceAtXRNode(inputSource);
    device.TryGetFeatureValue(CommonUsages.primary2DAxis, out
       inputAxis);
}

private void FixedUpdate()
{
    CapsuleFollowHeadset();

    Quaternion headYaw = Quaternion.Euler(0,
       rig.cameraGameObject.transform.eulerAngles.y, 0);
    Vector3 direction = headYaw *  new Vector3(inputAxis.x,
       0, inputAxis.y);

    character.Move(direction * Time.fixedDeltaTime * speed);

    bool isGrounded = CheckIfGrounded();
    if (isGrounded)
        fallingSpeed = 0;
    else
        fallingSpeed += gravity * Time.fixedDeltaTime;
```

```
        character.Move(Vector3.up * fallingSpeed *
            Time.fixedDeltaTime);
    }

    void CapsuleFollowHeadset()
    {
        character.height = rig.cameraInRigSpaceHeight +
            additionalHeight;
        Vector3 capsuleCenter = transform.InverseTransformPoint(
        rig.cameraGameObject.transform.position);
        character.center = new Vector3(capsuleCenter.x,
            character.height/2 + character.skinWidth ,
            capsuleCenter.z);
    }

    bool CheckIfGrounded()
    {
        Vector3 rayStart =
            transform.TransformPoint(character.center);
        float rayLength = character.center.y + 0.01f;
        bool hasHit = Physics.SphereCast(rayStart,
            character.radius, Vector3.down, out RaycastHit
            hitInfo, rayLength, groundLayer);
        return hasHit;
    }
}
```

Listing A.2: ContinuousMovement.cs Script

A.3 Game Controller

This script controls the entire game, it randomizes the order of the puzzles, checks for completion, makes sure the order of the solutions is forcibly the order that trigger anxiety on a patient, changes which objects are active and sends instructions to a lot of other scripts.

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using TMPro;

public class GameController : MonoBehaviour
{
    private List<GameObject> CurrentList;
    public List<GameObject> CabideOrder;
    public List<GameObject> Cabide;
    public List<GameObject> CupOrder;
    public List<GameObject> Cup;
    public List<GameObject> BookOrder;
    public List<GameObject> Book;

    public GameObject StartButton;
    public GameObject ExitButton;
    public bool passed = false;
    public GameObject FindObjective;
    public GameObject HintObjective;
    public string minigame;
    private bool tried;
    private bool tried2 = false;
    private List<int> order = new List<int>();
    private List<int> gameorder = new List<int>();
    private bool no = true;
    private int count = 0;
    private bool check;
    private int temp;

    public void StartGame()
    {
        Turniton();
        StartButton.gameObject.SetActive(false);
        GetComponent<BoardController>().Starttime();
    }
```

```
public void ExitGame()
{
    Application.Quit();
}

public void CheckForCompletion(List<GameObject> target)
{
    bool completion = true;
    for (int i = 0; i < target.Count; i++)
    {
        if (target[i].GetComponent<SnapToLocation>().number
           != target[i].GetComponent<SnapToLocation>().
        CurrentSnap.GetComponent<SnapObject>().number)
        {
            completion = false;
            break;
        }
    }
    if (completion)
    {
        tried2 = true;
    }
}

public void CheckForAll(List<GameObject> target)
{
    check = true;
    foreach (GameObject g in target)
    {
        if (g.GetComponent<SnapToLocation>().Snapped == false)
        {
            check = false;
            tried = true;
            break;
        }
```

```
        }
        if (check && tried)
        {
            CheckForCompletion(target);
            tried = false;
        }
    }

    public void RandomizeOrder(List<GameObject> target)
    {
        order = new List<int>();
        for (int i = 0; i < target.Count; i++)
        {
            bool check2 = false;
            temp = Random.Range(1, target.Count + 1);
            if (order.Count != 0)
            {
                for (int j = 0; j < order.Count; j++)
                {
                    if (order[j] == temp)
                    {
                        check2 = true;
                        break;
                    }
                }
            }
            if (check2)
            {
                i--;
                continue;
            }
            else
            {
                order.Add(temp);
            }
        }
```

```
        Debug.Log("Count is:" + order.Count);
    }

    public void CheckOrder(List<GameObject> target)
    {
        no = true;
        while (no)
        {
            RandomizeOrder(target);
            if (order[0] == 1)
            {
                for (int i = 1; i < order.Count; i++)
                {
                    if (order[i] != i + 1)
                    {
                        no = false;
                        break;
                    }
                }
            }
            else if (order[0] == order.Count)
            {
                for (int i = 1; i < order.Count; i++)
                {
                    if (order[i] != order.Count - i)
                    {
                        no = false;
                        break;
                    }
                }
            }
            else
            {
                no = false;
                break;
            }
```

```
        }
        for (int o = 0; o < order.Count; o++)
        {
            /*Debug.Log(order[o]);*/
            target[o].GetComponent<SnapObject>().number =
               order[o];
        }
        passed = true;
    }

    public void Turniton()
    {
        passed = false;
        if (count < gameorder.Count)
            switch (gameorder[count])
            {
                case 1:
                    foreach (GameObject g in Cup)
                    {
                        g.SetActive(false);
                    }
                    foreach (GameObject g in CupOrder)
                    {
                        g.SetActive(false);
                    }
                    foreach (GameObject g in Book)
                    {
                        g.SetActive(false);
                    }
                    foreach (GameObject g in BookOrder)
                    {
                        g.SetActive(false);
                    }
                    foreach (GameObject g in Cabide)
                    {
                        g.SetActive(true);
```

```
        }
        foreach (GameObject g in CabideOrder)
        {
            g.SetActive(true);
        }
        CurrentList = CabideOrder;
            CheckOrder(Cabide);
        FindObjective.GetComponent<TextMeshProUGUI>().
        text = ("Encontra e Ordena as 6 camisas no
           guardaroupa");
        HintObjective.GetComponent<TextMeshProUGUI>()
        text = ("A pista: Computador");
        GetComponent<HintMaker>().CabideHint(order);
        break;
    case 2:
        foreach (GameObject g in Cabide)
        {
            g.SetActive(false);
        }
        foreach (GameObject g in CabideOrder)
        {
            g.SetActive(false);
        }
        foreach (GameObject g in Book)
        {
            g.SetActive(false);
        }
        foreach (GameObject g in BookOrder)
        {
            g.SetActive(false);
        }
        foreach (GameObject g in Cup)
        {
            g.SetActive(true);
        }
        foreach (GameObject g in CupOrder)
```

```
            {
                g.SetActive(true);
            }
            CurrentList = CupOrder;
            CheckOrder(Cup);
            GetComponent<HintMaker>().CupHint(Cup);
            FindObjective.GetComponent<TextMeshProUGUI>().
            text = ("Encontra e Ordena os 6 copos no
               tabuleiro da cozinha");
            HintObjective.GetComponent<TextMeshProUGUI>().
            text = ("A pista: Televisor");
            break;
        case 3:
            foreach (GameObject g in Cabide)
            {
                g.SetActive(false);
            }
            foreach (GameObject g in CabideOrder)
            {
                g.SetActive(false);
            }
            foreach (GameObject g in Cup)
            {
                g.SetActive(false);
            }
            foreach (GameObject g in CupOrder)
            {
                g.SetActive(false);
            }
            foreach (GameObject g in Book)
            {
                g.SetActive(true);
            }
            foreach (GameObject g in BookOrder)
            {
                g.SetActive(true);
```

```
                }
                CurrentList = BookOrder;
                CheckOrder(Book);
                GetComponent<HintMaker>().BookHint(order);
                FindObjective.GetComponent<TextMeshProUGUI>().
                text = ("Encontra e Ordena os 3 livros nas
                   estantes");
                HintObjective.GetComponent<TextMeshProUGUI>().
                text = ("A pista: cor das estantes");
                break;
            }
        else
        {
            GetComponent<BoardController>().Stoptime();
            ExitButton.gameObject.SetActive(true);
            CurrentList = null;
            FindObjective.GetComponent<TextMeshProUGUI>().
            text = ("Conseguiste completar os desafios");
            HintObjective.GetComponent<TextMeshProUGUI>().
            text = ("Ganhaste");
        }
        count++;
    }

    void Start()
    {
        gameorder.Add(0);
        gameorder.Add(0);
        gameorder.Add(0);
        for (int i = 0; i < 3; i++)
        {
            gameorder[i] = (Random.Range(1, 4));
            for (int j = 0; j < i; j++)
            {
                if (gameorder[j] == gameorder[i])
                {
```

```
                    i--;
                    break;
                }
            }
        }
        Debug.Log(gameorder[0]);
        Debug.Log(gameorder[1]);
        Debug.Log(gameorder[2]);
    }

    void Update()
    {
        if (CurrentList != null)
            CheckForAll(CurrentList);
        if (tried2)
        {
            Turniton();
            tried2 = false;
        }
    }
}
```

Listing A.3: GameController.cs Script

A.4 Hint Maker

This script is called by the Game Controller script (see A3) and is given instructions to change the different hint objects so they correspond with the correct sequences expected from the player. That is achieved by writing on the television and changing some object's materials to fit color patterns.

```
using System.Collections;
using System.Text;
using System.Collections.Generic;
using TMPro;
using UnityEngine;
```

```
public class HintMaker : MonoBehaviour
{
    public List<Renderer> Computer;

    public List<Material> PCMaterial;

    public List<Renderer> Shelf;

    public List<Material> ShelfMaterial;

    public GameObject Text;


    public void CabideHint(List<int> order)
    {
        for (int i = 0; i < Computer.Count; i++)
        {
            Computer[order[i] - 1].material = PCMaterial[i];
        }
    }

    public void CupHint(List<GameObject> order)
    {
        for (int i = 0; i < order.Count; i++)
        {
            for (int j = 0; j < order.Count; j++)
            {
                if ((i+1) ==
                   order[j].GetComponent<SnapObject>().number)
                {
                    Text.GetComponent<TextMeshProUGUI>().text +=
                       (j+1);
                    break;
                }
            }
```

```
        }
    }

    public void BookHint(List<int> target)
    {
        for (int i = 0; i < Shelf.Count; i++)
        {
            Shelf[target[i] - 1].material = ShelfMaterial[i];
        }
    }
}
```

Listing A.4: HintMaker.cs Script

A.5 Object Position Randomizer

This is another script called by the Game Controller script (see A3). It randomizes the position of the key objects in each puzzle, choosing between 2 positions separately for each object.

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class ObjectPositionRandomizer : MonoBehaviour
{
    public List<GameObject> Cabidelist;
    public List<GameObject> Copolist;
    public List<GameObject> Booklist;
    public List<Vector3> Cabidepos1;
    public List<Vector3> Cabidepos2;
    public List<Vector3> Copopos1;
    public List<Vector3> Copopos2;
    public List<Vector3> Bookpos1;
    public List<Vector3> Bookpos2;
    private int c=0;
    void Start()
```

```
{
    c = 0;
    foreach (GameObject cabide in Cabidelist)
    {
        switch (Random.Range(0, 2))
        {
            case 0:
                cabide.gameObject.transform.position =
                   Cabidepos1[c];
                break;
            case 1:
                cabide.gameObject.transform.position =
                   Cabidepos2[c];
                break;
        }
        c++;
    }
    c = 0;
    foreach (GameObject cabide in Copolist)
    {
        switch (Random.Range(0, 2))
        {
            case 0:
                cabide.gameObject.transform.position =
                   Copopos1[c];
                break;
            case 1:
                cabide.gameObject.transform.position =
                   Copopos2[c];
                break;
        }
        c++;
    }
    c = 0;
    foreach (GameObject cabide in Booklist)
    {
```

```
            switch (Random.Range(0, 2))
            {
                case 0:
                    cabide.gameObject.transform.position =
                       Bookpos1[c];
                    break;
                case 1:
                    cabide.gameObject.transform.position =
                       Bookpos2[c];
                    break;
            }
            c++;
        }
    }
}
```

Listing A.5: ObjectPositionRandomizer.cs Script

A.6 Position Handler

This is the script present in the drawers, it locks it in place from different axis in order to bypass Unity's collision system and keep the drawer from creating collision problems.

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class PositionHandler : MonoBehaviour
{
    public bool X;
    public bool Y;
    public bool Z;
    public float xMin;
    public float xMax;
    public float yMin;
    public float yMax;
```

```
public float zMin;
public float zMax;

void Update()
{
    if (X)
    {
        Vector3 pos = Vector3.zero;
        if (transform.position.x < xMin)
        {
            pos = transform.position;
            pos.x = xMin;
            transform.position = pos;
        }
        else if (transform.position.x > xMax)
        {
            pos = transform.position;
            pos.x = xMax;
            transform.position = pos;
        }
    }
    if (Y)
    {
        Vector3 pos = Vector3.zero;
        if (transform.position.y < yMin)
        {
            pos = transform.position;
            pos.y = yMin;
            transform.position = pos;
        }
        else if (transform.position.y > yMax)
        {
            pos = transform.position;
            pos.y = yMax;
            transform.position = pos;
        }
```

```
        }
        if (Z)
        {
            Vector3 pos = Vector3.zero;
            if (transform.position.z < zMin)
            {
                pos = transform.position;
                pos.z = zMin;
                transform.position = pos;
            }
            else if (transform.position.z > zMax)
            {
                pos = transform.position;
                pos.z = zMax;
                transform.position = pos;
            }
        }
    }
}
```

Listing A.6: PositionHandler.cs Script

A.7 Snap Object

This is a script that works in tandem with Snap To Location script (see A8), when it intersects a specially designated object it checks it's the snap zone list to see if it can attach to it and turn off it's own physics. This only happens if the object is let go of by the player. It is called by the Game Controller script when checking for puzzle completion.

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.XR;
using UnityEngine.XR.Interaction.Toolkit;
```

```
public class SnapObject : MonoBehaviour
{
    public Vector3 offset;
    public int offsetangle;
    public List<GameObject> SnapLocationList;
    public GameObject Object;
    public bool objectSnapped;
    public int number;
    public bool grabbed;
    public bool insideSnapZone;
    public GameObject CurrentObject;
    private void OnTriggerEnter(Collider other)
    {
        {
            foreach (GameObject o in SnapLocationList)
                if (other.gameObject.name == o.name)
                {
                    {
                        insideSnapZone = true;
                        CurrentObject = o;
                        break;
                    }
                }
        }
    }

    private void OnTriggerExit(Collider other)
    {
        if (CurrentObject != null)
            if (other.gameObject.name == CurrentObject.name)
            {
                insideSnapZone = false;
                CurrentObject = null;
            }
    }
    void Update()
```

```
    {
        if (this.GetComponent<XRGrabInteractable>().isSelected)
        {
            grabbed = true;
        }
        else
            grabbed = false;

        if (CurrentObject != null)
        {
            if (CurrentObject.GetComponent<SnapToLocation>().
            Snapped && this.name ==
            CurrentObject.GetComponent<SnapToLocation>().
            CurrentSnap.name)
            {
                objectSnapped = true;
            }
        }
        else
        {
            objectSnapped = false;
        }

        if (objectSnapped == true)
        {
            GetComponent<Rigidbody>().isKinematic = true;
        }

        if (objectSnapped == false)
        {
            GetComponent<Rigidbody>().isKinematic = false;
        }
    }
}
```

Listing A.7: SnapObject.cs Script

A.8 Snap To Location

This is a script that works in tandem with Snap Object script (see A7). When intersected by a key object, it checks to see if the object can snap to it and attaches the object to itself, locking and not letting other objects attach until it's free. It is called by the Game Controller script when checking for puzzle completion.

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.XR;
using UnityEngine.XR.Interaction.Toolkit;

public class SnapToLocation : MonoBehaviour
{
    public bool Ready;
    public bool Snapped;
    public int number;
    public bool Occupied;
    public List<GameObject> ObjectList;
    public GameObject SnapRotationReference;
    public GameObject CurrentSnap;

    private void OnTriggerEnter(Collider other)
    {
        if (!Occupied)
        {
            foreach (GameObject o in ObjectList)
                if (other.gameObject.name == o.name)
                {
                    CurrentSnap = o;
                    this.GetComponent<MeshRenderer>().enabled =
                       true;
                    Occupied = true;
                    break;
                }
        }
```

```
    }

    private void OnTriggerExit(Collider other)
    {
        if (CurrentSnap != null)
            if (other.gameObject.name == CurrentSnap.name)
            {
                CurrentSnap = null;
                this.GetComponent<MeshRenderer>().enabled = false;
                Occupied = false;
            }
    }

    private void SnapObject(GameObject o)
    {
        if (CurrentSnap != null)
        {
            if (o.GetComponent<SnapObject>().grabbed == false &&
               o.GetComponent<SnapObject>().insideSnapZone)
            {
                o.gameObject.transform.position =
                   transform.position +
                   o.GetComponent<SnapObject>().offset;
                o.gameObject.transform.rotation =
                   transform.rotation * Quaternion.AngleAxis(
                o.GetComponent<SnapObject>().offsetangle,
                   Vector3.up);
                Snapped = true;
                Occupied = true;
                this.GetComponent<MeshRenderer>().enabled = false;
            }
        }
        else
        {
            Snapped = false;
        }
```

```
    }

    void Update()
    {
        if (Occupied)
            SnapObject(CurrentSnap);
        else
            Snapped = false;
    }
}
```

Listing A.8: SnapToLocation.cs Script

A.9 Water Lever

This is the script present in each faucet, it turns the water particles on and off gradually, according to the lever's angle.

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class WaterLever : MonoBehaviour
{
    public ParticleSystem Water;

    void Update()
    {
        var Emission = Water.emission;
        if (gameObject.transform.eulerAngles.z < 10)
        {
            Emission.rateOverTime = 0.0f;
        }
        else
        {
            Emission.rateOverTime =
                (gameObject.transform.eulerAngles.z)/2;
```

```
            }
        }
}
```

Listing A.9: WaterLever.cs Script

Appendix B

Survey and Test Results

B.1 Prototype Quality Survey

This was the survey given to the 10 professionals, as described in chapter 5.

VR as a tool for OCD treatment feedback

Thank you for taking your time filling this survey.

We are Game Design and Development Master's students from the University of Beira Interior. For our Project Report, we're currently developing a VR platform to be used as tool for OCD (Specifically the Order and Symmetry subtype) therapy sessions.

The objective of this VR platform is to, through the process of gamification, attempt to engage in the de-ritualization of the OCD patient through puzzles, inserted in a familiar environment, created considering the struggles and challenges of OCD patients. The purpose of this survey is to identify the positive and negative contributions of this platform towards helping OCD therapy sessions in tangent with a medical professional.

Due to the unfortunate Covid-19 outbreak, our testing and feedback ability was limited to digital, rendering physical testing impossible. Attached is a sample of a gameplay demonstration to review before replying to this survey: http://y2u.be/L3pNDLfbbV8

* Required

1. Medical Background

What's your field of expertise? *

- ◯ Psychology
- ◯ Psychiatry
- ◯ Other:

Where do you work? *

- ☐ Hospital
- ☐ Clinic
- ☐ Private Consultation Office
- ☐ Other:

How many years have you been working in your field? *

- ◯ 1-5 years
- ◯ 5-10 years
- ◯ +10 years

Which pathology is more frequent in your patients? *

- ☐ Order and Symmetry
- ☐ Cleaning and Contamination
- ☐ Doubt and Verification
- ☐ None of the above

2. Videogame and VR Headset Knowledge

Please check which devices you have used. *

- ☐ Playstation 4
- ☐ Playstation 5
- ☐ Xbox One
- ☐ Xbox Series X
- ☐ PC
- ☐ Nintendo Switch
- ☐ Android Phone
- ☐ Apple Iphone

Are you familiar with videogames? (1 being not familiar at all and 5 being extremely familiar) *

1 2 3 4 5

How often have you had contact with videogames? (0 being not at all and 5 being extremely often) *

0 1 2 3 4 5

How familiar are you with the concept of Immersion and Virtual Reality? (0 being not familiar at all and 5 being extremely familiar) *

0 1 2 3 4 5

Have you had any hands-on experience with Virtual Reality? *

- Yes
- No

Do you own, or know anyone who owns a VR device? *

- Yes
- No

VR tool gameplay example and feedback

http://y2u.be/L3pNDLfbbV8 - This example shows the player finding and sorting items which will always be in an order that will provoke the pathology of Order and Symmetry. After watching this gameplay example, proceed to the next questions.

Do you think that a video game built to help OCD should be: *

- ◯ Soothing the patient
- ◯ Provoking the patient thoughts

Where would you classify the game world shown in the video? (0 being not adequate to the experience and 10 being very adequate) *

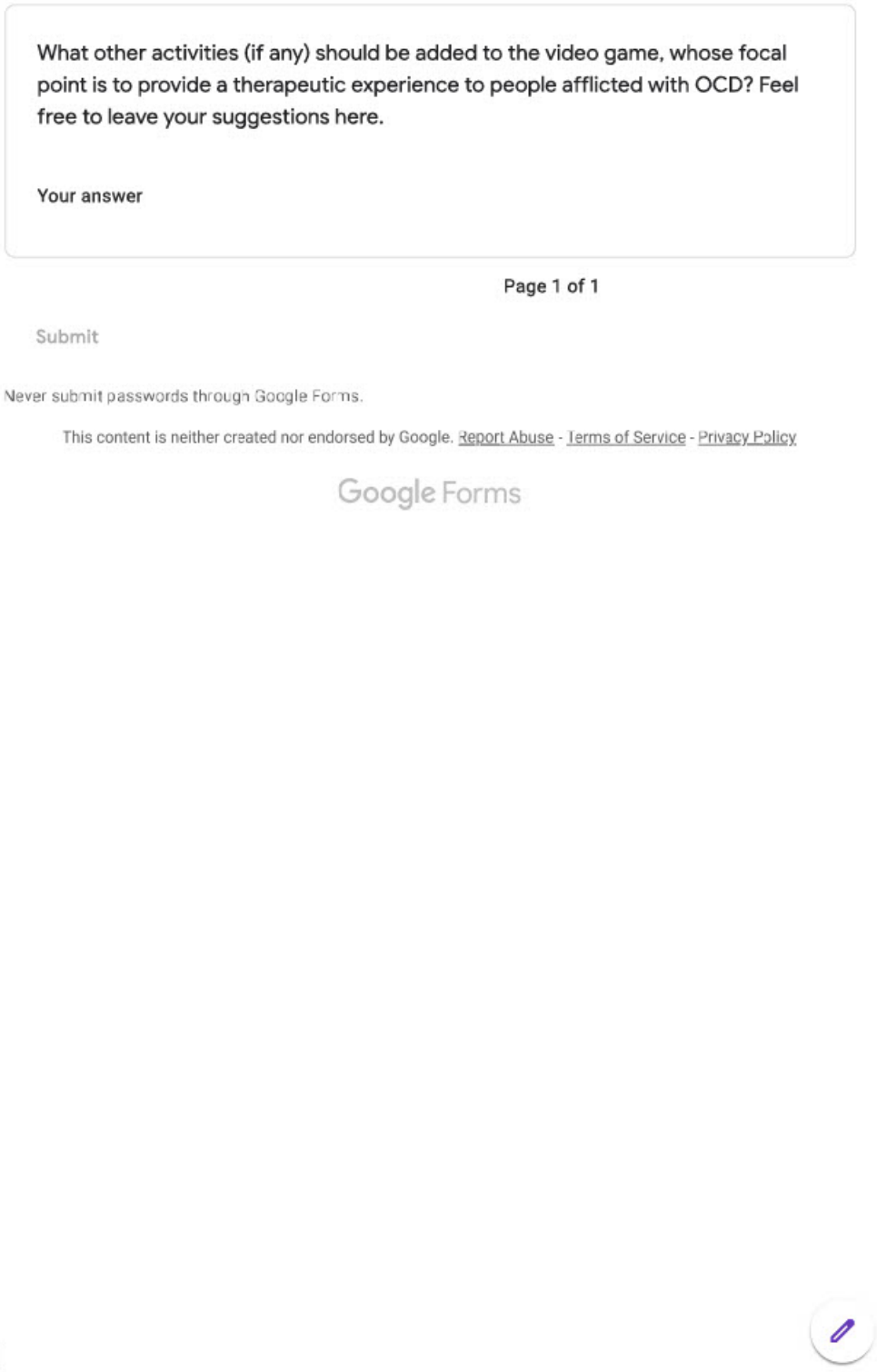
0	1	2	3	4	5	6	7	8	9	10
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

Where would you classify the gameplay shown in the video? (0 being not therapeutic at all and 10 being very therapeutic) *

0	1	2	3	4	5	6	7	8	9	10
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

Would you be interested to try a game like this out with patients as a possible therapy method? (This question is only for those who work with OCD patients, feel free to skip if that doesn't apply to you)

- ◯ Yes, I would.
- ◯ No I wouldn't.


What other activities (if any) should be added to the video game, whose focal point is to provide a therapeutic experience to people afflicted with OCD? Feel free to leave your suggestions here.
Your answer
Page 1 of 1
Submit
Never submit passwords through Google Forms.
This content is neither created nor endorsed by Google. Report Abuse - Terms of Service - Privacy Policy
Google Forms

B.2 Survey Results

These results were automatically generated by Google Forms [12] and made the data analysis faster.

VR as a tool for OCD treatment feedback

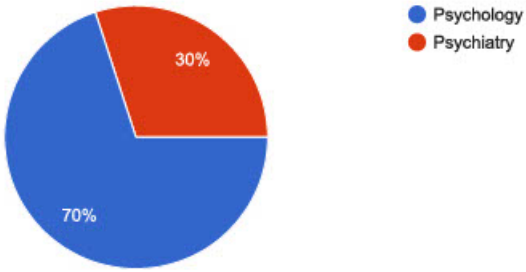
10 responses

Publish analytics

1. Medical Background

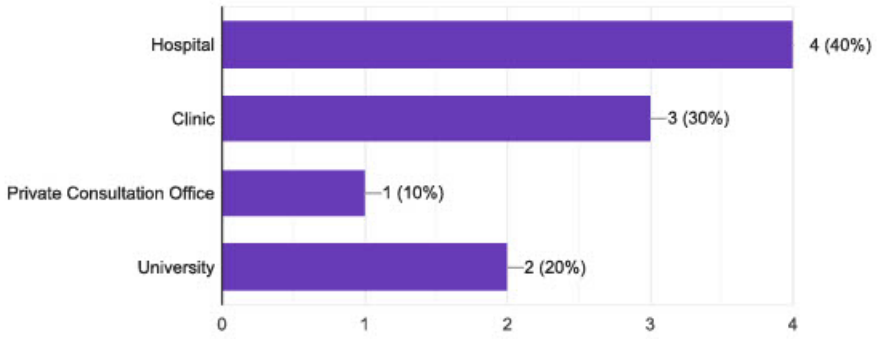
What's your field of expertise?

10 responses



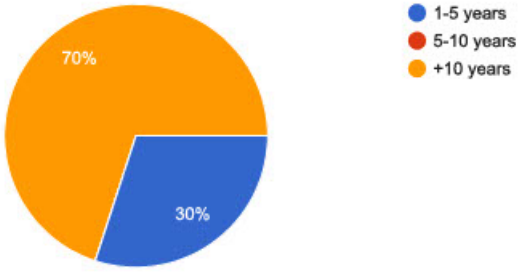
Where do you work?

10 responses



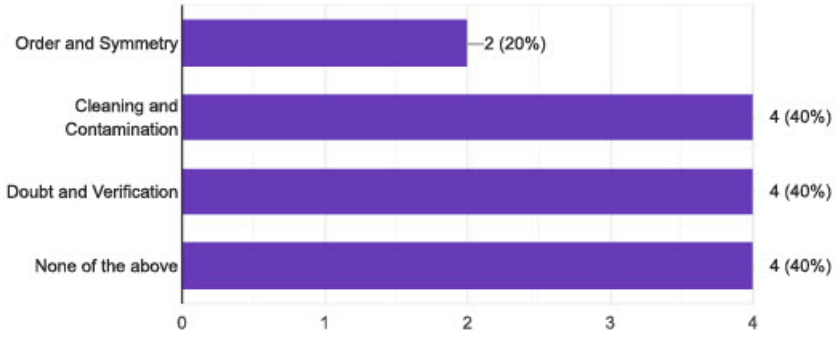
How many years have you been working in your field?

10 responses



Which pathology is more frequent in your patients?

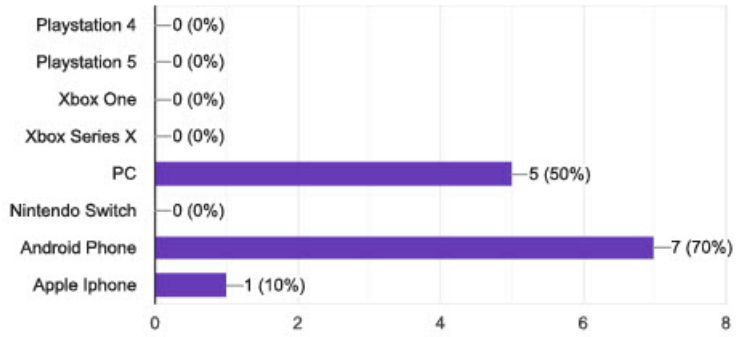
10 responses



2. Videogame and VR Headset Knowledge

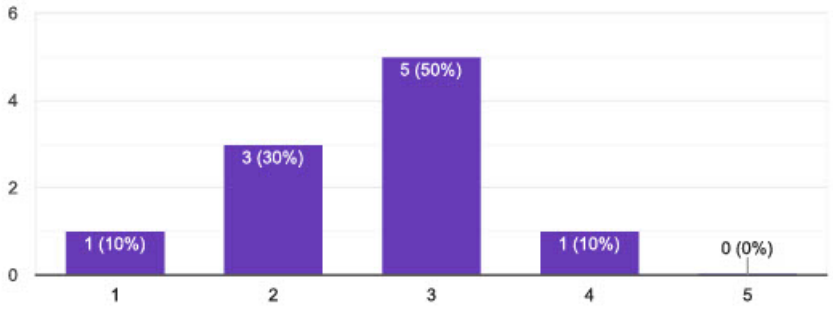
Please check which devices you have used.

10 responses



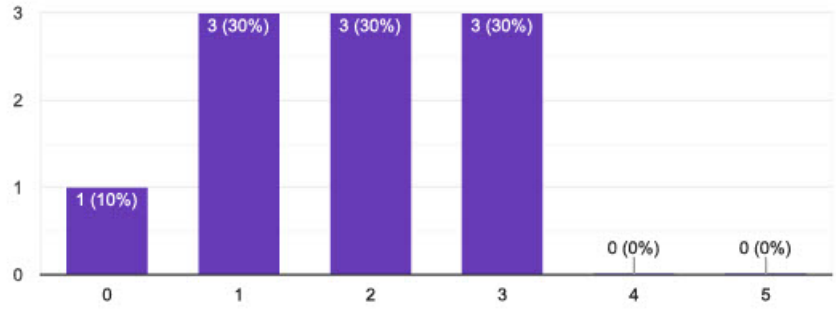
Are you familiar with videogames? (1 being not familiar at all and 5 being extremely familiar)

10 responses



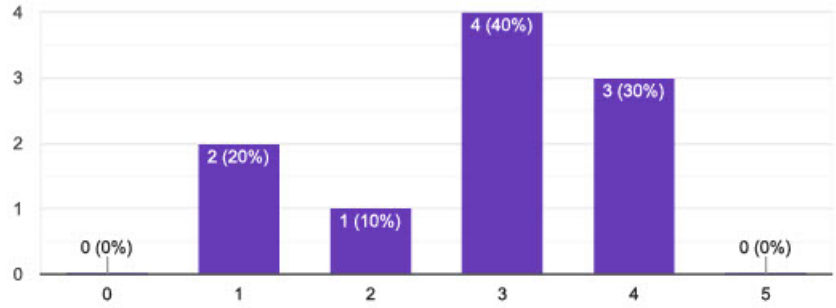
How often have you had contact with videogames? (0 being not at all and 5 being extremely often)

10 responses



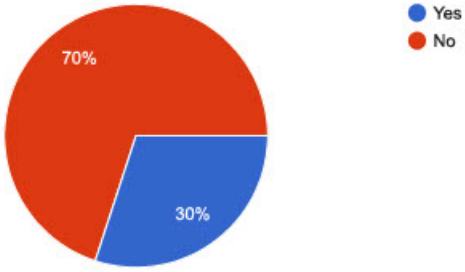
How familiar are you with the concept of Immersion and Virtual Reality? (0 being not familiar at all and 5 being extremely familiar)

10 responses



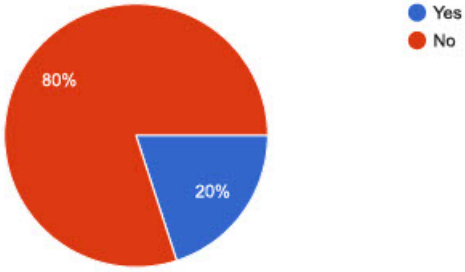
Have you had any hands-on experience with Virtual Reality?

10 responses



Do you own, or know anyone who owns a VR device?

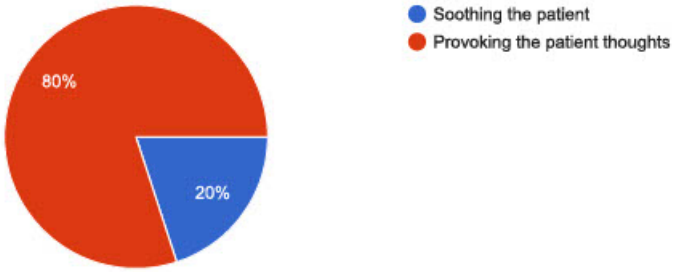
10 responses



VR tool gameplay example and feedback

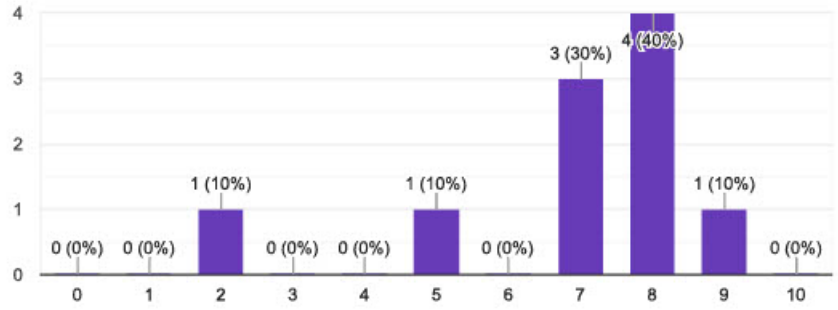
Do you think that a video game built to help OCD should be:

10 responses



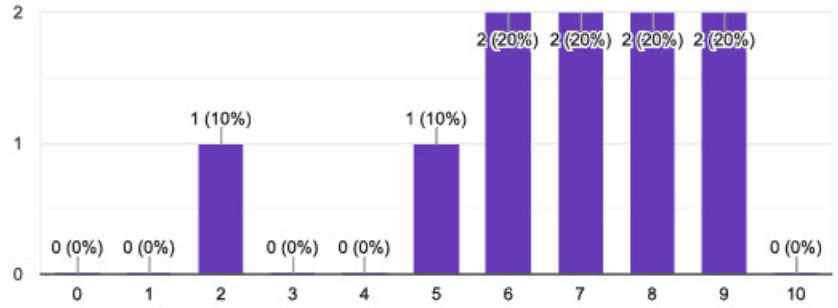
Where would you classify the game world shown in the video? (0 being not adequate to the experience and 10 being very adequate)

10 responses



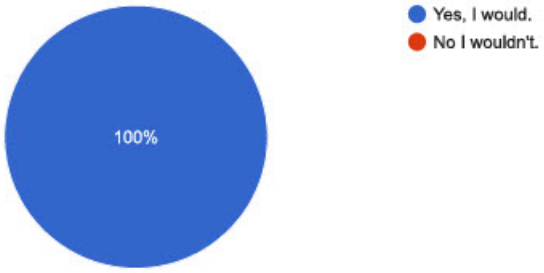
Where would you classify the gameplay shown in the video? (0 being not therapeutic at all and 10 being very therapeutic)

10 responses



Would you be interested to try a game like this out with patients as a possible therapy method? (This question is only for those who work with OCD patients, feel free to skip if that doesn't apply to you)

5 responses



What other activities (if any) should be added to the video game, whose focal point is to provide a therapeutic experience to people afflicted with OCD? Feel free to leave your suggestions here.

3 responses

Creio que o jogo tem potencialidades para o fim a que se destina, isto é, evocar ansiedade que será trabalhada pelo psicólogo em consulta. Creio que se destina sobretudo a uma fase inicial do tratamento de determinadobtipo de perturbações, mas pode servir como ferramenta de trabalho.

In second task (to organize the shirts), the order should be more random, that is, with more different colors, and could have different pieces of clothing.

In the future I sugest continuing to develop the game in sub types. As an example one directed for fear of contamination, other for anxiety around symetry and order, etc. Furthermore I believe this would be an excelente tool to introduce in my clinical practice. I work in an eating disorder unit with patients who also present diagnose of OCD. As per my experience most of the adolescents are very familiar and motivated to engage with computer games such as mine craft, etc. Using this tool could be an excelent asset to keep patients motivated within the therapeutic process.