Making a Game About Life with Dementia

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Abstract

People with conditions such as Alzheimer's disease or other variations of dementia can have considerable difficulty carrying out their lives in a normal manner and often find it difficult to remember events that happened recently or what they were doing only moments ago. After seeking more information about dementia from experts in the field, it became clear that there are misconceptions surrounding dementia from the public's view, and that such cognitive decline can often lead to frustration and even becoming annoyed with oneself, making anxiety or depression a prominent problem when caring for the people affected. The goal of this project was to make a game that shows some of the struggles that people with dementia have to go through, how the illness can progress over time, and addresses misconceptions about the illness. The data collected through online surveys and think-aloud sessions contributed to the quality of the game by providing feedback on bugs, how good of a teaching tool the game is and what could be added to further improve it.

Research Ethics Approval

This project obtained approval from the Informatics Research Ethics committee.
Ethics application number: 672243
Date when approval was obtained: 2023-10-27
The participants' information sheet and a consent form are in Appendix A.

Declaration

I declare that this thesis was composed by myself, that the work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted for any other degree or professional qualification except as specified.

(*Neilas Sabockis*)

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Tables of contents

Abstract i

Research Ethics Approval ii

Declaration ii

Acknowledgements iii

1 Introduction 1
- 1.1 Promoting dementia awareness through video games . . . 1
- 1.2 Research goals . . . 1
- 1.3 Structure of dissertation . . . 2

2 Background 3
- 2.1 Dementia and Alzheimer's Disease . . . 3
- 2.2 The value of serious games . . . 4
- 2.3 Teaching about disabilities using games . . . 5
  - 2.3.1 The Vale: Shadow of the Crown . . . 5
  - 2.3.2 Robin . . . 7
  - 2.3.3 Last Day of June . . . 7
- 2.4 Teaching about Alzheimer's using games . . . 9
  - 2.4.1 Inner ashes . . . 9

3 Initial steps before development 10
- 3.1 The general idea . . . 10
- 3.2 Requirements for Developing the Game . . . 10
- 3.3 Evaluation of Relevant Game Engines . . . 11
  - 3.3.1 Candidates . . . 11
  - 3.3.2 Selected Game Engine: Unreal Engine 5 . . . 11
  - 3.3.3 Rationale . . . 11

4 Design of Core Elements 13
- 4.1 Character Movement . . . 13
- 4.2 Game World Construction . . . 13
- 4.3 Main Menu Design . . . 14
- 4.4 Object Interaction and Animation . . . 14
- 4.5 Lighting Design . . . 14

4.6 Item Interaction . . . 14
4.7 Media Plates . . . 15
4.8 Environmental Triggers . . . 15
4.8.1 Pop-Up Text Guidance . . . 15
4.8.2 Voice-Overs . . . 15
4.9 A finished End-to-end System . . . 15

5 Expert Advice on Design Decisions 16
5.1 Considering Technological Evolution . . . 16
5.2 Cognitive Deterioration and Task Management . . . 16
5.3 Fatigue and Frustration meters . . . 17
5.4 Design Implications and Considerations . . . 17
5.5 Conclusion . . . 17

6 Final Development Phase 18
6.1 Finalised World Expansion . . . 18
6.1.1 Storage Space . . . 18
6.1.2 Bathroom . . . 18
6.1.3 Downstairs Kitchen . . . 18
6.1.4 Notes About the Environments . . . 19
6.2 Item Highlighting . . . 19
6.3 Rotation-based Character Detection . . . 19
6.4 Gramophone progression system . . . 19
6.5 Additional Voice Acting . . . 20
6.6 The Notepad . . . 20
6.7 More Carry-Enabled Items . . . 20
6.8 Items Vanishing . . . 20
6.9 Options Menu . . . 22
6.10 Storyline . . . 22
6.10.1 First stage . . . 22
6.10.2 Second stage . . . 22
6.10.3 Third stage . . . 23
6.10.4 Fourth stage . . . 23
6.11 Accessibility of the Game . . . 24
6.12 Summary of Development . . . 24

7 Game Evaluation 25
7.1 Overview . . . 25
7.2 User Survey . . . 25
7.2.1 Aims of Survey and Collected Data . . . 25
7.2.2 Analysis of the Collected Data . . . 26
7.3 Future Game Improvements in Response to Study . . . 28
7.4 Think-Aloud . . . 29
7.4.1 Setup of the Session . . . 29
7.5 Results . . . 29
7.6 Key Takeaways of the Session . . . 31

8 Conclusions **32**
8.1 Summary of the project 32
8.2 Potential future work 32
8.3 Skills and knowledge developed during the project 33
8.4 Reflections 33
8.5 Final thoughts 34

A Ethics information **38**
A.1 Participants' information sheet 39
A.2 Participants' consent form 42

Chapter 1

Introduction

1.1 Promoting dementia awareness through video games

Cognitive and memory function are core elements of daily living and personal identity, yet they are significantly impacted in individuals with dementia (Alzheimer's Association, 2024a). One of the problems that people affected by dementia experience is "sundowning", characterized by increased confusion and agitation during the late afternoon and evening (Alzheimer's Association, 2024b), among many others like degraded motor skills and, in extreme cases, forgetting who you are. To make the struggles of people with dementia be better recognised, they can be expressed through interactive experiences like virtual reality or ordinary computer games. Developing such a type of game provides an access point for a lot of people to more easily learn about a disability, while also making it easy to maintain constant engagement through curiosity.

This dissertation focuses on the development, design and evaluation of a video game with the goal of providing a tool for people to learn more about someone's life with dementia: the everyday struggles, progression of the illness and popular misconceptions about it. The medium of video games was chosen as gaming is an ever-growing economy and is bigger than movie and music industries combined, almost twice (AccessCreative, 2023). After consulting some specialists with knowledge about dementia, the necessary core features and objectives of the game became better-defined and more in-depth development of the game started. With the game complete, a user study was done to determine how well the game teaches a player about dementia and whether the user was having an overall satisfying experience with the game. The feedback collected provides insight into how the game could be improved and the steps that should be taken to further expand it.

1.2 Research goals

The aims of this research are to design, develop and evaluate a video game based on struggles tied to dementia. The main questions this research addresses are:

1. What is the best game engine that can be used to develop the game and what platform should be used for best accessibility?
2. What are viable ways to bring more awareness to mental illnesses like dementia and what they can do to a person through in-game mechanics?
3. Does the prototype version of the game achieve basic ability to teach a person something insightful about dementia?

1.3 Structure of dissertation

The rest of this report is structured as follows:

Chapter 2 provides insight on what a "serious" game is, why such games are relevant and valuable teaching tools, and various types of games that have been developed over the last decade, ranging form disabilities like blindness and chronic fatigue syndrome to Alzheimer's disease.

Chapter 3 discusses the general idea of the game in more depth, the requirements that need satisfying to develop the game, and what the best means of bringing the game to life are (what game engine should be used).

Chapter 4 discusses the thought-process behind the creation of the core game mechanics, their functional importance and integration withing the full game.

Chapter 5 explains the additions and adjustments to the game design that made after consulting dementia domain experts.

Chapter 6 provides an overview of the final phases of game development: assembling the mechanics like character voicing and game narration, item pickups, interactions and lighting, as well as finishing touches to the game world.

Chapter 7 explains how the game was evaluated: how and where the user study and think-aloud sessions were conducted, what type of information was collected from participants and how it was later used.

Chapter 8 provides conclusions on the research and also addresses what work could be done in the future

Chapter 2

Background

2.1 Dementia and Alzheimer's Disease

To develop a game focused around dementia it is important to first have a firm understanding of what dementia is and its impact on society. Dementia, in the most general terms, serves as a collective title for a decline in cognitive functions sufficient to interfere with daily life. Its most prevalent cause is Alzheimer's disease. While dementia broadly covers various syndromes associated with cognitive decline, Alzheimer's is specifically characterized by symptoms such as memory loss, difficulties with language, and impaired judgment. Alzheimer's accounts for 60 % to 80 % of dementia cases, taking up a significant part within the dementia spectrum (Alzheimer's Association, 2024b).

The epidemiological landscape of dementia and Alzheimer's reveals a concerning trend, with an estimated 50 million people worldwide living with dementia, a number projected to nearly triple by 2050 due to the aging global population (Alzheimer's Research UK, 2022). This shows the escalating public health challenge dementia and Alzheimer's pose, necessitating urgent attention and action to minimise the negative impact it can bring to society.

At the core of Alzheimer's disease lies a complex pathophysiological process, involving the accumulation of amyloid-beta plaques and tau protein tangles in the brain, leading to neuronal damage and loss. These changes disrupt neural networks, essential for cognitive functions, thereby contributing to the symptoms observed in Alzheimer's (National Institute of Aging, 2023). Understanding these mechanisms is crucial for developing targeted treatments and interventions for this disease.

Risk factors for Alzheimer's and dementia are multifaceted, but the most significant non-modifiable risk is age. However, emerging evidence suggests lifestyle factors such as physical activity, diet, and cognitive engagement may influence the risk of developing these conditions, offering potential ways to prevent and manage them (The Lancet, 2020).

The progression of Alzheimer's disease typically evolves from mild cognitive impairment, characterized by subtle changes in memory and thinking skills, to severe dementia, where individuals lose the ability to communicate and even respond to their environment.

This progression significantly impacts not only the affected individuals but also their families and caregivers, highlighting the importance of timely diagnosis and support (Alzheimer's Association, 2024b). However, it is also important to understand that the idea of dementia being a "living death" often reinforces the most negative stereotypes of this condition and that sometimes dementia charities seem to want to 'reinforce the stigma surrounding brain disease rather than concentrating on the good news like better services and support'(The Guardian, 2024), making the condition often look a lot worse than it is.

Diagnosing Alzheimer's and other dementias involves a comprehensive assessment, including medical history, neurological exams, and cognitive tests, complemented by advanced imaging techniques and biomarker analysis. Early and accurate diagnosis can enhance care planning and enable participation in clinical trials aiming to explore new treatments (Alzheimer's Association, 2024b).

2.2 The value of serious games

This section explains the idea on which this project is based — the multifaceted world of "serious" games (Laning, 2019), a genre of games that leans more towards serving educational, training, health, and social change objectives instead of providing traditional type of entertainment like most of the games nowadays. These games are becoming a valuable teaching tool in our modern, digitally-driven society, often leveraging interactive technologies to engage users in complex problem-solving, critical thinking, and experiential learning scenarios (Festing and Schumacher, 2021).

Serious games have a rich historical significance, tracing back as far as ancient civilizations where games were used for strategic training and educational purposes. For example, the game of chess, believed to have originated in India, was not only a pastime but was also viewed as a method to teach war strategy and foresight. This historical context highlights the long-standing recognition of games as powerful methods for learning and development.

In modern times, the significance of serious games has been magnified by various technological advancements, allowing for more immersive, realistic, and interactive experiences. They are used across various sectors including education, military, healthcare, and corporate training, often demonstrating versatility and effectiveness in enhancing learning outcomes (Warfighter Digital, 2023). For instance, in education, serious games can simulate complex real-world scenarios, providing a controlled environment for students to explore and learn from their decisions without real-world consequences.

Furthermore, serious games are praised for their ability to cater to diverse learning styles and needs. They incorporate elements of visual, auditory, and even kinesthetic learning, making education more inclusive and accessible (King, 2023). Their interactive nature also promotes engagement and motivation among learners, often a difficulty in traditional educational settings.

The application of serious games in healthcare, such as in rehabilitation or mental health interventions, showcases their therapeutic potential. By "gamifying" exercises

and treatments, patients are more likely to adhere to their therapy regimens, leading to improved outcomes (Team of Researchers, 2022).

In the realm of social change, serious games have been utilized to raise awareness on critical problems, foster empathy, and drive behavioral change. Games addressing topics like poverty, climate change, and social justice can influence players' perceptions and actions towards these problems and lead to a more mature and developed society (OpenCourseWare, 2013).

In short, the value of serious games lies in their unique ability to combine entertainment with practical, educational, and social objectives. As we advance further into the digital age, their role as a teaching tool and agent of change is expected to expand, highlighting their critical importance in shaping future generations and addressing global problems in a more interesting way.

2.3 Teaching about disabilities using games

Introducing the concept of disabilities through games offers an interesting method to foster understanding and empathy among learners. Games, by their interactive nature, can simulate experiences that might be difficult to convey through traditional educational means. They allow players to step into the shoes of individuals with disabilities, experiencing firsthand the difficulties and triumphs such individuals face daily. By engaging in these virtual experiences, people can develop a better comprehension of disabilities, in most cases enhancing their sensitivity and respect towards others who may appear, think, or act differently from themselves (Educators 4SC, 2024).

Moreover, well-designed serious games can ignite curiosity, offer meaningful choices, and present challenges that are both engaging and satisfying, thereby promoting deeper learning and understanding. These games are designed to go beyond mere entertainment; they become tools for exploration, experimentation, and making connections with real-world systems and problems. Through game-based learning, educators and caregivers can encourage reflection, discussion, and the development of important social-emotional skills, further enriching the educational experience (Boudreau, 2021).

In this section, we will explore various games designed with the purpose of teaching about disabilities, highlighting how these games achieve their educational goals and the impact they have on players' understanding and empathy towards individuals with disabilities.

2.3.1 The Vale: Shadow of the Crown

"The Vale: Shadow of the Crown" (Figure 2.1) is an innovative audio-based action RPG developed by Falling Squirrel (Falling Squirrel, 2021), which has gathered significant acclaim for its immersive experience for people with sight and accessibility for blind and visually impaired players. Released on August 19, 2021, the game is set in a medieval fantasy world and places players in the role of Alexandria, a blind princess who must navigate her way through a war-torn land using only audio cues and her combat training to survive and find her way home.

The gameplay is heavily reliant on specialized 3D audio to guide players through its environments, making sound staging and audio cues crucial for locating points of interest and engaging in combat. Players must listen carefully to the sounds of their enemies to parry attacks and counter with strategic moves. The game also incorporates RPG elements, allowing players to choose their equipment, play style, and magical abilities, making the overall experience more engaging.

This game has been praised for its emotionally engaging story and quality sound design, providing a fresh perspective on video game storytelling and gameplay. Its development involved consultations with the blind community and focus testing with the CNIB Foundation to ensure accessibility and an authentic experience (CBC Radio, 2023). The game's innovative approach to accessibility and storytelling has led to several award nominations and wins, including a nomination for Innovation in Accessibility at The Game Awards 2021 (Stewart, 2021) and winning Best Video Game Narrative at the 10th Canadian Screen Awards (Ahearn, 2022).

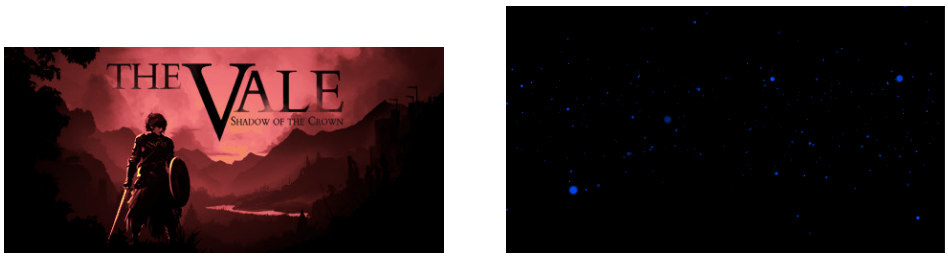

Figure 2.1 "The Vale: Shadow of the Crown" game banner (left) and what the gameplay typically looks like (right). It is mostly a black background and some colour bubbles floating around that represent a lack of vision.

Figure 2.2 A screenshot from the game "Robin".

Figure 2.3 June grieving for Carl at his gravestone.

2.3.2 Robin

"Robin" (Torre et al., 2018) (Figure 2.2) is a game designed to offer insight into living with Chronic Fatigue Syndrome (CFS), presenting players with a narrative that spans three days in the life of Robin who deals with this illness. The gameplay focuses on managing daily activities and energy levels, highlighting the difficulties faced by those with CFS, which is mainly not being able to do all of the tasks that you wish to do. Through its interactive experience, "Robin" aims to foster understanding and empathy for those living with invisible illnesses, showing the complex balance between activity and rest.

The game is based on "The Spoon Theory" metaphor written by Christine Miserandino (Miserandino, 2003). The story is a metaphor for the energy limitations faced by people with chronic illnesses, where daily tasks are equated to spoons, each representing a unit of energy. In her story, Miserandino explains that individuals with these conditions must carefully manage their "spoons" to avoid depleting their energy reserves, making everyday activities difficult and often causing the person to delay lots of their planned or unplanned activities that they were not able to complete due to a lack of energy and motivation.

2.3.3 Last Day of June

"Last Day of June"(Ovosonico, 2017) (Figure 2.3) is a deeply emotional and stylistically unique game that explores themes of love, loss, and the desire to change fate. The game tells the story of Carl and June, a couple deeply in love, whose lives are forever changed by a tragic car accident which happens on their way home from a date. This accident results in June's death and leaves Carl paralyzed from the waist down. The game delves into Carl's grief and his desperate attempts to alter the past to prevent

the tragedy, offering players a chance to experience the story from the perspectives of various characters in their small community.

As players navigate the game, they are faced with the task of modifying the outcomes of each of the four characters stories, in the hope of saving June. Despite Carl's greatest efforts to change the events leading up to the car accident, the game reveals that some events are inevitable, and despite all attempts to alter them, the outcome remains the same. Carl, however, discovers a sketchbook by June in one of his visions that depicts her attempts to save Carl from dying in the car accident, instead of the other way around. In a selfless act of love, Carl uses the notebook to go back in time and chooses to sacrifice his own life to save June and their unborn child by swapping places with her in the car during the final replay of the fateful day, leading to a bittersweet conclusion with June visiting Carl's grave.

The game's storytelling is enhanced by its distinctive art style, reminiscent of a watercolor painting, and the lack of traditional dialogue, relying instead on body language and emotional expressions to convey the narrative. The characters communicate through indecipherable sounds, requiring players to interpret their emotions and intentions through their actions and the game's visual cues, making this a really moving game. While the game focuses mostly on Carl's emotional distress after losing a loved one, in some moments it still shows how much a of a struggle living with a physical disability can be and how this struggle is worsened by psychological pain, making the overall situation for Carl much worse.

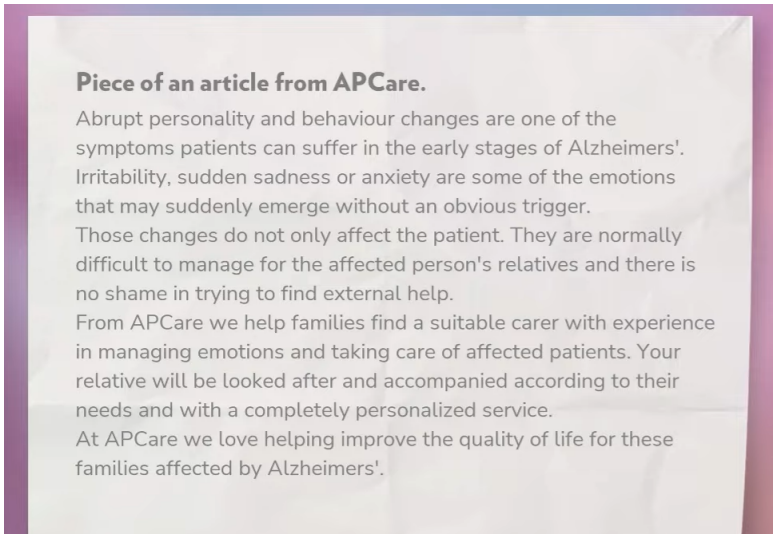

Figure 2.4 A note from "Inner Ashes" explaining Alzheimer's disease and hinting towards its relevance in the game.

2.4 Teaching about Alzheimer's using games

2.4.1 Inner ashes

"Inner Ashes" (Calathea Game Studio, 2023) (Figure 2.4) is a game that elevates the narrative adventure genre with its exploration of Alzheimer's disease through the eyes of Henry, a forest guard struggling with the condition's early onset. Although the game is not widely played, it is praised for its emotive storytelling and exceptional visuals, immersing players in a journey that delves into the complexities of memory and familial bonds.

Players engage with gameplay mechanics inspired by actual therapeutic methods, such as tangram puzzles (Zhang et al., 2023), letters and the use of post-it notes, designed to offer insights into Henry's life and how his illness progressed over time. Henry is also sometimes tasked with finishing certain lists of objectives, often having trouble due to his condition. These various elements not only enhance the gameplay but also serve to deepen the player's connection to the narrative, helping them develop a better understanding of the struggles faced by those with Alzheimer's.

The heart of "Inner Ashes" lies in the intricate relationship between Henry and his daughter Enid. Their story, marked by love, loss, and the pursuit of reconciliation, becomes the main point driving the narrative forward, making each revelation that happens within the game feel emotionally impactful. This relationship shows the game's central themes of memory's power and the highly enduring nature of familial connections.

Players of the game praise "Inner Ashes" for its immersiveness and compelling voice acting, which accentuate the game's emotional depth. The narrative's pacing and the unique artistic direction contribute to an experience that evolves from a leisurely exploration into a narrative journey through Henry's mind. The game stands as a testament to the potential of video games as a medium for storytelling and empathy. Its nuanced portrayal of Alzheimer's, combined with engaging gameplay and a heartfelt narrative, makes it a great game for those seeking a meaningful and educational gaming experience.

Chapter 3

Initial steps before development

3.1 The general idea

Every game starts with an idea. It was already clear at the start of the project that the software would be a game about disability. However, it was unclear what disability it would be. Deciding whether to represent a physical or a mental disability was the first step. Since there are ample options in both categories, I choose mental disabilities out of pure curiosity regarding the human mind. Then I considered the different types of mental disabilities and found dementia to be the most fascinating after understanding how it can mentally hollow out a person like no other disease or illness. Attention-deficit hyperactivity disorder (ADHD) had also been a contender but I could not conceive how to display ADHD symptoms in a 3D game.

The game would be developed in 3D space instead of 2D. While a 2D game might have been easier to make, I felt this option would have hindered my ability to express certain ideas of dementia effectively, for example items out of your sight disappearing or reappearing, and thus diminish the immersion. After constructing a basic idea of the concepts for this game, it was necessary to further expand this idea by naming more specific attributes. For this a list of project requirements was made, Section 3.2.

3.2 Requirements for Developing the Game

This section outlines the essential requirements necessary for the successful development of the game project. Each requirement has been carefully considered to ensure a compelling gaming experience.

1. **3D Development Capability:** The game should be designed in a 3D environment, necessitating tools and expertise in 3D game development to create a dynamic and engaging world.
2. **Stereo Audio Support:** To enhance the immersive experience, the game should support stereo sound, providing the ability to enhance the gameplay with realistic directional audio effects and music.

3. **Color Support:** Modern visuals will be achieved through basic or superior color support, ensuring that the game is visually appealing and captures the vibrancy of its world.
4. **Advanced 3D Lighting:** Good quality 3D lighting is crucial for adding depth and realism to a game world, enhancing the visual experience for players.
5. **Robust Coding Infrastructure:** Extensive coding capabilities are required to avoid bottlenecks in development, ensuring smooth gameplay and functionality.
6. **Cross-Platform Compatibility:** The application will be designed to run on a variety of devices, including Windows and Mac computers, and potentially even consoles, to maximize accessibility.
7. **World-Building Tools:** Access to convenient and modern tools for world creation is helpful for designing intricate game environments efficiently and without compromising on detail or quality.
8. **3D Asset Availability:** A rich library of 3D assets is not vital for world-building but highly preferred, allowing for the creation of diverse and detailed environments that bring the game to life without needing to make every asset yourself.

3.3 Evaluation of Relevant Game Engines

Given the defined project requirements, the next step is identifying the most suitable development platform. This section presents an analysis of potential game engines and justifies the selection of the optimal engine for this project.

3.3.1 Candidates

The game engines considered for this project are:

1. Unity Game Engine
2. Unreal Engine 4 (UE4)
3. Unreal Engine 5 (UE5)

3.3.2 Selected Game Engine: Unreal Engine 5

3.3.3 Rationale

The decision to opt for Unreal Engine 5 over other candidates is based on several factors:

Technological Superiority: Unreal Engine 5 introduces significant advancements over its predecessor, Unreal Engine 4, particularly in rendering capabilities and coding power. UE5's integration of Nanite and Lumen technologies allows for cutting-edge realism in lighting and world rendering. While Unity provides comparable coding capabilities to UE5, it lacks these innovative rendering technologies.

Asset Support, Compatibility and User Interface: Although Unity possesses extensive asset support, UE5 offers a compelling advantage in terms of asset compatibility.

UE5 allows for the use of UE4 assets, thereby expanding the available resource pool without compromising on quality. Moreover, UE5 has a much cleaner and straightforward UI than UE4 and is much easier to get used to.

Future-Proofing and User Experience: UE5's design and technological framework make it a more future-proof choice than UE4, offering a more user-friendly and efficient development experience. Its advanced features and optimizations not only cater to current project needs but also accommodate future expansions and technological advancements.

Personal Development and Exploration: Choosing UE5 aligns with my desire for personal growth and exploration of new technological landscapes. Having prior experience with Unity, the exploration of UE5's capabilities, especially its Blueprint visual scripting system and latest light rendering technologies, presents an exciting and useful learning opportunity.

Graphical Excellence: When compared to the lighting and rendering systems of Unity, UE5's technological capabilities (Nanite and Lumen) are superior and align closely with the project's ambition to create a visually appealing game.

Conclusion: While Unity, UE4, and UE5 are all capable platforms, UE5 was chosen for its clear advantages in advanced rendering technologies, asset compatibility, and potential for creating a graphically impressive game within the project's scope and constraints. Were there a tie, my desire to learn a new game engine would have been the deciding factor.

Chapter 4

Design of Core Elements

This chapter outlines the early work, specifically the development flow on all of the core components in order to have a basic working end-to-end system. These components, how they were made, and their necessity for the game are described below.

4.1 Character Movement

A core aspect of the game is having a movable character, embodying a person with early-stage dementia. This character's movement is central to the gameplay and is implemented by gathering character rotations and vector inputs, the combination of which is then mapped to movements of the mouse and keyboard keys to ensure responsive and intuitive control. Special attention had to be given to the mouse movement integration, as any small mistake in the code would lead to the movement controls becoming chaotic (unexpectedly having the character move in a completely different direction after you move your mouse). Notably, actions such as jumping or crouching were deemed unnecessary for the game's context and thus omitted.

4.2 Game World Construction

The initial vision for the game world included both indoor and outdoor environments, with inspiration drawn from 1960s American residential architecture (The Click Americana Team, 2019) for the layout of the house. Due to time constraints, the focus was narrowed to the indoor spaces of the house. The development process involved creating a preliminary model of the entire house, followed by detailed development of key areas, particularly the "main room" where initial gameplay commences. This space was populated with free 3D assets to evoke a setting that is both a workspace and a relaxation area, complete with a desk, chair, books, a gramophone, a cozy seating area and more relevant props. Once this room was fully finished, I was able to realise how important it is to have a fleshed-out environment — it adds a lot to the game's immersion and makes it feel much more interesting.

4.3 Main Menu Design

The main menu integrates a cinematic shot of an outdoor area initially intended for the game, utilizing UE5's advanced cinematic tools. This shot forms the animated backdrop of the menu, which includes fundamental options such as "Play Game" and "Quit Game," increasing user interest in the game from the outset.

4.4 Object Interaction and Animation

Interactivity within the game world is facilitated through programmable object animations, such as doors that the player can open and close. Moreover, sound cues play a critical role in enhancing realism, with distinct sounds for actions like door interactions. The technique for object interaction involves the use of "rays" emitted from the player's perspective. These rays have a predetermined amount of allowed distance such that, for example, you are unable to open a door from across the room. Then collision checks would take place: if the ray collided with some object in the world that had a collision box with certain parameters, the action programmed to that object would start taking place. This is what powered all of the interactions with objects in this game, and me now being able to use ray casting is valuable, as it is one of the few most common ways of facilitating interactions with objects in the environment.

4.5 Lighting Design

The aesthetic appeal of the game is significantly enhanced through extensive lighting design. A combination of global and directional lighting ensures well-lit environments and realistic shadow play. Additionally, light scattering techniques are employed for even illumination. For objects like light bulbs and chandeliers; point, cone and rectangular lighting was used to light up specific areas in the rooms in a realistic manner. In much later stages of development, when trying to get the existing lighting to look better for the game, I ran into some light rendering problems that were there for seemingly no good reason. I later found out that some important lighting options had different values in the project settings from what they were supposed to be for my specific hardware. This made it clear to me that it's really important to make sure all of your project settings are checked before any major development phases and are best suited for your system.

4.6 Item Interaction

An ability to pick up, carry and drop items was implemented. Only specific items can be picked up, and when done so, they float in front of the player until they come in contact with another specific object. This specific way of handling items was implemented because there are not many items in the game that you can carry, making an inventory system not that useful, and the item floating in front of the character felt like a good substitute because it always lets the player know that something is being carried ant that the item should be used somewhere. Once the item in hand is used, it is destroyed

to prevent stage skips or needless clutter and the player is able to progress in the story. Items are designed with enlarged hitboxes to facilitate easy interaction, contributing to a more user-friendly gaming experience.

4.7 Media Plates

A media plate was added and programmed, which is a type of object that can display video when placed in the world. This object was put on top of a TV screen to imitate a TV playing whenever a certain sequence of events would happen in the game. While this served as an interesting idea for the game at the start, it was later removed due to the unreliability of the media plate displaying video and the lack of official and unofficial documentation on how to use this type of object correctly.

4.8 Environmental Triggers

Special objects had to be programmed in order to have certain events play out. These objects are invisible boxes, which do one of the following things after you walk into them:

4.8.1 Pop-Up Text Guidance

In-game guidance is provided through a system of pop-up text widgets, which serve to inform and direct the player's actions. These widgets are designed to appear on the screen at specific moments, offering information, such as movement instructions (for example, "Use WASD to move"). The design of these widgets includes an animation feature where the text fades in upon activation and fades out after a set duration, ensuring that the guidance is noticeable yet unobtrusive. A key aspect of this system is the implementation of safeguards to prevent an overload of simultaneous text pop-ups, which could overwhelm or confuse the player. This design ensures a smooth and informative gameplay experience, guiding the player without distracting them.

4.8.2 Voice-Overs

Narrative depth and player instruction are further enriched through the use of voice-overs. A narrator's voice is used at strategic points within the game to both instruct the player on gameplay mechanics and to impart thematic content, such as insights into dementia.

4.9 A finished End-to-end System

After putting all of the described systems together, a basic end-to-end system was achieved. This system was made so that I would able to test all of the implemented functionalities one after the other in succession and do tests until a point of failure was found. This bug-hunting approach helped with finding bugs between different interacting systems and proved itself really useful even in the future development phases.

Chapter 5

Expert Advice on Design Decisions

In the development of interactive experiences, particularly those that simulate real-world problems, expert advice plays a pivotal role in shaping design decisions that enhance the authenticity and engagement of the game. Drawing upon domain-expert insights, this chapter delves into the possibilities of integrating additional mechanics like technology adaptation and timed cognitive deterioration into gameplay, thereby offering a more immersive and accurate experience.

5.1 Considering Technological Evolution

One of the experts explained in detail that they often observe people with dementia having difficulties when encountering newer versions of gadgets that they are used to. This had the potential to provide a unique vantage point for the game's design. The concept revolves around the player engaging with familiar tasks within a nostalgic context, using an old-fashioned style of interaction, such as the simplicity of clicking items in a sequence to accomplish tasks like cooking on an old oven.

Transition to Modernity: The game then strategically disrupts this nostalgia by transitioning the player to a contemporary setting where the gadgets have evolved, but the player's character has deteriorated. This not only reflects the passage of time but also introduces complexity into the gameplay. Modern gadgets, with their intricate functionalities, demand more from the player than mere clicks. To mimic the confusion often felt when adapting to new technology, the game incorporates puzzles or obstacles.

5.2 Cognitive Deterioration and Task Management

Building on another expert's input regarding cognitive deterioration, the game design can incorporate mechanisms that reflect a decrease in the player's ability to manage complex tasks. This aspect of gameplay mirrors real-life experiences with cognitive difficulties, where tasks that once seemed straightforward become daunting.

Dynamic Task List: Initially, the game might present a comprehensive list or thought bubble of tasks, allowing the player to maintain a clear overview. However, as the

game progresses, this clarity diminishes. Tasks could become jumbled or only partially revealed, demanding a more granular approach to problem-solving.

Evolving Interaction Complexity: At the outset, completing a task such as making a cup of tea might be as simple as clicking on a kettle. Over time, the game increases in complexity, requiring the player to engage in each step of the process, from filling the kettle to waiting for it to boil, thereby simulating the increasing difficulty individuals face with cognitive deterioration.

5.3 Fatigue and Frustration meters

Another piece of advice provided by the experts and endorsed by my supervisor was the inclusion of some type of progress indicator. This idea could be expressed through the inclusion of fatigue or frustration meters. This meter would be part of the user's screen and would stay in one of the corners so as to not be too distracting. Such an addition could be valuable because it is able to represent how people with dementia become more and more frustrated with themselves as time goes on and as the illness progresses.

5.4 Design Implications and Considerations

Incorporating these elements into the game's design has potential to improve the player's experience and also educate them more, subtly conveying the realities of technological adaptation and cognitive decline. However, after the meeting with the experts, I was left with more ideas than I could possibly implement for this project. I had my own growing list of additional ideas and mechanics that I wanted to implement, in addition to advice and tips from my supervisor. The next best step was to fully develop the flow of the game in order to be able to assess which ideas should be implemented and which ones should be considered for potential future work.

5.5 Conclusion

Expert advice has been really helpful in shaping some of the design decisions that lend depth and authenticity to the game. By thoughtfully integrating the difficulties of adapting to new technology, the nuances of cognitive deterioration and a visual representation of frustration, the game could hold a lot more depth and meaning to it. With a long list of ideas to implement, it was time to choose which ones were the best for this project.

Chapter 6

Final Development Phase

This chapter discusses the last additions and modifications made to the game. Most ideas for the additions were thought of on my own, but some were also implemented after speaking with experts and considering their input. Below are the changes that were made to the game in the last development phase.

6.1 Finalised World Expansion

At the point in time after the interview, it was clear roughly how big the game could be when considering time constraints, and so it was expanded by adding 3 more areas:

6.1.1 Storage Space

This space is positioned right outside the main room. It is populated with a hung guitar, a shelf with items, and boxes containing random items to simulate a storage space. This space requires the player to repair a radio in order to progress further.

6.1.2 Bathroom

This space is unlocked after completing all of the relevant objectives from the storage space area. It is a fully-equipped bathroom including a shower, toilet, towel hanger, shelves, and a wash basin. This area reminds you that you should water your plants, after which you are able to advance to the downstairs kitchen.

6.1.3 Downstairs Kitchen

Access to this space is granted after all of the bathroom-related objectives are finished. The kitchen was modeled to have a modern look and feel. This was done in order to be able to show how people suffering from dementia have trouble dealing with modern gadgets, but this idea was not implemented due to time constraints. Other ways of showing the struggles were implemented instead and are covered in Section 6.10.4

6.1.4 Notes About the Environments

The environments were assembled from scratch, making world building in this case a time-consuming, but important task. Every key area was also equipped with light sources and light switches to make it easier to see. As the world was built prior to having a clear story to the game, it required me to extensively think about object placement and how their positions would later form the story. By the end of the game's development I realised that this was not a good idea and it only made the development process longer for no good reason. The right way would have been to first develop a story mostly considering only the fact that it takes place in a house, and then build the world around it. This would have saved me a good amount of time, which I could have spent on other additions or improvements. Although this was not the best way to do things, I still managed to improve my world-building skills and especially my creativity through being forced to think flexibly, which are both valuable assets for a game developer.

6.2 Item Highlighting

An additional mechanic was added to the game to make progression slightly easier in the case when you are stuck. The basic idea here is that the general area around an object will become highlighted so that you know it is supposed to be interacted with. Upon interaction with the objective-related item, the highlight self-destructs and you are able to progress. This was implemented by having invisible cubes turn visible when the object within them is supposed to be interacted with. These cubes themselves have a transparent mesh, but also have a special post-process volume applied to them, which is responsible for applying the highlight to the borders of items through some complex programming. Unfortunately, this addition was not used very often due to the needlessly complicated way it was programmed by me, which made it hard to implement on other objects. By the very end of the project I was able to figure out a much more efficient way of implementing this by simply spawning and destroying the cubes instead of switching their visibility status.

6.3 Rotation-based Character Detection

Some areas of the game require the player to be facing a certain item for long enough to progress. The idea behind this is that if you are searching for something in the game world, you are set as to have "found" the item after looking at it instead of having to press buttons, which helps with the immersion of the game. This is implemented by having an invisible box on the ground which constantly checks if the player is standing in it and what direction they are facing. If the player is in this box and the right direction is faced for long enough, the item is registered as "seen" and the game sequence continues.

6.4 Gramophone progression system

A way to progress through the stages of dementia was implemented with the help of a gramophone object in the world. After a certain sequence of events is completed, you are

given instructions to interact with a gramophone in your room. Upon interacting with it, a sound object is spawned on top of the gramophone to simulate spatial audio across the room for better immersion. This object then starts playing a certain track, which depicts the completion of a stage in the game. As the music is playing, the meaning of the song is explained to the player by the narrator: it is revealed that each of the songs represents memories of people with dementia in certain stages of the illness. The first song that you are able to listen sounds mostly coherent and intact, but in later stages the music gets more distorted, low-quality and confusing, showing the deterioration of the character's mind as the player finishes each stage. After a certain time period, a key spawns and you are able to unlock the next relevant door to progress. It should be noted that the rights to use this music have been given by the author through email.

6.5 Additional Voice Acting

Since the gameplay area was significantly expanded, more voicing for the narrator was required to explain certain things that happen to the player and to help with progression of the game. Additionally, a friend of mine helped with voicing the character itself for added immersion. The main character sometimes hints towards what you should to next in order to help the player to not get lost.

6.6 The Notepad

A notepad object (Figure 6.1) is introduced in the kitchen area of the game. The purpose of this object is to help the character "keep track" of the fact that they are making a cup of coffee. Upon first interacting with the notepad, the player is able to start making coffee by following the instructions given on screen. In the event where the player is forcefully made to "forget" what they are doing, they must go back to the notepad and interact with it to "remember", up until the point where the coffee is made.

6.7 More Carry-Enabled Items

More carry-enabled items were added including batteries for the radio, a ewer for watering plants, and a coffee cup with a coffee container which are necessary for completing the final stage of the game. The coffee cup and container were specially programmed so as to not be carry-enabled at first, but once a certain task is completed, a carry-enabled version of the object will spawn instead of the non-moveable one.

6.8 Items Vanishing

This feature enables the "forced forgetfulness" in this game. More specifically, if you are tasked with finding a cup and bringing it to the kettle, the cup will vanish in front of you and a sound effect will play upon interaction to simulate forgetfulness. This feature could also be perceived as becoming "blind" to the tasks that you were doing, thus the cup becoming invisible since in your mind it is not relevant to you anymore. In order

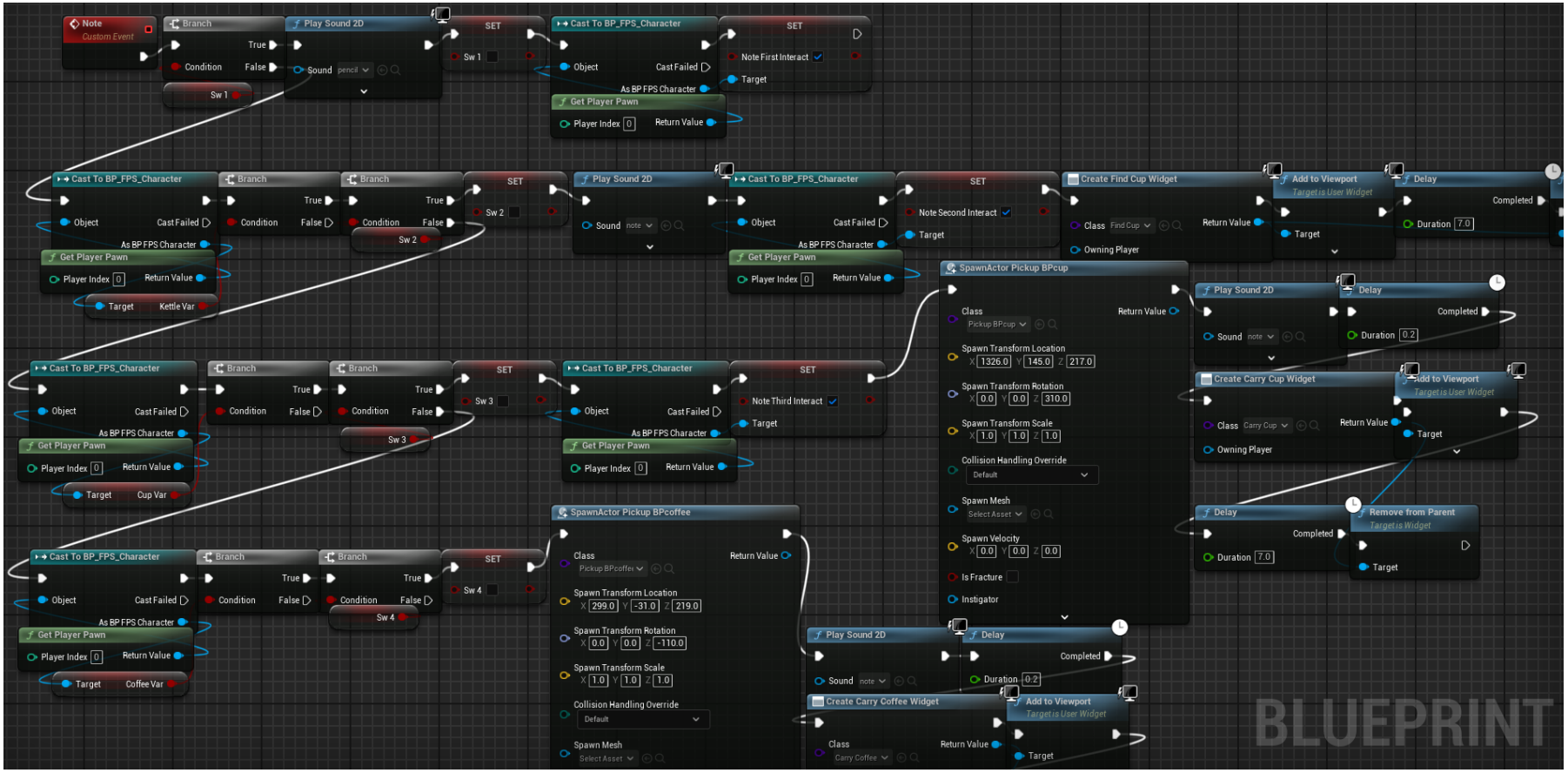

Figure 6.1 The entire functionality of the notepad in Blueprint. This piece of code is responsible for casting to other blueprints, spawning items and on-screen instructions. It also includes multiple switches to shut parts of the functionality down after they are executed and direct the execution elsewhere.

to “remember” about the cup, you interact with the notepad which holds all of your tasks. After this, you are able to pick up the cup and carry it back to the kettle. The same functionality described here also applies to the coffee container.

6.9 Options Menu

An options menu was added, accessible through the main menu. It lets the player adjust the game’s resolution, VSync, graphics settings, and window mode to their liking, making the game more accessible to people who might not have a powerful computer to run the game

6.10 Storyline

This section explains the flow of the game from start to finish. The description is split into four parts, each representing a different stage of the game:

6.10.1 First stage

Once “Play game” is pressed in the main menu, the player appears in the main room of the game. Movement instructions are given via on-screen text and the narrator explains how to interact with the environment. The player is then instructed to turn on the lights and go do some reading at their table. The screen fades out and back in upon interacting with the table and doing some reading. So far, nothing out-of-the-ordinary happens in the game. After the reading, the character says that he would like to listen to some music on the gramophone. Upon seeing the instruction to interact with the gramophone, the player does so and music starts playing from the gramophone. The level of distortion in the music is very minimal — this indicates the very start of the character developing dementia, all of which is explained by the in-game narrator. Once the narrator is finished talking, a key is spawned on one of the tables. This key can be carried to the door to progress to the next stage.

6.10.2 Second stage

Once the character leaves their room, they realise that they were meaning to replace the batteries for their radio. You are then tasked with finding the radio. Upon seeing it, the character thinks about where the batteries could be. The first idea to come to their mind is to search the storage boxes in front of them. Upon interacting with the highlighted boxes you realise that the batteries are not there. The character speculates that they may be downstairs, and so the player is tasked to go downstairs to check for them. After spending some time downstairs, the character realises that the batteries are in their room on the table with the small clock. The player can pick up the batteries and carry them to the radio. Once the batteries touch the radio, they become installed and the radio starts playing. The screen briefly fades out and then fades back in once the character has had enough of the radio tunes. The narrator explains that people with dementia find more comfort in listening to music from their young age, as this music can bring back many

important memories that the people highly value. After the narrator is done talking, the player is instructed with playing the gramophone again. This time, a different track plays and something about it is noticeably off. The narrator then explains that there are some oddities present in the music that represent the first signs of memory loss. Once the narrator is finished talking, another key is spawned on the same table and the player is now able to advance to the next stage.

6.10.3 Third stage

The player now has a key which they can carry to the bathroom door to unlock it. Once unlocked, the only way to progress is to look at the post-it note that is stuck to the wall by the sink. Upon seeing the note, the character realises that they forgot to water their plants. The narrator explains that it is harder to live without using constant reminders like post-it notes. After this, you are tasked to go downstairs and grab the plastic ewer to water the plants, only to realise that it is not there. The character is unsure of where the ewer is, so the player is tasked to look for it somewhere else. Once the player finds it by the storage boxes, the character questions whether the ewer was really there before. The player is then tasked to bring the ewer to the sink and after touching the sink it will be filled up with water. The player then carries the ewer to the plants in their room and waters them by touching the ewer to the plants. After this, the character's frustrations are acknowledged by the narrator and the payer is again able to interact with the gramophone. Once interacted with, a new track plays — this time it is significantly warped and repeating in places, the musical flow is more confused and tangled. The narrator explains the further cognitive decline of the player and the last key is presented to the player.

6.10.4 Fourth stage

The final stage is the kitchen area and can be unlocked with the provided key from the last stage. Once the door to the kitchen is opened, the character says that they would like to make some coffee. They also remind themselves that they should make a physical note of this, since they are prone to forgetting. The player is then tasked to interact with the notepad by the kettle. Once done, the player can then interact with the kettle to start boiling the water. After this the player is tasked with finding their coffee cup. Once the cup is found, it will disappear upon interaction to simulate the forgetfulness of the character. In order to "remember" about the cup, the player must go back to the notepad and interact with it. Upon interacting, a carry-enabled cup will appear in the same place and the player is then able to pick it up and carry it to the kettle. Once by the kettle, the cup will place itself down and then the player is tasked with finding the coffee container. Once found, the character will also "forget" about it after interacting. The player must once again go and interact with the notepad to remember about the coffee container. Once it is brought back and placed down, the general kettle area will become highlighted and once the player interacts with it, the screen fades out and the game comes to a closure.

6.11 Accessibility of the Game

The game was developed in a way where the user interface is simple, easy to understand and to-the-point so that people who are not as literate with computers could play it without being overwhelmed with too many different kinds of buttons and controls. The only buttons necessary to play the game are “E” for interactions with objects, “F” for picking up and dropping items and “WASD” keys for movement and “MOUSE 1”, making the game very simple to play. A planned addition to the game was including the ability to remap your keybinds so that people who have trouble using a mouse and keyboard could remap the buttons to their own custom controllers or whatever they find more suitable to play the game, however, this addition did not make it to the final build due to time constraints.

6.12 Summary of Development

In summary, many different systems were added and many upgrades were made to the game following the interview with experts. The house was expanded to four areas from one, where a bathroom, storage space and kitchen environments were added. Item highlighting was implemented to guide the player in the right direction in case of halted progress, rotation-based character detection for better immersion when looking for items, a gramophone-based progression system that shows the deterioration of the character’s mind, items vanishing, more carry-enabled items, additional voice acting and a notepad object for the game sequence in the kitchen area. On top of this, an effort was made to make the game more accessible through minimal controls. All of these additions were made to smoothly integrate with each other so that the overall gaming experience feels cohesive, immersive, and progressively engaging, enhancing the narrative depth and player interaction within the game’s expanded environment.

Chapter 7

Game Evaluation

7.1 Overview

This chapter explains how the finished prototype of the game was evaluated and what changes could be made to the game after the evaluation procedures. The evaluation plan consists of two key parts: an online user survey and a think-aloud session, both of which are responsible for giving valuable feedback on the game to the researcher so that the game can be further improved. Once the feedback is collected and carefully analysed, considerations for changes to the game are noted for future work.

7.2 User Survey

7.2.1 Aims of Survey and Collected Data

The aim of this survey is to collect data on multiple aspects of the game and the satisfaction of the player to be able to further improve the overall experience. The data collected include:

1. How well does the game present the struggles of people with dementia?
2. How engaging did the game feel/how motivated the player was to keep playing?
3. Rating of the quality of graphics.
4. Rating of the flow of the game.
5. Rating of the concept of the game
6. Did the player experience any minor or major bugs while playing the game?
7. Were there any performance problems when playing the game?
8. Were there any features that the player particularly liked/disliked about the game?
9. Suggestions for improving the game.

The people who completed the user study were contacted via an online sign-up sheet. Once enough people (n = 8) responded to the advertisement, the game survey was conducted online by sending individual emails to respondents including the relevant ethics forms, instructions on how to start the game, and a link to the feedback survey.

7.2.2 Analysis of the Collected Data

While a sample size of 8 is nowhere near as large as it could be when, for example, developing a full-scale game with a pre-existing follower base, it is still valuable feedback for something the size of a university project. Since everything related to the survey was done to the best of my ability and was based on the University Research Ethics Policy guidelines, the only weakness of this survey is the small sample size.

The first question asks the participants to confirm that they agree to the ethics forms terms. All of the participants agreed to the terms presented in the ethics forms, and so all of the provided responses were counted.

The next ten questions in the survey provide actual feedback on the game and are discussed in order:

1. **How well was the game presenting the struggles of people with dementia?**
   The collected data shown in Figure 7.1 suggests that the game is able to present the struggles at least somewhat well, with the average response standing between "Very well" and "Somewhat well." 3 of the participants checked "Very well", another 4 checked "Somewhat well" and 1 participant checked "Neutral."
2. **In general, how engaging did the game feel/how motivated were you to keep playing?**
   Figure 7.2 shows that participants were generally able to maintain interest in the game, with 3 participants saying they were very motivated to keep playing, another 3 saying they felt somewhat motivated and 2 participants remaining neutral. This puts the average response at slightly above "Somewhat motivated."
3. **How would you rate the quality of graphics?**
   The survey results in Figure 7.3 show that the participants had a generally positive outlook on the graphical aspect of the game with an average rating of 7.25 out of 10. Two participants gave this aspect a score of 6, another two gave it a 7 and the remaining four participants gave it an 8.
4. **How coherent did the flow of the game feel?**
   Figure 7.3 suggests that the participants observed the game to have a good flow to it with an average rating of 7.25 out of 10. One participant gave this aspect a score of 6, another four gave it a 7 and the remaining one participant gave it an 8.
5. **How would you rate the concept of the game?**
   The data shown in Figure 7.3 suggests that the participants were very happy with the game's concept, meaning the game holds a lot of potential to be a better teaching tool. An average rating of 8.75 out of 10 was recorded with three participants giving a score of 8, four participants a 9 and a single participant giving a 10.
6. **Did you experience any minor or major bugs while playing the game? Leave blank if there were none.**
   Five of the people who responded to this survey managed to find bugs in the game. Two of the responses commented on the same bug where "stepping on an item when holding it can send you flying." One participant complained that "Sometimes it's a bit hard to pick up items, and sometimes it's unclear if you are holding them or not." Another bug described has to do with one of the on-screen

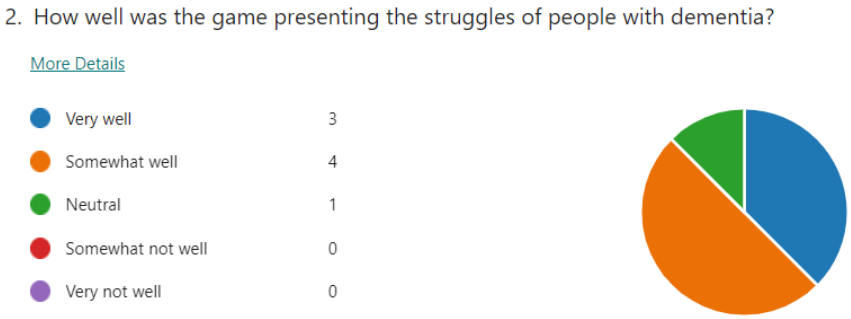

Figure 7.1 Survey results for how well the game presents the struggles of people with dementia.

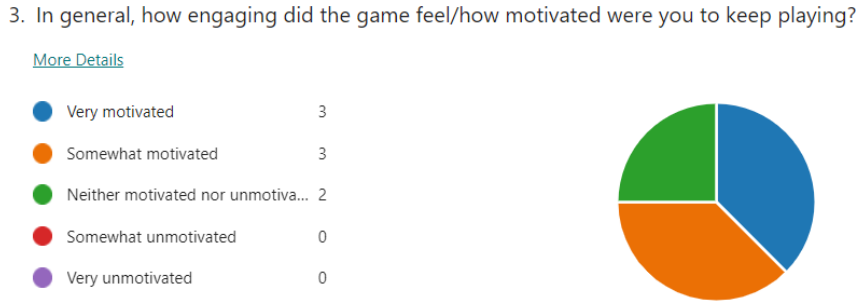

Figure 7.2 Survey results for how motivated the participants were to keep playing.

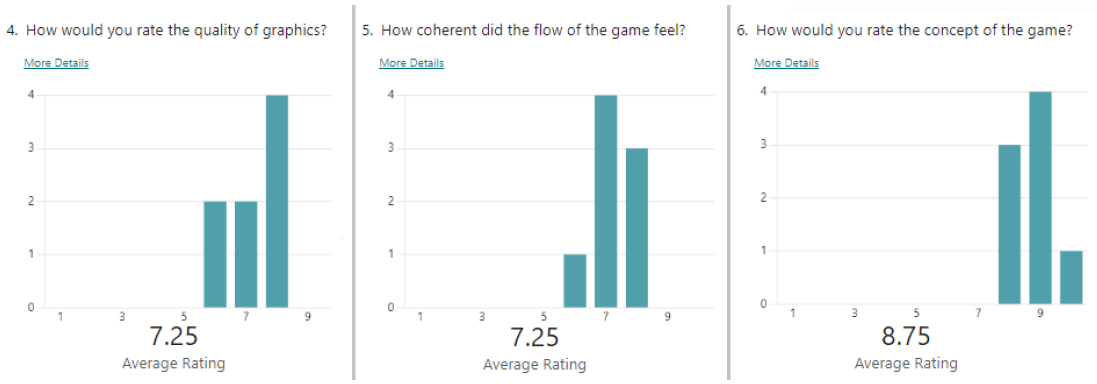

Figure 7.3 Survey results for quality of graphics, flow of the game and its concept.

guidance pictures having a white background instead of a transparent one and the last bug describes a small lighting glitch with the shadow of a shelf.

7. **Were there any performance problems when playing the game? Leave blank if there were none.**
   Only one participant encountered performance problems, however, they were not entirely sure whether the problem came from the game or from their computer not being able to run the game well.
8. **Were there any features that you particularly liked about the game?**
   The responses suggest that the participants liked the item highlight system, even though it was not used extensively in the game. Positive comments were also made on the gramophone progression system twice, with single mentions of items disappearing when interacted with and the narration.
9. **Were there any features that you disliked?**
   The participants did not dislike anything already present in the game, however, there were many suggestions on how to make the game better. This is covered in the following question.
10. **If you have any suggestions for improvement of the overall experience, please write your ideas here. Write "No suggestions" if you do not have any.**
    The suggestions made in the survey had to do with populating areas of the house with more items to make it feel less empty, adding some type of ambient noise to make up for the silence in the game, further expanding the story itself, having subtitles for the narration and monologue present in the game, and applying the highlight system to more of the story-critical objects.

7.3 Future Game Improvements in Response to Study

After analysing the survey responses it became clear what types of fixes and additions would make the game objectively better. These improvements are:

More Extensive Item Highlighting Some items in the game are deliberately not hinted towards so that the player is forced to figure out what to do by themselves. However, in the case that the player is genuinely lost and does not know how to further progress, highlighting the objective after a set time period could help immensely with helping avoid unintended frustration.

More Items in the Environment There were complaints that some areas feel too empty and unpopulated. This is true and adding more objects like plants, pans and other decorative items would definitely add to the immersion. The reason this was originally not accounted for was the lack of free assets that fit the atmosphere of the game, or if the assets were good they turned out to be paid assets. The shortage of assets could be fixed by either searching for them longer online or spending time modeling them from scratch in Blender.

Subtitles for the Narrator and Character This addition would greatly help the game since is it not always easy to understand someone who speaks with a different

accent to you. The subtitles should be implemented for both the narrator and the character voices, and even to other characters if the game is further expanded.

Bug Fixing Bug fixing is standard practice in game development and is always important to upkeep player satisfaction. The most problematic bug found was walking over carry-enabled items or attempting to mash them under your feet. This would send the character and the held item in unpredictable directions and could potentially freeze progress by glitching a key item out of the map. Further analysis into the code would have to take place in order to find a solution to this problem.

7.4 Think-Aloud

A separate method of evaluation was done in parallel to the online user survey called a think-aloud protocol. Random participants around campus were picked for this method of evaluation, and after being informed and agreeing to the terms presented in the ethics forms, they were given the chance to play through the game. After an extensive search for testing candidates, I managed to hold four think-aloud sessions with four different students. While the number of participants was not that high, since everything related to the think-aloud session was done to the best of my ability and was based on the University Research Ethics Policy guidelines just like the online user survey, the only weakness of the think-aloud sessions is the small sample size.

7.4.1 Setup of the Session

All of the think-aloud sessions happened in a quiet spot of the library building to minimise outside interference. It was also necessary to be in a building to be able to power the laptop so it could run the game properly. The participants were presented with the finished prototype of the game on my laptop device. My own laptop was used to make the evaluation go as smoothly as possible so that the participants do not have to install the game on their own computers and so that they could still participate even if they did not have their own computer with them. Since the game is self-leading and designed in a way where progression is fairly clear, no additional guidance was given to the participants, other than telling them how to start the game. It was also made clear to the participants that they should be constantly thinking aloud while playing. Notes during the sessions were made with a pen and paper.

7.5 Results

To make the results more easily presentable, each of the participants will be referred to by the letters A, B, C and D. Once all of the think-aloud sessions were complete, 6 new significant problems were identified that at least one of the participants experienced:

Having to click mouse 1 to be able to turn: Participants A, B and D noticed at the very start of the game that you are supposed to first click on the game screen with your mouse to be able to rotate your character in the game. Participant C did not

have this happen to them and thus did not address this happening. Participants A, B and D were able to fairly quickly figure out how to move their character by trying random button presses on both the mouse and keyboard.

Interacting with books instead of the table: One of the first instructions given to the player in the game is to "go do some reading", the intention being that the player will walk up to their work table and interact with it. Participants A and D performed the right interaction from the very start, but participants B and C spent some of their time first trying to interact with books on the bookshelves instead of the table. After some time, both participants realised that they should try and interact with the books on the table.

Battery item starting to fly around if bumped into: Participant A was the only participant who found that if you bump into the radio's batteries after they appear in the world, the batteries will spontaneously launch themselves in an unpredictable direction and will keep moving until you either are able to grab them or wait for their momentum to dissipate.

A key being able to clip through an invisible wall: Participant C managed to get one of the keys stuck behind the intended boundaries of the map. When the second key is given to the player, an invisible wall appears by the staircase, preventing the player from going downstairs and unlocking the kitchen door too early. Participant C was not aware of this wall existing and attempted to go straight through it. While the character itself stayed on the intended side, the key managed to slip through the solid material and get stuck on the other side. Amazingly, the participant also managed to bring the key back by not letting go of it and backing up all the way back to the main room. Once enough distance was created between the character and the wall, the key suddenly popped back in front of the character and the participant was able to further progress.

Ewer registering as found even though it was not looked at: Participant C was also the only participant that experienced a bug that I thought was already fixed — the ewer registering itself as "found" even though it was not looked at by the player and the invisible box tied to the "WasEwerFound" variable was never stepped into.

Searching for the kitchen notebook sometimes took longer than expected: Participants B and D encountered a problem where they could not find the right item to progress in the kitchen area of the game. Participant D first looked for the notebook in the side rooms by the kitchen, and when they noticed that the notebook is not in those rooms, they started looking around the kitchen area and eventually found it. Participant B, however, decided to go back upstairs and searched for the notebook in all of the available places, eventually realising that it might be in the kitchen area and then successfully finding it seconds later.

7.6 Key Takeaways of the Session

The think-aloud session provided a lot of valuable feedback on bugs and the lack of clarity with certain objectives of the game. While some lack of clarity is intended, the unintended parts like not interacting with the table at the start could be addressed by using item highlighting more extensively. This would make it easier for the player to understand where the objective is if they are still lost after a certain period of time.

On the side of bugs, a key potentially clipping through an invisible wall is not intended and could completely halt the progression of the game. In future work, this could potentially be resolved by either making the invisible wall thicker or by "teleporting" the key back into the right map bounds if it is found to be outside of them. The bug with the ewer being "found" when it is not could be resolved by double-checking the implementation of the specific trigger and potentially adding coordinate checks of for the character alongside their rotation value.

Chapter 8

Conclusions

8.1 Summary of the project

The aim of this project was to create an educational game about life with dementia. A list of requirements for making the game was created after which a fitting game engine was selected and development started. A lot of effort was put into learning how to use Unreal Engine 5 to make the game visually appealing, informative and engaging.

A basic build of the world was first made, after which some basic functionality like a main menu, walking, looking around, opening doors, carrying items, playing monologue and walk-in triggers was implemented to have a working end-to-end system. Once the end-to-end system was established, an interview was organised with dementia domain experts. The experts provided feedback on how the struggles of dementia could be accurately portrayed in the game and once the interview concluded, the second phase of development began. The game was further expanded to have 4 areas in total for exploration, new mechanics were added like items disappearing, item highlighting, the gramophone progression system, additional voice acting and an options menu.

Once the game was finished with development, an online user survey and a think-aloud session was done to collect data on the satisfaction, teaching capabilities and bugs of the game. Suggestions on how to improve the game were also asked for and provided a lot of additional insight in how the game could be better.

8.2 Potential future work

Future work for this project could consist of fixing all of the bugs that were found while evaluating the game, namely lighting problems, unexpected sequence breaks and items glitching out of the map or having unpredictable behaviour. In addition to this, many of the suggestions made by study participants could be implemented (items becoming highlighted, more items in environment, subtitles for the in-game voicing) to further improve the immersion and game flow. Finally, more research could be done on the subject of dementia and further interviews could be organised with experts for additional advice and ideas for the game. With further high-quality implementations added to

the game under the supervision of experts, this game holds the potential to not only be a casual game teaching about dementia, but even a tool for professional training of carers. In terms of more casual play, accessibility of the game could be expanded by implementing different colour blindness modes for people with colour perception deficiencies and by letting the player change the movement and interaction keys to whatever they prefer, potentially even including controller support for the game.

8.3 Skills and knowledge developed during the project

The amount of skills and knowledge that I developed by undertaking this project is enormous. While I had some experience with Unity back at highschool, I only went as far as creating a moveable character that could shoot a rifle. With this project, I was able to explore implementing many different advanced systems from scratch, and the amount of world-building and programming knowledge that I gained through this is incomparably greater than what I was able to learn with Unity.

Firstly, I became much more confident when it comes to programming with Unreal Engine's Blueprint system. At the start, calling and connecting blocks to execute functions and manage their flow seemed hard to mentally grasp, especially considering that there are so many different blocks that you can call and that each one of them serve a different purpose. With some guidance online, trial-and-error approaches to coding things and experimenting with random blocks, I started getting a lot better at Blueprint programming, and, honestly, this project had me having the most fun in terms of programming ever in my life. I am sure that this knowledge will prove itself incredibly useful in the future when I start developing more games as a hobby.

I also gained a lot of experience in world-building on Unreal Engine 5. While most of the world building was focused around a single house and with a limited amount of assets, I can see how this knowledge could be applied to larger and more item-populated environments to build a truly immersive and interesting world to explore.

Since good lighting and object rendering was a significant part of this project, I learned a lot about how a world's lighting should be managed and how the game engine renders objects. I now have knowledge on what types of lighting should be used where, how to set certain properties to materials so they become more or less shiny or reflective, how to use post-process volumes to change the ambience and feel of the environment through subtle rendering changes and how to modify the level of detail of objects depending on distance. All of this is much needed knowledge for a game developer to be able to make an immersive experience and can be applied to many 3D game projects.

8.4 Reflections

Reflecting on the decisions made during the project, many of those decisions were good and backed up by either my supervisor, study participants or the dementia-domain experts. There were, however, some bad ones as well.

One of the major problems that I encountered with the development of the game was building the world before having a story in place. This situation had me thinking outside of the box with item placement and trying to build a world around a story that was not yet developed. While I was able to exercise my creativity this way, I feel like creating a story first would have saved me some time with world creation.

Another thing that I wish I could have done differently is to have had an in-depth look into project settings and how they can impact the project from the very start of the game development. When I was first having performance problems with UE5, I looked up tutorials online on how to fix these problems and found the improvements to be minimal. This made me assume that my system is not good enough to run the editor well, and so I continued development with constant UE5 crashes and even Windows crashes from time to time. Only at the start of the second semester I figured out that some of the settings for rendering were not supported well by my graphics card, and after changing some of those settings my laptop could run UE5 with no problems whatsoever.

8.5 Final thoughts

This project provided me with plenty of opportunities to learn new skills and accumulate valuable knowledge on game development with Unreal Engine 5, which has made me an undeniably better game developer. In addition to this, I got to learn more about the human mind and, most importatly, teach others about it through video games.

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Appendix A

Ethics information

An online user study was performed with $n = 8$ participants to determine how successful the development of the game was and how to further improve it. A think-aloud session was also held with $n = 4$ different participants, who provided live feedback on the game and what they were experiencing as they were playing.

A.1 Participants' information sheet

Participant Information Sheet

Project title:	Making a game about life with disabilities
Principal investigator:	Brian Mitchell
Researcher collecting data:	Neilas Sabockis
Funder (if applicable):	

This study was certified according to the Informatics Research Ethics Process, reference number 672243. Please take time to read the following information carefully. You should keep this page for your records.

Who are the researchers?

The researchers are a 4th year BSc Computer Science student Neilas Sabockis and the principal investigator Brian Mitchell.

What is the purpose of the study?

The study will collect information about how engaging, moving, and meaningful the game is. Additionally, information on how to improve the game (graphics, storyline, bugs) will also be collected. The primary aim is to understand what a person would want to see in a documentary-based game to make the experience more fulfilling and realistic.

Why have I been asked to take part?

You have been invited to take part in the study because you have basic computer knowledge and are able to provide written feedback on the game.

Do I have to take part?

No – participation in this study is entirely up to you. You can withdraw from the study at any time, without giving a reason. After this point, personal data will be deleted and anonymised data will be combined such that it is impossible to remove individual information from the analysis. Your rights will not be affected. If you wish to withdraw, contact the PI. We will keep copies of your original consent, and of your withdrawal request.

What will happen if I decide to take part?

If you take part in this study, information will be collected regarding the game's engagement, storyline, logicality, informativeness and graphics. The data will be collected through an online questionnaire. The session could last up to an hour; however, you can end the session early if you wish to do so. Participant audio and video will not be recorded.

Are there any risks associated with taking part?

There are no significant risks associated with participation.

Are there any benefits associated with taking part?

There are no direct benefits from taking part in this study.

What will happen to the results of this study?

The results of this study may be summarised in published articles, reports and presentations. Quotes or key findings will be anonymized: We will remove any information that could, in our assessment, allow anyone to identify you. With your consent, information can also be used for future research. Your data may be archived for a maximum of 4 years. All potentially identifiable data will be deleted within this timeframe if it has not already been deleted as part of anonymization.

Data protection and confidentiality.

Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly confidential. Your data will be referred to by a unique participant number rather than by name. Your data will only be viewed by the research team consisting of BSc Computer Science student Neilas Sabockis and principal investigator Brian Mitchell.

All electronic data will be stored on a password-protected encrypted computer, on the School of Informatics' secure file servers, or on the University's secure encrypted cloud storage services (DataShare, ownCloud, or Sharepoint) and all paper records will be stored in a locked filing cabinet in the PI's office. Your consent information will be kept separately from your responses in order to minimise risk.

What are my data protection rights?

The University of Edinburgh is a Data Controller for the information you provide. You have the right to access information held about you. Your right of access can be exercised in accordance Data Protection Law. You also have other rights including rights of correction, erasure and objection. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk. Questions, comments and requests about your personal data can also be sent to the University Data Protection Officer at dpo@ed.ac.uk.

Who can I contact?

If you have any further questions about the study, please contact the lead researcher, Neilas Sabockis (email: neilllas2002@gmail.com).

If you wish to make a complaint about the study, please contact inf-ethics@inf.ed.ac.uk. When you contact us, please provide the study title and detail the nature of your complaint.

Updated information.

If the research project changes in any way, an updated Participant Information Sheet will be made available on http://web.inf.ed.ac.uk/infweb/research/study-updates.

Alternative formats.

To request this document in an alternative format, such as large print or on coloured paper, please contact the lead researcher Neilas Sabockis (email: neilllas2002@gmail.com).

General information.

For general information about how we use your data, go to: edin.ac/privacy-research

Participant number:_____

A.2 Participants' consent form

Participant Consent Form

Project title:	Making a game about life with disabilities
Principal investigator (PI):	Brian Mitchell
Researcher:	Neilas Sabockis
PI contact details:	brian.x.mitchell@ed.ac.uk

By participating in the study you agree that:

- I have read and understood the Participant Information Sheet for the above study, that I have had the opportunity to ask questions, and that any questions I had were answered to my satisfaction.
- My participation is voluntary, and that I can withdraw at any time without giving a reason. Withdrawing will not affect any of my rights.
- I consent to my anonymised data being used in academic publications and presentations.
- I understand that my anonymised data will be stored for the duration outlined in the Participant Information Sheet.

Please tick yes or no for each of these statements.

1. I allow my data to be used in future ethically approved research. ☐ **Yes** ☐ **No**

2. I agree to take part in this study. ☐ **Yes** ☐ **No**

Name of person giving consent	Date dd/mm/yy	Signature

Name of person taking consent	Date dd/mm/yy	Signature

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