

# CE301 THERAPEUTIC GAME DROP SORT

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## **Acknowledgements**

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## **Abstract**

Drop Sort is a game targeted towards providing aid in the development of children with Autistic Spectrum Disorder. Behavioural therapies are the standard treatments for children with ASD but they are very time and resource intensive, especially during COVID. As the world is shifting towards a more online environment due to COVID, having a way for patients to still progress with their therapies is essential. The objective of Drop Sort is to help reduce the strain on therapeutic services by exploring the fact that Children with autism are also known to be "heavy use gamers." Drop Sort aims to tackle a core part of Pivotal Response Treatment known as conditional discrimination through training multiple cue responding which is where when asked the question: "What color is the cat?" The response of the child is "meow" instead of the color of the cat as the child only recognized 'cat'. Drop Sort is a sorting game created with C# in Unity utilising its navmesh agents, rigidbody, OnTrigger methods and much more, where the player has to sort entities correctly according to cues, getting increasingly difficult over time. Further progress is saved over time to see the improvements of the player by a therapist which was one of the main aims of the project. For my poster the main objective is to be eye catching and to achieve that I made use of animating a 2D birds eye view of the game, included instruction and only kept meaningful key text.

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## Literary Review

### Autistic Spectrum Disorder:

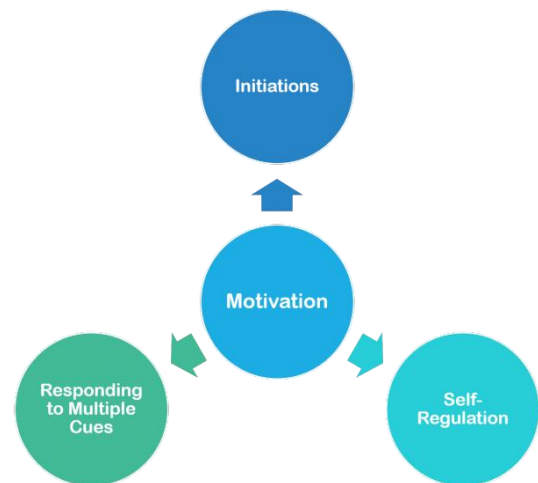
Autistic spectrum disorder (ASD) is a complex developmental condition that can be challenges in social situations such as interaction, speech, nonverbal communication, restrictive/repetitive behaviours[1]. As it is a spectrum there is wide variation in the type and effect it has on the individual making every case unique. It is not an illness but more that their brain works in a different way to other people and the symptoms can change over time. Autism is also associated with hypersensitivity input which means sensory overload is common for people with autistic spectrum disorder. There is no standard treatment for ASD, instead there are many ways to help minimize the symptoms and maximize their abilities, there are appropriate therapies and interventions according to their symptoms. The game would need to keep in mind that children with ASD are very sensitive and needs to be able to aid their symptoms in some way.

### Research Papers:

#### **Go Go Games: Therapeutic Video Games for Children with Autism Spectrum Disorders[2]:**

##### Introduction:

This paper goes into describing the design for a therapeutic video game with a target audience for early elementary children with autism spectrum disorders with the hypothesis that games can be fun and also provide evidence-based therapies to bridge the gap between the amount of therapy recommended for children with ASD and the amount they received. Pivotal Response Treatment (PRT) is a technique known to be effective in educating children with ASD was used in the process of creating a suite of games. ASD is the fastest growing disorder in the US. Behavioural therapies are the standard treatments for children with ASD but they are very time intensive and resource intensive. A 2011 national survey showed that 41% of US children with autism are “heavy use gamers” this means that as they spend most of their time playing video games, taking advantage of this an approach can be done by creating games that is targeted towards this audience to help tackle the strain on resources by using the time children on the autism spectrum use gaming to also help provide the most beneficial, for children with ASD, behavioural therapies. This same study also found that video games have equivalent and deep penetration across gender, race and socioeconomic status.



*Fig1.1 Displaying motivation links*

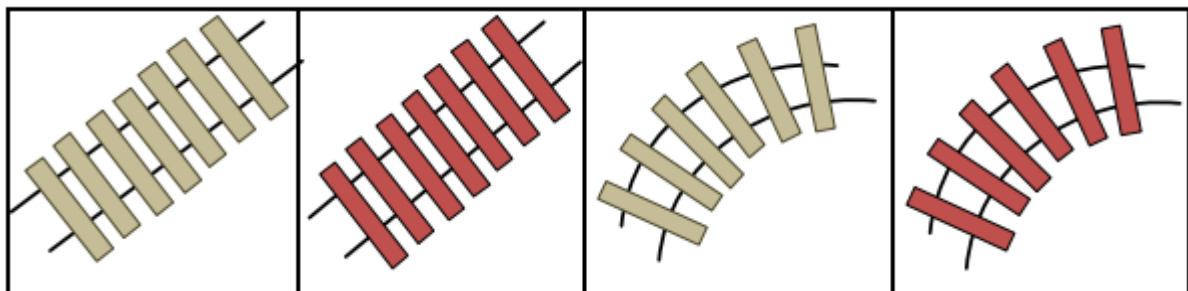
##### System Design- The Skill Target:

Go Go Games’ objective is to teach a skill known as multiple cue responding. Multiple cue responding is best explained when observing the thought process when coming to a traffic light. When approaching a traffic light if the light is green with a right arrow, one would easily

continue on without stopping and take a right. To make this decision two cues occur that are processed, one being the color of the light and the second being the shape of the light, if any of these cues were different the decision would be different. This is a known challenge for children with ASD as children on the spectrum often get fixated on a particular single cue instead of taking all the cues in and simultaneously deciding. Another known challenge for children with ASD would be “Tunnel Vision” studies which cite children cannot tell the difference between letter E and F or between a spoon and a fork.

#### System Design- Therapeutic Approach:

Pivotal Response Treatment (PRT) is a behavioural therapy that targets key skills that are known to bring incremental improvements in other “collateral” areas and has had extensive research done to prove its effectiveness. Multiple cue responding is one of the skills that has had improvements through using PRT and overall leads to improvements in general learning/skills. A core element of PRT that underlies Go Go Games’ games is known as conditional discrimination, which is where for example when asked the question what color is the duck the response is quack quack instead of the color of the duck[3]. Go Go Games’ approach was to use a method by PRT practitioners where structures in the environment are deliberately changed so that a child must notice multiple cues at once. In this case a practitioner used train tracks, as the child liked trains, and would ask the child to add a piece to the track with multiple cues using color and shape such as asking the child to add a brown curved track.



*Fig1.2 Displaying tracks with differing characteristics*

PRT also dictates that these artificial scenarios be carried out in realistic situations as such to be relatable to the real world and would also further aid in PTR by using a child's interests to reinforce the therapy.

## **Can Game-Based Therapies be trusted? Is Game Based Education effective? A systematic review of the Serious Games for Health and Education[4]**

### Introduction:

A video game is firstly a form of entertainment, but in this article an in-depth evaluation is done to determine whether a “Serious Game” can be made that goes further than just entertainment purposes. The article makes note on how games made for entertainment purposes evolved into different things over time such as exergaming which involves video games that recreate leisure activities, sports and healthy exercise. Using this information, the article focuses on seeing whether the medical and social sectors benefit too while also targeting different areas of the population like children, the disabled and elderly, just as exergaming has showing that games can promote healthy exercise. The serious games are intended to help professionals as well as enabling users to enjoy themselves through learning how to handle simple social interaction situations. The article further highlighted medical, technological and social objectives:

- Medical objectives: To treat and inform about diagnosis or to rehabilitate people from different groups with or without functional diversity, with the aid of a user-friendly, simple and attractive tool.
- Technological objectives: To design and develop accessible computer applications that implement games with semi-real characters.
- Social Objectives: To aid education, integration and socialization at home, at school and in urban environments.

### Methodology:

Augmented reality and virtual reality is being used in this section looking into serious games for health and development. Serious game scenarios combine the real environment with virtual objects, this allows for a mixed environment for the user who now feels more involved and identified. Using virtual reality, it is possible to develop serious games for both medical or educational purposes, where it is possible to recreate different situations environments such as traumatic situations to help in rehabilitation.

Playing serious games can also stimulate the development of basic learning skills such as paying attention, visual-motor coordination, logical spatial reasoning, visual perception, spatial structuring, spatial orientation and creativity. Since the development and growth of serious games drifting from being solely about entertainment and created a new field promoting education and health environments creating the “Serious Games Foundation.” Serious Games for rehabilitation and made to help people with their rehabilitation making their exercises easier and less traditional. Serious Games for education/training professionals would be games designed to teach and immitate real life scenarios to learn and gain experience. Serious Games for health prevention and education depends on the orientation of the game as it can be from diet to sport to hygiene to social skills.



*Fig2.1 Serious Games Demand Circle*

## **What Language would be most Appropriate?**

A game for health has many useful applications such as diagnostics, prevention, advertising, training, fitness, rehabilitation and relaxation. There are many languages that have the capability to make games but I believe the deciding factor would boil down to the factor of object orientated programming[5]. Object orientated programming is a programming style or organize and maintain code which is essential for game development as video games can run from over thousands of lines of code to even millions making it necessary to have code that can be easily modified and maintained. OOP does this by organizing code into objects which holds the state and behaviour of the object, where state is the characteristics and behaviour is what the object can do. Languages like python[6] that do not use OOP makes developing games a lot more complicated and are limited by things like speed and memory consumption, as it is a interpreted language making it slower compared to languages such as C++.

The two most common languages for game designers currently are C++ and Java. Java is similar to python in the sense it is categorised as an interpreter language but compiles also. This is due to initially it is first compiled into ByteCode which JRE can understand and then is followed by the ByteCode being interpreted by the JVM making it an interpreted language[7]. Straight away comparing which one is better between C++ and Java, C++ is the industry standard. As java requires the JVM and JRE[8] it is slower than C++ which compiles directly to the Native Code making the game run faster. C++ also has the ability to handle memory allocation/deallocation while java does not. C++ requires the use of many external libraries for many things like threading and graphics rendering while java comes with this already in packages making it a lot more straight forward to begin programming. Java is cross platform as the JVM is portable and can run on most if not all devices as if it is coded once it can work on any machine running JVM, while C++ requires the compilation of the native device architecture and can make some libraries that your program uses unsuitable.

Overall the two languages do not seem to outweigh the other but personally java would have been the language of choice for this project mainly due to having more past experience in it, but upon further consideration there is also C# which is another C based language just like C++. C# is a high-level language while C++ is low level, this main difference boils down to how C++ compiles down to machine code whereas C# compiles down to the Common Language Runtime[9] which is interpreted by JIT in ASP.NET and also C# is a component-orientated programming language which focuses on interchangeable code modules that work independently. Initially there was no attraction towards C# for the same reason of having background knowledge with but using C# with unity would provide a whole new and fascinating way to create a game for my project.

Unity allows for a visual representation of the game and is very effective while rendering 2D and 3D scenes as it allows for viable changes to be made during runtime, allowing for the experimentation of the game logic without having to wait to compile and rerun the whole project. It also gives a very smooth workflow, which through using unity can be picked up and understood quickly and easily as it is a visual program. Unity allows the visual understanding of how to handle the complexity of doing something in 3D, this is a further for me personally as I am more of a visual learner, also known as spatial learners, being able to create a game with constant visual progression that unity provides will compliment my learning methods and aid me to understand and progress without the worries of learning a coding language. Unity further also allows for simplicity when it comes to cross-platform development as a single script can be compiled and used for many platforms, this is quite important as the current climate of game development is very much geared for cross platform support. Finally, Unity has one of the best game engines to use when compared to other technologies. I believe that using Unity to create a Therapeutic Game is not only a good challenge as I have never used the engine before, but also an achievable one with the resources at hand.

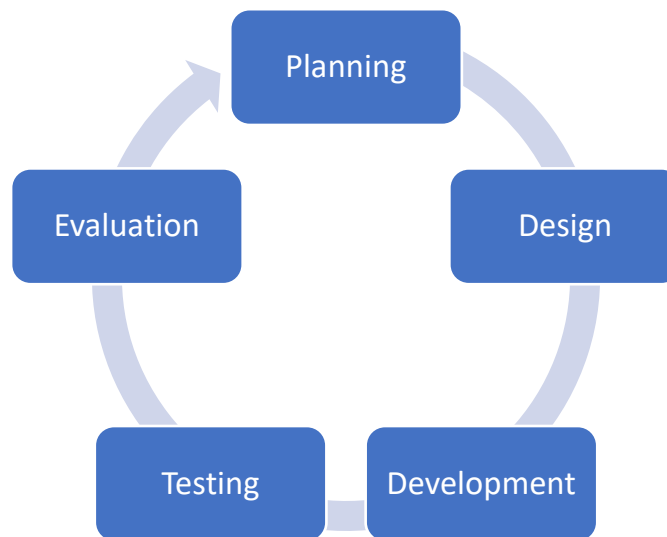


## **Blender**

The game should be able to provide an enjoyable environment to play in and to achieve this Blender was used. While Unity does have a way to create objects and further has plugins available for making models I decided to use a program that is feasible to understand and often used by Unity developers. Blender is a free opensource application that can be used for both 2D and 3d modelling, it has many tools for modelling, rendering, rigging, animation, simulation, motion tracking and can be further used for low-poly and UV maps. Looking at the options and understanding the timeframe, a way to make low-poly models for the game would be something that is achievable as this will be the first-time utilising Unity also. Low-poly models are easier to load, view, edit and overall being less intensive with less polygons, further consideration would be towards less complicated structures for children with ASD. Additionally, this is a skill that would be very useful for creating indie games such as Drop Sort.

## Methodology

### Agile Plan



*Fig 3.1 The Agile cycle*

In project management, the scope outlines the features or requirements[10] to be accomplished and the resources needed to deliver them successfully within set deadlines. Agile itself is known for its flexibility and operates off the fact that the scope will change throughout the project at different stages. This is why agile operates in iterations and only the scope for the current iteration is set while future scopes are undetermined till the current iteration is complete. This allows for the customer to be able to change requirements as the project evolves. In agile detailed estimates and functionalities are implemented in the next iteration only. The agile management method will be tailored for this project personally to ensure quality and progress in the project is clear.

#### Planning:

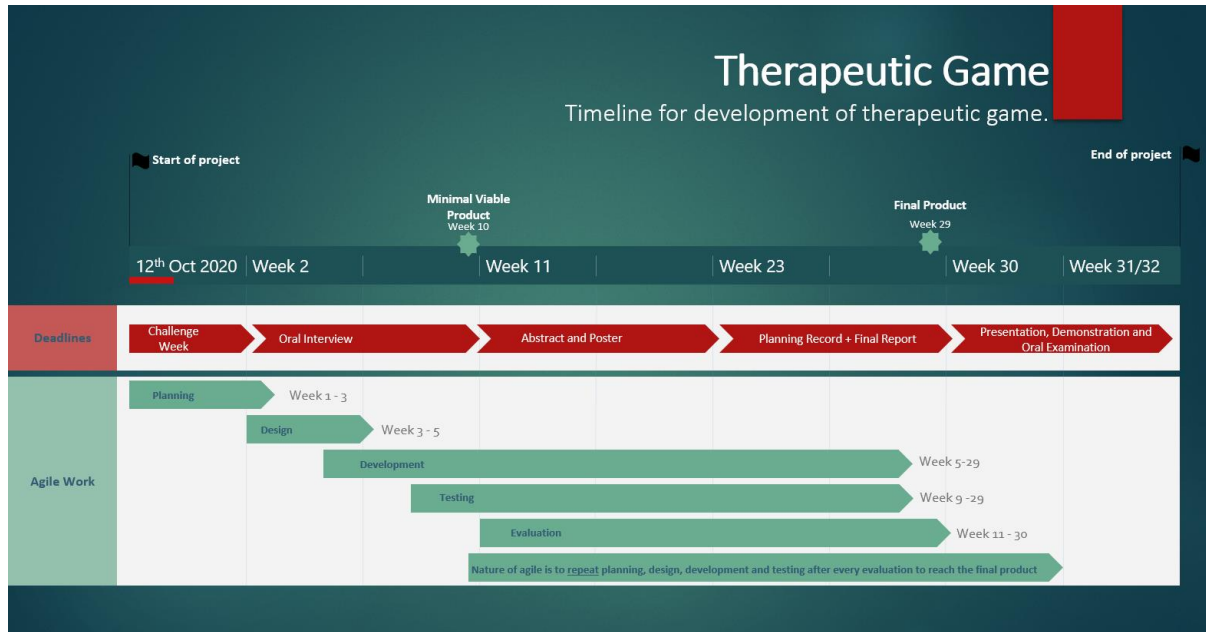
The agile planning stage is concentrated towards answering questions, what tasks need to be done and when the said task will be done, further a project vision, roadmap and business case must be determined[11]. Analysing dependencies between tasks is done to ensure changes can be made accordingly, optimized progress and leading to a decrease in time wasted. Traditionally most importantly the first step is to compile a list of technical requirements, time consumption, team formation and cost estimation, but as this is a one-man project some of the factors are made redundant leading to a heavy concentration on the technical requirements and time consumption. These requirements once decided are placed in the backlog to be worked towards as iterations go on. The backlog contains all of the requirements needed to deliver the final product.

#### Project Vision: The Requirements:

- Determine the type of therapy the game will provide,
- Develop a game that responds to the players current effective state,

- The game must provide some benefit to the player,
- Determine and record the players progress in the therapy or change in effective state.
- Determine methods in which companies and studies could use the game in real therapeutic situations to prove effectiveness of the game.

Project Roadmap:



*Fig 3.2 Timeline displaying Project Roadmap*

Project Intent:

The intent of this project is to provide an alternative way of therapy in a direction that has much potential with the advancement of technology. With the increasing number of people receiving and needing a form of mental health/therapeutic services the strain on the resources available and services are also increasing. As technology is becoming more available and advanced day by day this can be used to reduce the strain on therapeutic services, this is the aim of this project: To provide services from home and allow for research and progress to be recorded whether it be stress relief, anxiety or even children on the autism spectrum. As the world is shifting towards a more online environment due to COVID, it is essential during the current climate to have a way for patients to still progress with their therapies from home and not lose progress, whether it is to aid with a disability or being able to provide a distraction with further benefits such as stress relief or brain exercises. This project will allow me to broaden my knowledge in terms of therapy and will allow for new intuitive ways for therapies to apply games into helping people.

Design:

An agile design process allows you to use an iterative as well as an incremental approach[12] to deliver your design to your customer. This can be achieved by dividing the functionality into parts that are delivered independently and progress can be made separately and delivered sooner for faster feedback. In the process of creating a design the goal is not to make a final product but to improve the design in each iteration. For the purpose of the design of a therapeutic game, the main features to be focused on would be rapport building, frustration

tolerance, decision making, problem solving, response to rules, positive reinforcement and atmosphere.

#### Development:

This stage takes the design documentation and makes it a reality through coding. This will be using the decided programming language, java, and is as expected the most time-consuming process as it the backbone of the whole project requires a lot of technical work to do with coding the game. This process will be broken down into sections to complete making it easier to keep track of code and observe progress and errors easily and even make changes. This is where most progress will be made to ensure that the requirements set out are completed by the end of the project. Different iterations will have advancements in coding to ensure progress is made to making a complete game and any issues are flagged to be addressed in future iterations. The development of the project will be kept in Jira, Gitlab and shown in the implementation of the game.

#### Testing:

This stage is important to ensure that the game is running as intended and any issues that arise are addressed once again in the development stage. Ensuring that the game is also compatible with the target audience at a certain stage or developing a plan to test the success and usability of the game, whether it can be used and make a difference in therapeutic situations. Further use of user test cases for the systems functionality, individuals to test to identify opportunities for further design improvements and to see if the goals were reached.

#### Evaluation:

Once all previous development phases are complete the final stage is to objectively review what the testing shows and which goals/requirements were met, which ones fell short and overall how much of a success the project has been. Ideas, improvements and changes are further discussed towards resolving concerns or issues then as per the agile development methodology. Evaluation also occurs every time a new iteration begins, meaning an evaluation is also done between sprints to ensure the product and the goal of the project do not stray.

## Project Management

### Jira

#### Sprint 1:

Date: October 1<sup>st</sup> – October 12<sup>th</sup> 2020

The initial sprint was dedicated to searching online for ideas and research papers on therapeutic games leading into making a list of possible routes to go down for the project. This sprint was not set up properly with story points. Below is the key for the Burnup charts that were used to display the sprints and their progress:

 Work scope    Scope projection    Completed Work    Guideline

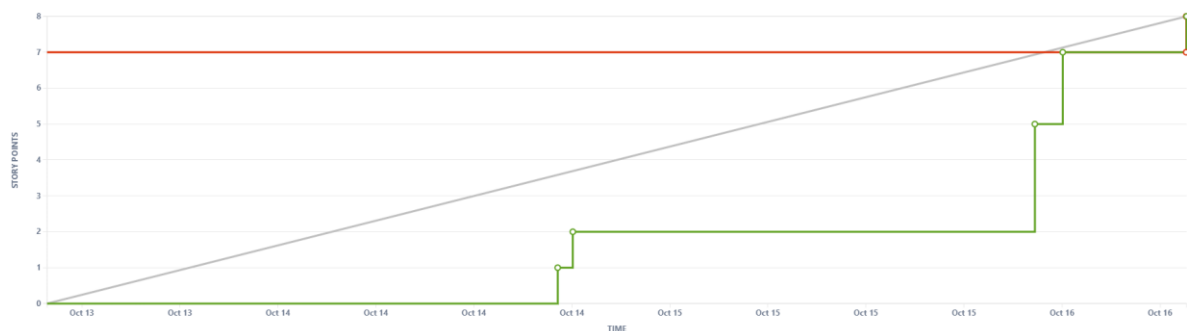
*Fig 4.1 Burnup chart Key*

Burnup charts were used to display the sprint progress as you are able to accurately see changes in tasks and their respective story points, which is essential for an agile plan which calls for change as a project progresses.

Story Points: N/A

Tasks: 2

#### Sprint 2:



*Fig 4.2 Sprint 2 Burnup chart*

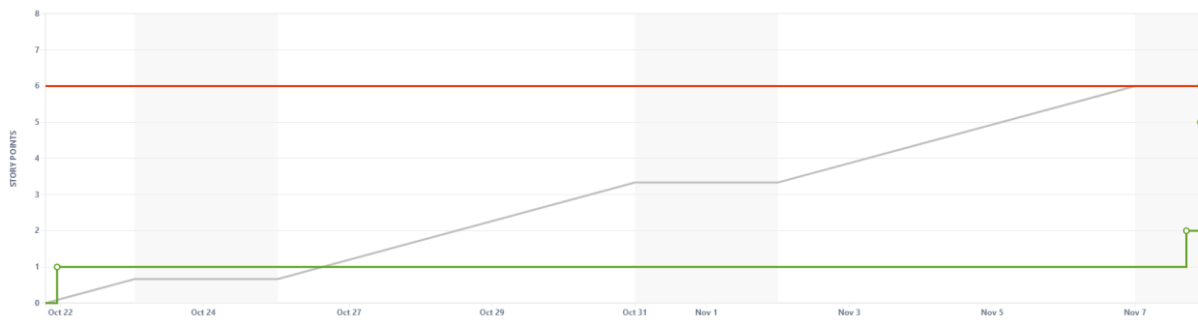
Date: October 13<sup>th</sup> – October 16<sup>th</sup> 2020

This sprint was set with the goal to finalise the direction of the project, choice on the type of management technique and creation of the challenge week presentation. The decision of children with ASD being the target audience for this project was made here and the programming language of java.

Story Points: 7

Tasks: 5

### Sprint 3:



*Fig 4.3 Sprint 3 Burnup chart*

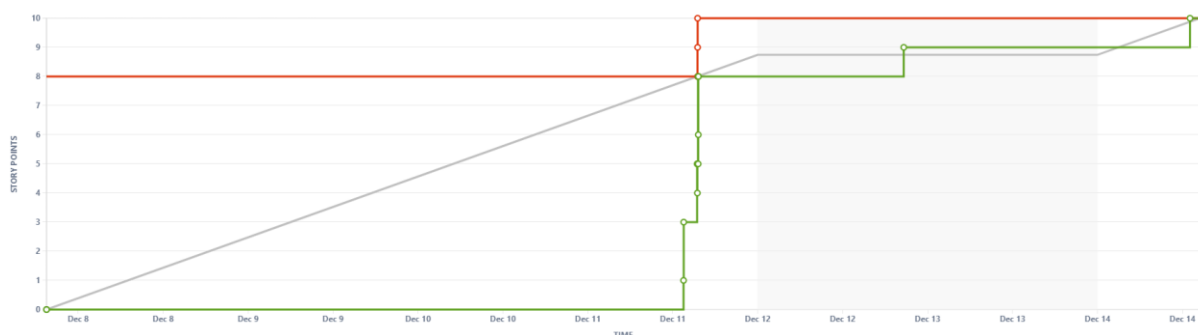
Date: October 22<sup>nd</sup> – November 7<sup>th</sup> 2020

This sprint had the objective of finishing off the planning stage of the project and then completing the design stage of the project. This is where the decision of the game being a type of puzzle game which would be targeted towards an audience of children with ASD using Pivotal Response Treatment (PRT) which is a behavioural therapy. Further research was done on the planning stage and the design stage document was completed with diagrams. Finally, the language of choice was also change from java to working with C# in Unity.

Story Points: 6

Tasks: 4

### Sprint 4:



*Fig 4.4 Sprint 4 Burnup chart*

Date: 7<sup>th</sup> December – 14<sup>th</sup> December 2020

Before the sprint began, time was spent to increase my familiarity with Unity where I learnt about prefabs, materials, scripts and objects and how they all come together in the program. This sprint was dedicated to being able to present a minimal viable product and creation of the presentation for the oral presentation. I was able to meet my goal and create the presentation and a minimal viable product where the game:

- Had a player which could detect collision,
- Contained two kinds of AI following different movement methods,
- AI which would change direction after exiting the collision with a barrier.

Story Points: 10

Tasks: 7

## Sprint 5:

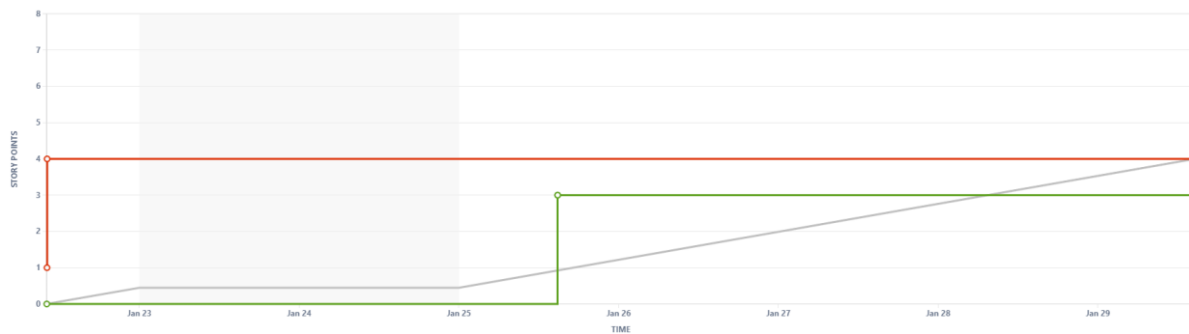


Fig 4.5 Sprint 5 Burnup chart

Date: 22<sup>nd</sup> January – 29<sup>th</sup> January 2021

This sprint was focused on reflecting on the feedback that was received from the oral presentation and progressing in the coding of the game. I was able to do research and have a discussion with my supervisor into the testing for my project. Further the AI spawning system was improved to be overtime instead of on mouse click.

Story Points: 4

Tasks: 2

## Sprint 6:

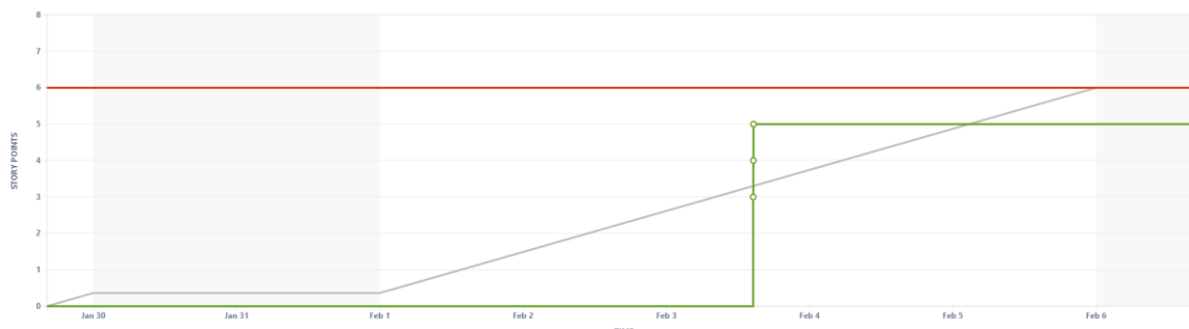


Fig 4.6 Sprint 6 Burnup chart

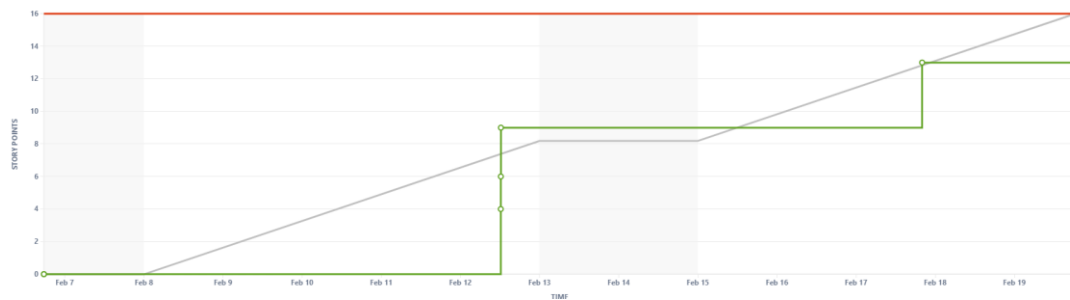
Date: 29<sup>th</sup> January – 6<sup>th</sup> February 2021

This sprint continued the development of the main game mechanics and follow up on the testing aspect of my project. I created a points and life system with a barrier that would check if the AI is on the correct side and increase their score or decrease their health. Further an email was sent to the psychology department through my supervisor for suggestions and ethical approval for my game to be tested with children with ASD.

Story Points: 6

Tasks: 4

### Sprint 7:



*Fig 4.7 Sprint 7 Burnup chart*

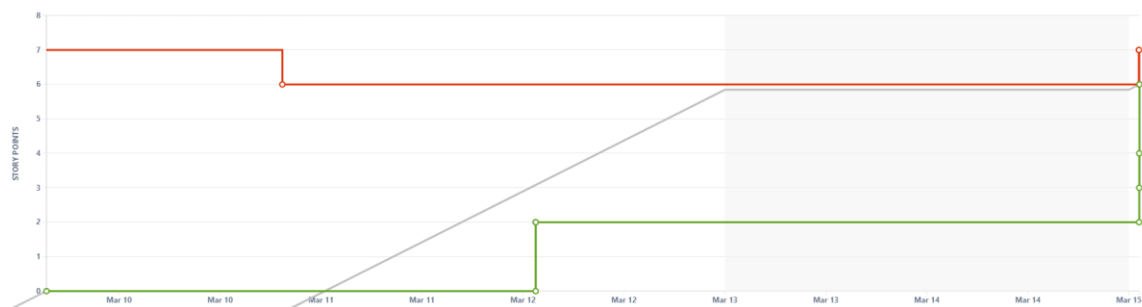
Date: 6<sup>th</sup> February – 19<sup>th</sup> February 2021

This sprint was one of the more challenging ones which concentrated on visual elements with the use of a new software, blender to create a surface for the game to be based on. Through the use of Blender, I was able to create a low-poly island, import it into unity and after some lighting difficulties it was able to have a color map material on it. Further the games code especially with Nav meshes and AI direction movement was adjusted to allow for the island to replace the flat plane.

Story Points: 16

Tasks: 5

### Sprint 8:



*Fig 4.8 Sprint 8 Burnup chart*

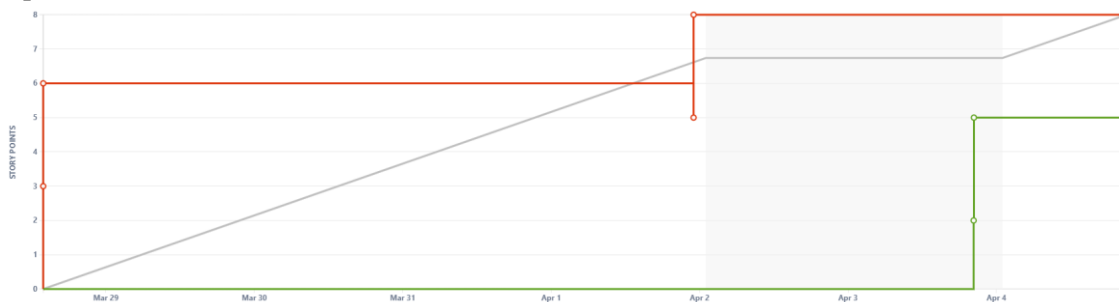
Date: 9<sup>th</sup> March – 15<sup>th</sup> March 2021

This sprint lined up with the deadline of abstract and poster which was the main objective while also planning a discussed end user study to be completed as the psychology had not responded which meant the ethical approval would not happen in time. The poster and abstract were approved and the plan of using normal students for an end user study was reached. Further documentation was updated.

Story Points: 7

Tasks: 3

### Sprint 9:



*Fig 4.9 Sprint 9 Burnup chart*



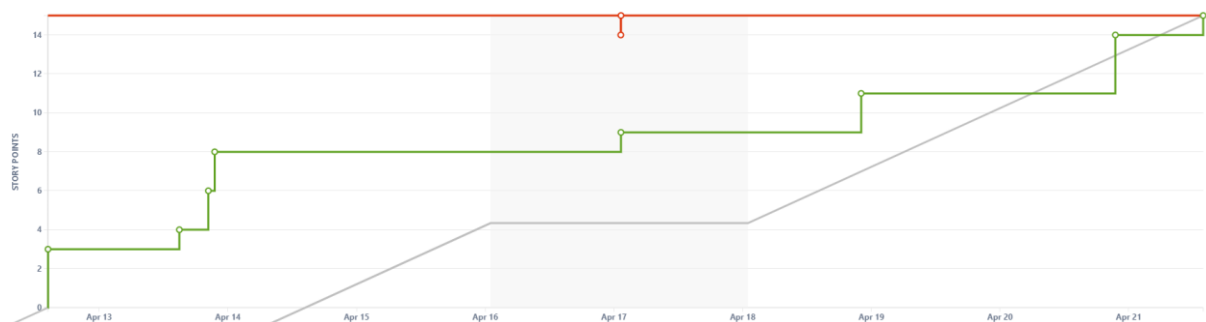
Date: 29 <sup>th</sup> March – 5 <sup>th</sup> April 2021
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This sprint had the objective of implementing the important function of storing user data and progress online through a login system and creating a menu to go with the game. A menu was created with interactable settings and was able to create a login system with the use of Firebase which could send and receive scores. Further did some quality of life changes for the game:

- Added a sign to indicate direction,
- Fixed and tweaked the score system and a method to remove the spawned AI,
- Added more models to the game to not notice removed AI.

Story Points: 8	Tasks: 3
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### Sprint 10:



*Fig 4.10 Sprint 10 Burnup chart*

Date: 13 <sup>th</sup> April – 22 <sup>nd</sup> April 2021
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This sprint was dedicated to the final touches to the game to be a final initial iteration of the game, improve on the clarity of the game and further many bug fixes and changes to the firebase system which proved challenging being a new topic. A lot of changes were done during this sprint:

- A speech bubble system was implemented to indicate which side was correct.
- A game over screen was created.
- Created sprites for the health system and fixed the bug in the system to start at 0 health.
- Changed high score system from showing all users most recent score to display date and time of only the playing users score.
- Settings menu was recreated due to an error removing it.
- Fix warning messages such as successfully logged in and stuff to display.
- Sound effects: point up, health down, switch triggered and speech bubbles pop up.
- Research into singletons to fix many issues with going between scenes and not duplicating objects and being able to refer to correct objects. The menu manager, game manager and firebase manager were made into singletons. Firebase manager further made to not destroy on load.
- Button interactions were hard coded into scripts instead of using Unity's UI.

Further the report was organised by combining the documentation and creating a contents page.

Story Points: 15	Tasks: 8
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## GitLab

Gitlab was primarily utilised to update code changes and additions. These updates would be done in sections, when a major changes and milestones would be reached. There has been a total of 16 scripts in use for the game:

AIMovement	This script would use a camera to send a ray to the mouse click location and set the location for the player to move.
AIMovementPoint	This script would first set the AIs initial direction to walk in, then would change direction according to a Boolean which would set their direction OnTiggerExit() with the barrier or checkpoints. The Boolean would be connected to the Trigger direction setting left or right coordinates.
CheckPoint	This script would check that the AI on the left side is correct and would increase the score or decrease the health respectively.
CheckPoint2	This script is identical to CheckPoint but to check for the right side.
DeSpawner	This script would remove an object that has gone past a certain coordinate, ensuring that redundant objects were kept in check.
EndScore	This script would get the Score script value to display when the game is over.
FirestoreManager	This script would handle all interactions between Unity and Firestore, this would be from knowing who is logged in and what their scores are/is.
Health	This script would handle the players health, changing the sprite of the health point as the players health would decrease. Further would call an Endgame() function in MainManager when health hit 0.
MainManager	This would handle most of the functions during the Game scene. →Would handle the Speech bubble UI to display at different times of the game and change text and sprites. →Would call the Firestore function to save the score value received when a game over button was pressed. →Would handle the game over UI. →Further held objects to be referred to as a Singleton from the FirestoreManager.
Score	This script would handle the score of the game. For every 50 points gained the a delayed coroutine would be called to invert a Boolean to switch the sides which the AI is correct.
ScoreElement	Object to hold score and date values.
Settings	This script would control the music volume using an audiomixer object with a sliders value and a fullscreen toggle. Further made

	into a Singleton and DontDestroyOnLoad() to make sure this continued form the menu to the game.
Sign	This script would control an objects color in the game to indicated which direction the AI will go to after passing the invisible barrier.
TimedSpawner	This script makes use of InvokeRepeating() to randomly chose between 2 AI objects to Instantiate at a chosen rate.
Trigger	This script controls the main Boolean that indicates which direction to send AI. It checks for collision with the Player to change the direction Boolean.
UIManager	This script manages multiple interactions in the Menu scene: →Would handle button interactions to call FirebaseManager functions such as Login() →Would handle which UI objects to be SetActive() depending on which function was called after a button press. →Holds all the Menu scene objects and is a Singleton to be referred to by Firebase Manager

Link to GitLab Repository: [https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/tree/master](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/tree/master)

Link it GitLab README.md containing technical documentation:

[https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/blob/master/README.md#technical-documentation](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/blob/master/README.md#technical-documentation)

## **Design**

### **Agile:**

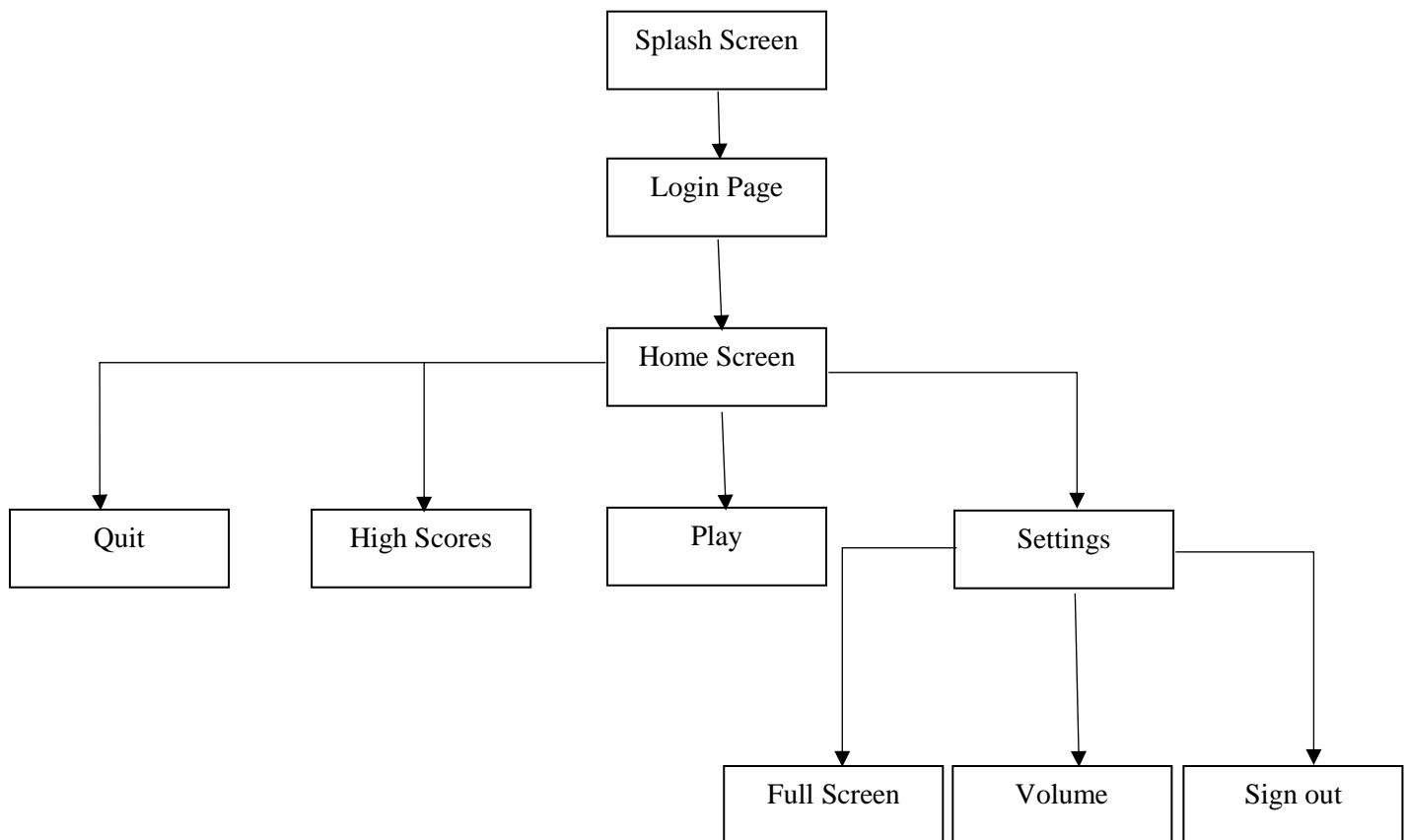
There are two ways to approach the design stage[14], the visual which I what the target audience seen such as the UI, and the architecture, which is what happens behind the UI and the tools needed to achieve it. The design of a therapeutic game would include but are subject to change due to the evolving management methodology, agile, are[12]:

- Rapport Building: The game would have features which would allow to see and save progress over time.
- Frustration Tolerance: The game would seek to maintain a low level of stress and low levels of frustrations to ensure the playing of the game and to encourage people to return.
- Decision Making: The game would observe their decision-making skills to understand if there is patience or impulse, what choices are made.
- Problem Solving: The game would be able to observe problem solving skills where necessary just as in decision making.
- Response to Rules: The game would have certain methods coded in to deal with different situations that would be referred to as rules.
- Positive Reinforcement: The game would show progress and even show rewards when situations are handled or answered correctly.
- Atmosphere: The game would, depending on the direction the therapeutic game would take, have certain visual choices and coordination to create a welcoming and beneficial environment.

### **Design Brief:**

To be able to make a game for children with ASD, the game will need to be able to test and train children with ASD to respond to certain ques, while also being progressive so not only one que would be responded to but as the game went on it would get harder requiring the child to respond to more/different ques over time. To be able to achieve this I have chosen to make a type of sorting game such as one object would appear and the child has a limited amount of time to be able to choose where this object is to sorted according to its characteristics.

## Site Map:



Splash Screen: This section will contain a type of splash art for the game and loading bar with version of the game and will fade into the Login Page when fully loaded.

Login Page: This section will have the login allowing for the game to keep track of who is playing the game and be able to save information and progress done for the individual.

Home Screen: This section will be faded into after the Login Page and will contain the main elements and is the screen the child is returned to when the game is lost. The section will have the buttons Play, High Scores, Help, Settings.

Play: This section will take the user into the game to play the game and continue to play until they have lost all lives or lost the game and will have a popup appear displaying their score and return them to the Home Screen to play again.

Help: This section will show an animation of how to play the game, being very basic and straight forward to avoid confusing the child.

High Scores: This section will hold and display high scores of different users and depends on the end user, whether it would help encourage the user to do better or cause stress.

Settings: This section will have options to change the game volume or design of the game such as if the user likes different kinds of objects to help the child with ASD be encouraged to play.









Credits: This will just be a basic rolling screen of credits such as who made the game.

Difficulty: This will be a control that can be changed on whether the user would like to start the game with one que or more ques, increasing the starting difficulty.

Progress: This will display where the user makes mistakes on what number of ques and which ques and can even be translated into a graph. This is mainly to track progress and see progression over time and what sections need more work.

## User Personas, Stories and Journeys:





### Children with ASD:

<b>NAME</b> <b>Johnathan Nile</b>	<b>Background</b> Johnathan is a fun loving child who is on the autism spectrum	<b>Technology</b>    
<b>TYPE</b> <b>Playful</b>	<b>Frustrations</b> Not being able to keep up with classmates Bot being able to respond to multiple ques	<b>Motivations</b> Due to being on the spectrum Isabella has been a pivotal point in his life to motivate Johnathan to keep on trying
<b>Skills</b> <b>Maths</b> 0 25 50 75 100 	<b>Demographic</b>  Male 8 years  Brentwood	<b>Goals</b> To overcome boundaries set by having ASD
<b>English</b> 0 25 50 75 100 		

Story: As a <role> child with ASD </role> I want to be able <goal> to play a fun game </goal> that will <benefit> help my difficulties with ASD</benefit>.

Journey: As a child would mainly be interested in playing the game. A user would first open the game and login. Next would click the Play button. If the child was having difficulty to play the game they would click the Help button instead. The child also may be interested in seeing their high score by clicking on the high score button. Further the child may go into the setting to access the volume controls.







## Therapist working with Child with ASD:

<p>NAME</p> <p><b>Bethany Rose</b></p> <p>TYPE</p> <p><b>Idealist</b></p>	<p><b>Background</b></p> <p>Bethany recently graduated from university and has since spent time studying and practicing in a clinic which uses Pivotal Response Treatment to help children on the spectrum with ASD.</p>	<p><b>Technology</b></p> <p> </p>
<p><b>Skills</b></p> <p>Communication</p> <p>0 25 50 75 100</p> <p>Tennis</p> <p>0 25 50 75 100</p>	<p><b>Frustrations</b></p> <p>Bethany's frustrations lie where some children on the spectrum do not get diagnosed with being on the spectrum or are inaccurately diagnosed on the spectrum and aims to fix when these situations occur.</p>	<p><b>Motivations</b></p> <p>Due to being in a family that took in and cared for children on the spectrum, Bethany has been motivated from a young age to listen and talk to people about their issues leading Bethany to pursue psychology.</p>
	<p><b>Demographic</b></p> <p> Female 26 years</p> <p> Brentwood</p> <p>Therapist</p> <p>Single</p>	<p><b>Goals</b></p> <p>To do more research towards having an autism spectrum that is not only based on men.</p>

Story: As a <role> therapist of a child with ASD </role> I want to be able <goal> to help my client </goal> with his difficulties and <benefit> see my child's progress and improvements and make changes to the games difficulty and help the child improve over time </benefit>.

Journey: As a therapist would mainly be interested in seeing the progress of the child. A user would first open the game and login. Next would click the Settings button. The therapist would be interested in the progress of their child they would click the progress button, and depending on the results they see they would interact with the difficulty button and if they wanted to alter the high score toggle button they would click the high score button.

## Parent of Child with ASD:

<p>NAME</p> <p><b>Isabella Nile</b></p> <p>TYPE</p> <p><b>Guardian</b></p>	<p><b>Background</b></p> <p>Isabella is a well versed nurse and able to help children and people but finds trying to raise a child with ASD more challenging than her work.</p>	<p><b>Technology</b></p> <div></div> <div></div>
<p><b>Skills</b></p> <p>Nursing</p> <p>0 25 50 75 100</p> <p>Yoga</p> <p>0 25 50 75 100</p>	<p><b>Frustrations</b></p> <p>Not having enough information and help with her child of special needs. Not being able to get her child the best help due to the current pandemic. Cost of raising a child on the spectrum with ASD</p>	<p><b>Motivations</b></p> <p>Due to being motivated to help people in need Isabella perused her desire and became a nurse and is training to become a paediatrician.</p> <p><b>Goals</b></p> <p>Become a paediatrician Help her child with ASD</p>
<p><b>Demographic</b></p> <p> Female 34 years  Brentwood</p> <p>Married Nurse</p>		

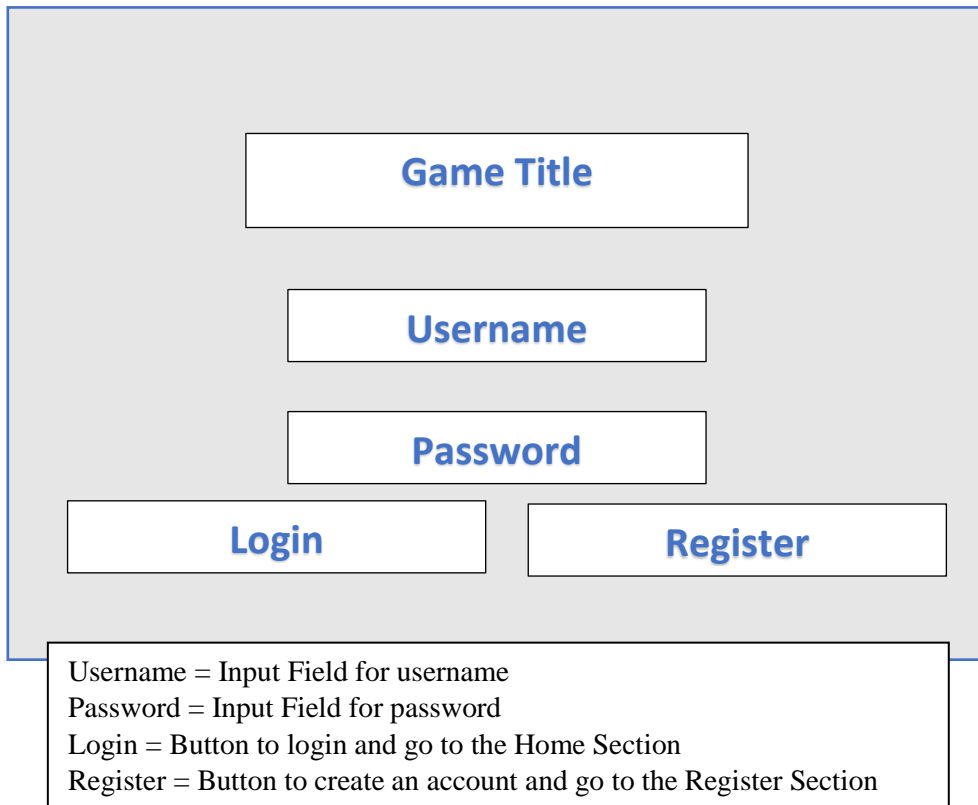
Story: As a <role> parent of a child with ASD </role> I want to be able <goal> to help my child </goal> with his difficulties and <benefit> see my child's progress and improvements. </benefit>.

Journey: As a parent would mainly be interested in seeing the progress of the child. A user would first open the game and login. Next would click the Settings button. If the parent was interested in the progress of their child they would click the progress button, while if they wanted to alter the high score toggle button they would click the high score button. Otherwise they would change the difficulty of the game for their child.



## Wire Frame:

### Login Section:



The Login Section wireframe consists of a light gray rectangular container. Inside, the elements are arranged vertically: a 'Game Title' label, followed by 'Username' and 'Password' input fields, and then two buttons labeled 'Login' and 'Register' side-by-side. A legend box at the bottom explains the components.

**Game Title**

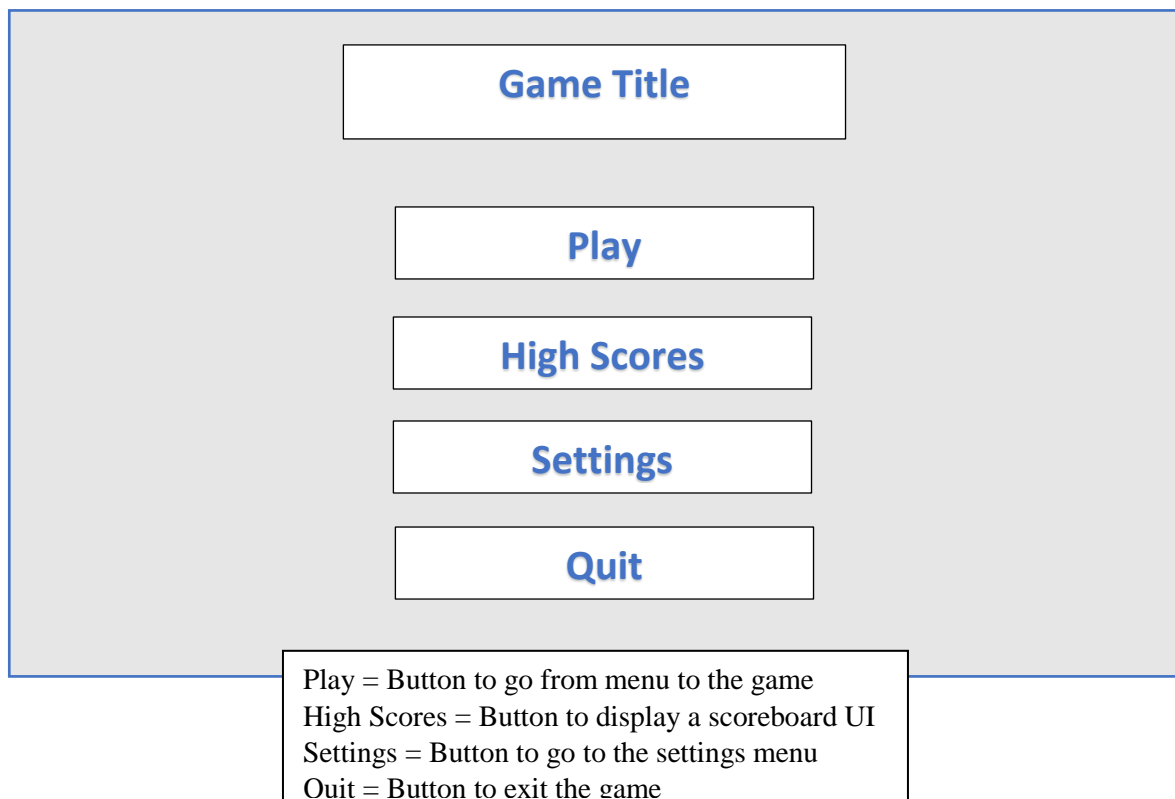
**Username**

**Password**

**Login** **Register**

Username = Input Field for username  
Password = Input Field for password  
Login = Button to login and go to the Home Section  
Register = Button to create an account and go to the Register Section

### Home Section:



The Home Section wireframe consists of a light gray rectangular container. Inside, the elements are arranged vertically: a 'Game Title' label, followed by four buttons labeled 'Play', 'High Scores', 'Settings', and 'Quit'. A legend box at the bottom explains the components.

**Game Title**

**Play**

**High Scores**

**Settings**

**Quit**

Play = Button to go from menu to the game  
High Scores = Button to display a scoreboard UI  
Settings = Button to go to the settings menu  
Quit = Button to exit the game

### Settings Section:

Settings

Background Music

Sound Effects

Help

Sign out

Background Music = Bar to control background music volume.  
Sound Effects = Bar to control background music volume.  
Help = Description of how to play the game  
Sign out = Sign out the user

### High Scores Section:

Scores

Date	Score
D/M/Y	X
...	...
...	...

Back

Date/Top

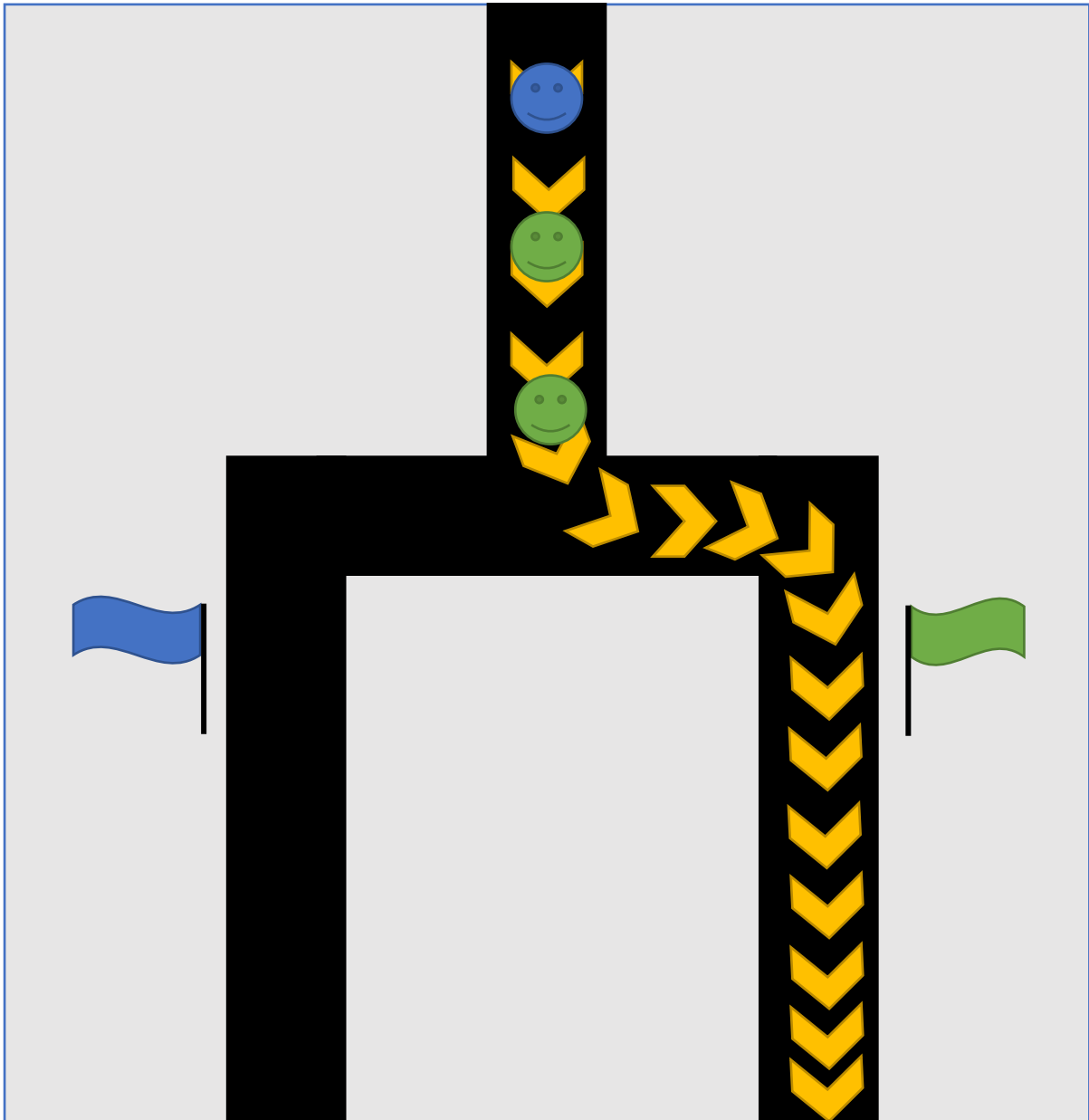
Back = Button to go back to menu  
Date/Top = Button to display in order of highest score or recently played

Register Section:

The registration form is titled "Game Title - Registration". It contains four input fields stacked vertically: "Email", "Username", "Password", and "Confirm Password". At the bottom of the form are two buttons: "Back" and "Register".

Email = Input Field for email  
Username = Input Field for username  
Password = Input Field for password  
Confirm Password = Input Field for password to confirm typed correctly  
Back = Button to login and go to the Home Section  
Register = Button to create an account and go to the Login Section

Play Section:



In the game object will flow down the track and follow the route laid by the yellow arrows. If the object matches the flags ques then the user would have done it correctly and earned a point, but if done incorrectly would lose a life. The use is able to change the path the objects are following by using arrow keys. In this situation the path is already going to the right and would match the first 2 objects would match the flags que of green. But when the third object comes it would not match the que and the user would lose a life. The que that was incorrect would also be recorded for progress purposes. The user would be required to change the direction of the yellow arrows to the blue flag to not lose a life and earn a point.

## Implementation

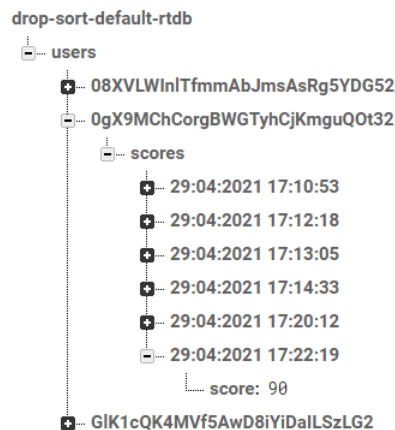
Each script in Gitlab has a “boilerplate” attached in the start, explaining what the script does and how. Further comments are found throughout the script for more specificity. This is further linked in the technical documentation README.md found on Gitlab.

Rapport Building:

The product needed to be able to have a method to be able to keep track of a patient’s progress. To achieve this each user needs a personal account and a way to store the scores that they receive. Firebase is Backend-as-a-Service which provides a variety of tools and services to aid in the development of applications. It database program with does not use SQL, the data is stored in JSON-like documents and is Realtime. Firebase is used for this project as an online database to be able to store user’s data confidentially and it can be accessed at any time and be up to date with the user data. To be able to do this a google-services.json file is saved in the games assets directory which is then used to access the online database. The script that handles the games interaction with Firebase is FirebaseManager.cs

The game has UI that is controlled through the UIManager.cs which holds the input fields that the FirebaseManager.cs refers to when coroutines are being called.

- ▶ UIManager objects = [https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/blob/master/Scripts/UIManager.cs#L31](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/blob/master/Scripts/UIManager.cs#L31)
- ▶ FirebaseManager reference to UIManager = [https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/blob/master/Scripts/FirebaseManager.cs#L101](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/blob/master/Scripts/FirebaseManager.cs#L101)



*Fig 5.1 Firebase database*

The Firebase database stores data as shown in *Fig 5.1* through a task referencing the child in the tree:

- ▶ FirebaseManager storing = [https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/blob/master/Scripts/FirebaseManager.cs#L232](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/blob/master/Scripts/FirebaseManager.cs#L232)

The game through these scripts completes registration, login and sign out correctly and further can display the users scores [Appendix I].

Frustration Tolerance:



*Fig 5.2 Checkpoint Condition delayed change for AI accepts AI already past “barrier”*

The product would need to be fair towards the user for it to be enjoyable. During the game after a certain score was reached speech bubbles would appear to indicate the new direction to send the AI and the checkpoints conditions would change accordingly. With the use of a coroutine and a delayed Boolean, AI that was already past the barrier and moving to their dedicated checkpoint, before the player was informed of the direction change, operate off the previous checkpoint acceptance criteria.

- ▶ Score delay coroutine = [https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/blob/master/Scripts/Score.cs#L64](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/blob/master/Scripts/Score.cs#L64)
- ▶ CheckPoint referring to Score = [https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/blob/master/Scripts/CheckPoint.cs#L28](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/blob/master/Scripts/CheckPoint.cs#L28)

Decision Making & Problem Solving:



*Fig 5.3 Player moving and interacting with red Trigger to change direction*

The game challenges the user to interact with the trigger correctly to be able to tell the AI which direction to go in. The user is informed with speech bubbles which side requires which AI for a given amount of time then the speech bubbles disappear. If the user gets the AI wrong they have to react in time to be able to not get more wrong. Further the user must react to when the speech bubbles pop up again to change the AI accepted.

- ▶ Player movement = [https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/blob/master/Scripts/CheckPoint.cs#L28](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/blob/master/Scripts/CheckPoint.cs#L28)
- ▶ Trigger change direction = [https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/blob/master/Scripts/Trigger.cs#L29](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/blob/master/Scripts/Trigger.cs#L29)

#### Response to Rules:

To be able to have the game operate between scenes as intended there are certain “rules” that were implemented. Singletons are very important as without them the FirebaseManager would not be able to recognise the input fields, who the current user is between scenes and what score the user achieved. Singletons are created in the Awake method to check if an instance of the script already exists, if an instance already exists then it destroys itself while if an instance doesn’t exist it sets itself as the instance. Further singletons can be referred to between scenes and even if they have not been instantiated yet such as the relationship between MainManager and FirebaseManager which are in different scenes. Singletons are present in MainManager, UIManager, FirebaseManager and Settings (for user settings to persist between scenes such as music volume).

- ▶ Singleton instantiation = [https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/blob/master/Scripts/MainManager.cs#L56](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/blob/master/Scripts/MainManager.cs#L56)
- ▶ FirebaseManager using MainManager singleton = [https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/blob/master/Scripts/FirebaseManager.cs#L118](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/blob/master/Scripts/FirebaseManager.cs#L118)

Of the four singletons FirebaseManager and Settings also make use of DontDestroyOnLoad which means when going between scenes that the same instance persists allowing for the score to be saved to the user who is logged in and also so the settings will be the same always.

Another main element of the game is the Booleans that the game operates off to know when to change directions and Checkpoint conditions. The primary Boolean that other classes refer to for direction is the Trigger direction bool = [https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/blob/master/Scripts/FirebaseManager.cs#L118](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/blob/master/Scripts/FirebaseManager.cs#L118). This governs the AIMovePoint bool for direction and Sign bool for color.

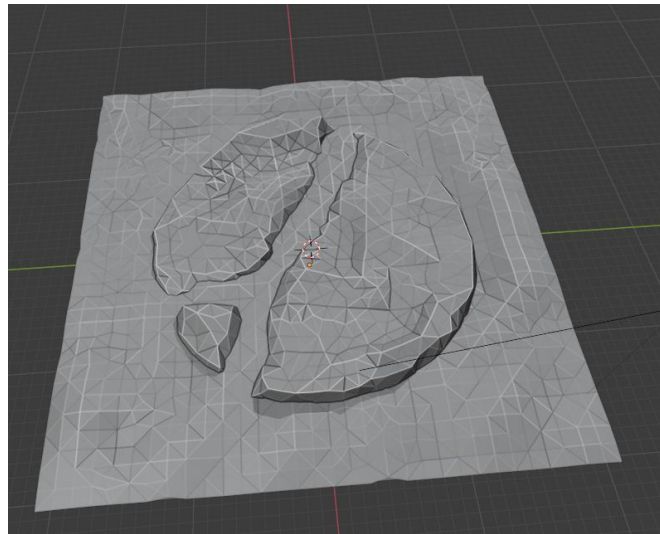
- ▶ AIMovementPoint reference to Trigger = [https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/blob/master/Scripts/AIMovementPoint.cs#L38](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/blob/master/Scripts/AIMovementPoint.cs#L38)
- ▶ Sign reference to Trigger = [https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/blob/master/Scripts/Sign.cs#L25](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/blob/master/Scripts/Sign.cs#L25)

#### Positive Reinforcement:

For the user to be encouraged to play and find the experience enjoyable the users scores are initially listed in a descending order instead of by date and time, to give the user a target to beat while reminding them of what they accomplished. During the game when the user correctly sorts the AI their score increases and a positive sound effect is played. Further when the game ends encouraging “Well Done!” text is displayed to create a more positive feeling to play the game, avoiding more negative connotations such as “You Lose!” or “Game Over!”

- FirebaseManager ordering by Score in descending =  
[https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/blob/master/Scripts/FirebaseManager.cs#L246](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/blob/master/Scripts/FirebaseManager.cs#L246)
- CheckPoint sound effect and score value increase for correct=  
[https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/blob/master/Scripts/FirebaseManager.cs#L246](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/blob/master/Scripts/FirebaseManager.cs#L246)
- MainManager EndGame called =  
[https://cseegit.essex.ac.uk/ce301\\_2020/ce301\\_saleh\\_danyal/-/blob/master/Scripts/MainManager.cs#L76](https://cseegit.essex.ac.uk/ce301_2020/ce301_saleh_danyal/-/blob/master/Scripts/MainManager.cs#L76)

Atmosphere:



*Fig 5.4 Game Island in Blender*

The aim of the atmosphere of the game was to create an environment where the user could relax and not feel alarmed by the game overall an enjoyable. The objective would be to make the user feel like they are in their own world in the game and can concentrate the games tasks, almost like the user was on this Island on their own with no fear of distractions around them. With using Blender for the first time, the idea of creating a low-poly Island seemed to fit the direction of the game while also being an achievable challenge. First beginning with a sphere from object mode then switching to sculpt mode and enabling dynamic topology to be able to create a low-poly design, working away slowly at the structure of the sphere to create an Island. Next using shader editor and trying out different combinations of nodes (such as gloss or transparency) with Mix Shader node and values to color the island. Further use of Edit Mode to select polygons and paint them with chosen colors in Vertex Paint. Lastly to be able to use the model with the colors a UV map would need to be made to be able to export a color map to be used as a material for the Island in blender. Overall the experience in Blender was difficult to get the hand of, having multiple editors open at the same time, but was very beneficial with the tools available and was a rewarding experience and resulted in an Island that worked well with Unity's NavMeshAgents.



## Testing

Testing is dedicated to check the systems functionality of all implementations and whether they correspond with original goals and requirements. The games robustness will also be tested here by repeating certain tasks in the same session. To be able to do this test cases will be made highlighting each test.

### Test Cases:

Test #	Test Case Description	Test Data	Expectation	Result	Pass/Fail
1	Check user login with correct data	Email = test@essex.com Password = test123	Logged in successfully	As Expected	Pass
2	Check warning message correlates with missing/incorrect input	Email = Password = test123	Warning message to display "Missing Email"	As Expected	Pass
3	Check user registration with correct data	Username = test2 Email = <a href="mailto:test2@essex.com">test2@essex.com</a> Password=test123 Confirm=test123	Registered Successfully	As Expected	Pass
4	Check warning message correlates with missing/incorrect input	Username = test3 Email = <a href="mailto:test3@essex.com">test3@essex.com</a> Password=test123 Confirm=wrong00	Warning message to display "Password Does Not Match"	As Expected	Pass
5	Check Scores button correctly displays the users scores	Clicking score button while logged in	A scoreboard to display all the users scores	As Expected	Pass
6	Check volume slider gradually changes when user changes it	Dragging the slider in the settings menu labelled Volume	Volume to gradually changer according to slider	As Expected	Pass
7	Check toggle for Full Screen is called when interacted with as not available in Unity editor till exported	Debug.Log to see the command being called	Expectation "QUIT" being print in the Unity terminal	As Expected	Pass
8	Check Play Button changes the game to Game scene and Player is able to move	Clicking Play button then being in the Game scene. User able to move the Player	User able to mouse click to move the Player after scene change	As Expected	Pass
9	Player is able to change direction sign	Player moves through the Trigger to change the sign color indicating direction	When the Player touches the Trigger, a sound effect plays, the sign changes color	As Expected	Pass

			indicating direction		
10	Check AI moves according to sign direction	AI moving past invisible barrier setting direction and Player changing direction during	When AI exit the invisible barrier, they move in the same direction as the sign indicates when Player hits Trigger.	As Expected	Pass
11	Check Points increase when correct sorting of AI and Health decrease	AI moving into the end Checkpoints	When the AI goes to the correct side the Points increase by 10 and when incorrect the 1 health sprite will go empty	As Expected	Pass
12	Check when the sides change that AI that is already near the Checkpoints are accepted	AI moving into the end Checkpoints when Points = 50	When the Speech Bubbles indicate the side change, the AI which have already passed the Barrier still gain the user 10 Points	As Expected	Pass
13	Check when Health hits 0 the game ends and the Score gets saved	Players health = 0 Score = 60	The Game Over UI covers the screen, Player can no longer move and no more AI spawn. Main Menu button is clicked, Scores button clicked, Score = 60 on scoreboard with correct date and time	As Expected	Pass
14	Check Sign out occurs successfully	test2 scoreboard = 60,30 with d/m/y/h/m Sign out button clicked Email = <a href="mailto:test@essex.com">test@essex.com</a> Password=test123 test scoreboard = 120, 90 ,90... with d/m/y/h/m	Test2 and Test accounts both have different scoreboards as they are different accounts	As Expected	Pass

15	Check the Game can be played multiple times without issues	Play button clicked Score=30 Play button clicked Score =20 Play button clicked Score =30 Scores button clicked, scoreboard score=30,20,30 with d/m/y/h/m	Able to play multiple games in the same session without issue and the scoreboard will update successfully	As Expected	Pass
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The initial approach was to be able to have the game user tested by a group of children who have ASD with attempts being made to be able to get in contact with the psychology department but with further consideration due to COVID, receiving ethical approval was not a feasible approach in the given time frame. For the testing to be considered relevant to the topic a similar method would be optimal, hence the user testing would proceed as initially planned but be performed by a group of individuals with different areas of study. While they do not have an association with ASD, a user testing from a wide range of individuals would provide fair testing and further the individuals would be clearly informed about what ASD is and how the game is aimed to train conditional discrimination. To achieve this end, an email was sent out to the individuals asking if they are willing to partake in the testing of my game [Appendix II]:

“Dear all,

For my final year project, I have created a game for children with ASD and would appreciate if you could test the game and provide some feedback on a google forum about the game. Please reply to this email to confirm you would like to test the game and I will forward you the link to the google forum and game.

Thank you for your time.”

For future testing if ethical approval is granted, observing the average scores of the children with ASD playing the game over a few months would be optimal. Whether the scores increase over time with their therapy sessions or if there is some other pattern present. Further whether the therapists themselves find the game beneficial for the patient. Once the individual agreed to participate they would be emailed with a link to a google form where they are advised about:

- 1) What ASD, conditional discrimination and multiple cue responding is:

## Drop Sort Feedback

Thank you for taking part and providing feedback on my Project, please take the time to read the below information to understand the games target audience. If there are any questions please feel free to email me!

**What is Autistic Spectrum Disorder?**

Autistic spectrum disorder (ASD) is a complex developmental condition that can be challenges in social situations such as interaction, speech, nonverbal communication, restrictive/repetitive behaviours. As it is a spectrum there is wide variation in the type and effect it has on the individual making every case unique.

**Conditional Discrimination and Multiple cue responding:**

Drop Sort aims to tackle a core part of Pivotal Response Treatment known as conditional discrimination through training multiple cue responding which is where when asked the question: "What color is the cat?" The response of the child is "meow" instead of the color of the cat as the child only recognized 'cat'.

*Fig 6.1*

- 2) What they are meant to do for the testing,
  - a. Registration
  - b. Login
  - c. Play the game at least 3 times to allow for some understanding of the game.
  - d. Explore the games menu buttons: In settings changing the volume of the game, check their scoreboard
  - e. Informed to keep the game open for the following test cases.

**Testing Procedure:**

- 1) Open the game and click the CREATE button to register
- 2) Login using the same account information you registered with
- 3) Play the game at least 3 times to allow for some understanding of the game
- 4) Please explore the games menu button such as In SETTINGS changing the volume of the game or check SCORES
- 5) Please keep the game open for the following test cases

*Fig 6.2*

- 3) Given a set of test cases to check. This is a simplified version of the one done above for more robustness.
  - a. Were you able to register?
  - b. Were you able to login?
  - c. If you entered any input incorrectly was there a warning message?
  - d. Did all button interactions result in the expected interaction? (Such as did Play take you to the game and did Settings take you to the settings menu?)
  - e. Were you able to adjust the volume with the slider?
  - f. Were you able to view all your scores?
  - g. Please now go to settings and use the Sign out button, were you able to sign out?

**Test Cases \***

- ☐ a. Were you able to register?
- ☐ b. Were you able to login?
- ☐ c. If you entered any input incorrectly was there a warning message?
- ☐ d. Did button interactions result in the expected interaction? e.g. Play button went to game
- ☐ e. Were you able to adjust the volume with the slider?5
- ☐ f. Were you able to view all your scores?
- ☐ g. Please now go to settings and use the Sign out button, were you able to sign out?

*Fig 6.3*

- 4) Asked if they could see a connection of how the game can be beneficial for children with ASD:
  - a. If they could see how the game could aid in conditional discrimination.
  - b. If they could see how the game trains multiple que responding.
  - c. If they believed this could be beneficial for children with ASD.

Could you observe if the game aids in conditional discrimination? \*

Choose ▼

Could you observe if the game trains multiple que responding?

Choose ▼

Do you believed this could be beneficial for children with ASD? \*

Your answer \_\_\_\_\_

*Fig 6.4*

- 5) Asked for their opinions:
- Improvements,
  - Bugs/Errors encountered,
  - How their overall experience was.

Any Improvements/Suggestions?

Your answer \_\_\_\_\_

Any Bugs/Errors encountered?

Your answer \_\_\_\_\_

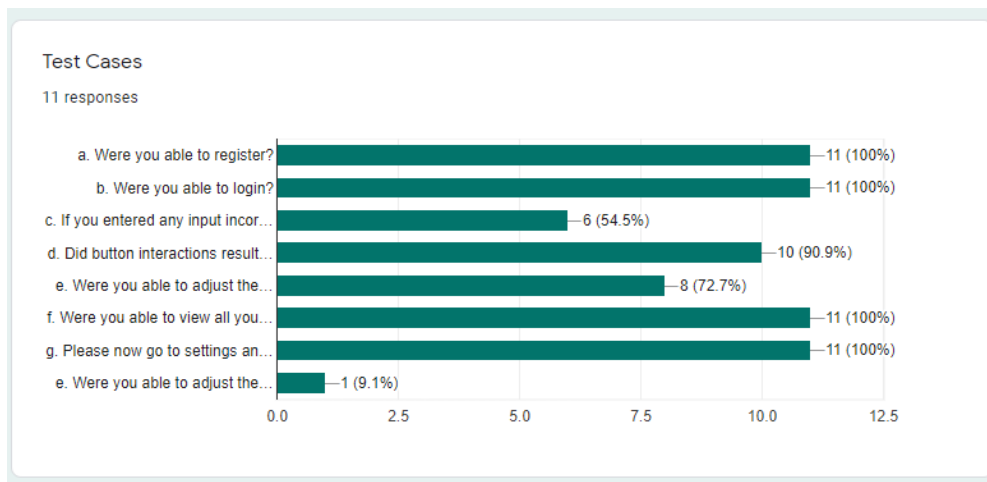
How did you find the overall experience? \*

Great      1      2      3      4      5      Bad

○      ○      ○      ○      ○

*Fig 6.5*

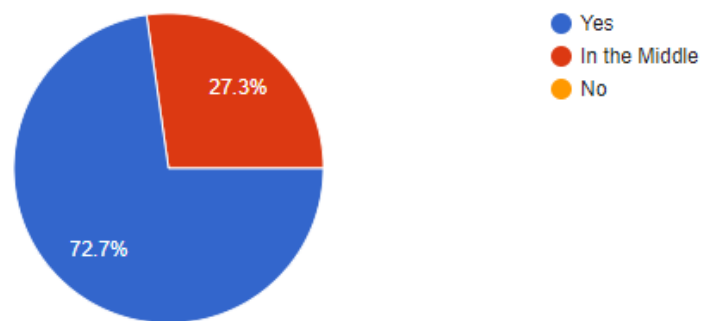
## Results Section:



*Fig 6.6 Test cases results (note both e label on the y-axis are equal e=7)*

Could you observe if the game aids in conditional discrimination?

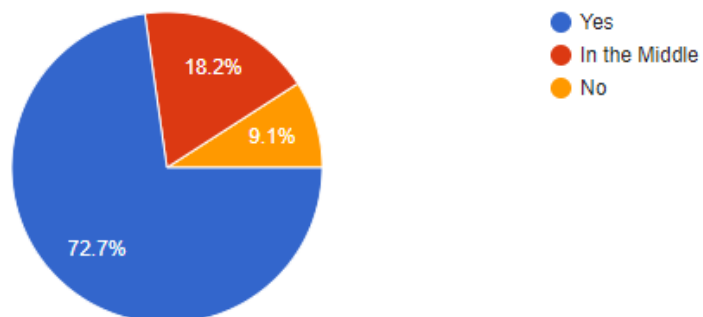
11 responses



*Fig 6.7 Conditional discrimination responses*

Could you observe if the game trains multiple que responding?

11 responses



*Fig 6.8 Multiple que responding responses*

### Any Bugs/Errors encountered?

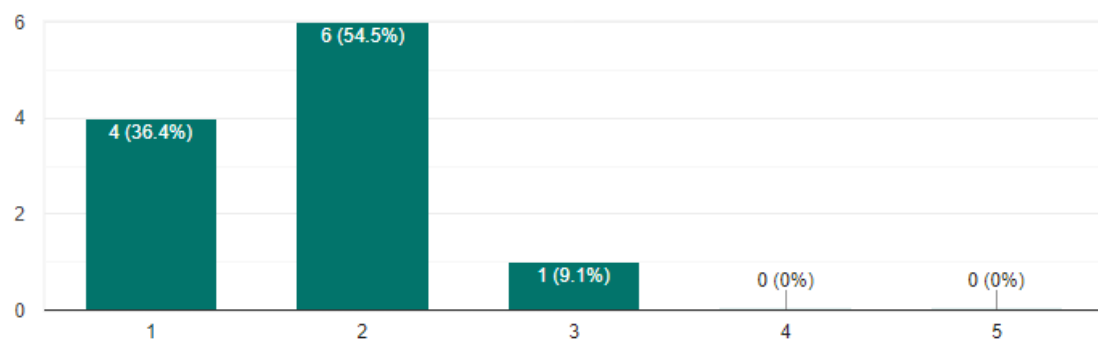
11 responses

No
no
Yes when button clicked would be shown as still clicked.
None
No bugs or errors.
I have to go through the button completely? I dont think if that is how it is suppose to be

*Fig 6.9 Bugs/Errors responses*

### How did you find the overall experience?

11 responses



*Fig 6.10 Overall experience, where 1 = Great and 5 = Bad*

*Refer to [Appendix III] for the following results:*

- Do you believed this could be beneficial for children with ASD?  
11 responses
- Any Improvements/Suggestions?  
11 responses

## Evaluation

With a total of 15 tests cases done and all being successful, knowing how these tests can relate the Implementation to the objective is key, while another layer to this is the test users who also did their separate test cases. By going through the test cases, we can see which test links with which objective:

1. Through the test cases we can see that the Rapport Building linked to test #1,2,3,4,5,14
  - ▶ We can further see through the users tests that the testers were able to register, login, view the scoreboard and sign out successfully 100% of the time.
  - ▶ With having 6 test cases which correlate with the objective and the test users having no issues, the system currently in place meets the requirements for being able to hold and display the users data.
2. Through the test cases we can see that the Response to Rules linked to test #14,15
  - ▶ These test cases do thorough checks for this objective and observe that the relationship between scripts and when going between scenes are kept intact with no issues.
  - ▶ Button interactions done by the test users and worked as expected 90.9% of the time indicating that the functions do work as expected.
3. Through the test cases we can see that for Atmosphere linked to test #6,7
  - ▶ This objective is further affected by the use of Blender to create the Island
  - ▶ The test cases check that the user has control over the settings to be able to chose settings that is comfortable to the user.
  - ▶ The test users overall experience rating for the game (*Fig6.10*) is generally positive indicating that the game did create a positive atmosphere to test in.
4. Through the test cases we can see that the Positive Reinforcement linked to test #5, 13, 11
  - ▶ The test cases see when the game ends that “Well Done!” is displayed, when points increase a sound also plays and the scoreboard is ordered by highest score. While these are small adjustments towards the game for what the user sees they can encourage a user to keep playing and grant satisfaction for doing well.
5. Through the test cases we can see that that Frustration Tolerance linked to test #12
  - ▶ When it comes to this objective the test that is done is quite an important for the game to be fair.
6. Through the test cases we can see that the Decision Making & Problem-Solving linked to test #9,10,11,12
  - ▶ Through these tests we can see that the user was able to move around and interact with the environment, being able to change the direction the AI move and react in time attempting to stay alive as long as possible.
  - ▶ Having four test cases that reflect this objective indicates that the game does qualify as a puzzle game and therefore in turn provide benefits to children with ASD.

While there is at least one test case for each objective having more test cases allows for more concrete results such as with atmosphere and frustration tolerance. Though response to rules has only two test cases, the method used to test the robustness of the response to rules is very dependable with it being more objective than subjective. With atmosphere being more subjective, asking questions to the test users about the feel and environment the game creates would prove to be beneficial to assess this objective. For frustration tolerance a test case was done and successful but with going through feedback it is obvious that the game is not overly considerate towards new players and is one of the weaker objectives. A game that is has a low frustration tolerance will not prove to be enjoyable by children or beneficial. Overall, this project is on the right track to be able to provide a game that is both enjoyable and in theory beneficial towards children with ASD and has met the initial targets but needs to evenly concentrate on all objectives. Test users found that 72.7% (*Fig6.7/6.8*) they could relate the game to being beneficial towards the target audience.



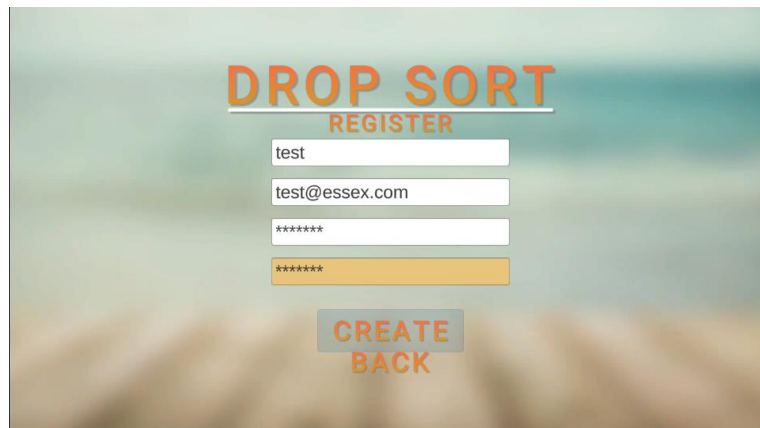
## **Discussion**

This project has been able to meet the objectives set but it still would require proper testing with the target audience to be able to confidently say that the game aids in conditional discrimination. Further this game needs to be at a stage where it is enjoyable to play regularly, especially if the target audience is children a lot of visual improvements need to be made with animations for interactions. This will not only attract children to play a game that looks better but can also make the game much clearer helping tackle the weaker area of frustration tolerance. Overall for a first attempt in using Unity and Blender this project has been a successful learning experience with coding in C#, understanding Unity/Blender and successfully creating a game that achieves set out objectives. Through the feedback received from the user tests users it clarified what Drop Sort should aim to improve, having similar expectations for the game asking for customizability such as character design, convenience such as having the tab key move between fields, for the game to start easier and more overall variation of the AI. With this in mind and wanting to progress the project new goals have already been set for this project.

### **Future Work:**

- ▶ Introduce AI Variation, with Identifying characteristics not only color
- ▶ Introduce more customizability for the Player
- ▶ Introduce animation between UIs
- ▶ Introduce a pause menu
- ▶ Change the difficulty of the game to start off slow and slowly get faster

## Appendix I



**DROP SORT**  
REGISTER

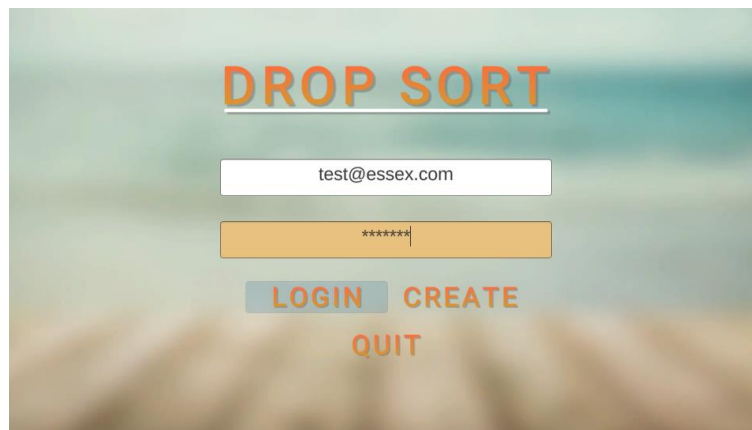
test

test@essex.com

\*\*\*\*\*

\*\*\*\*\*

CREATE  
BACK

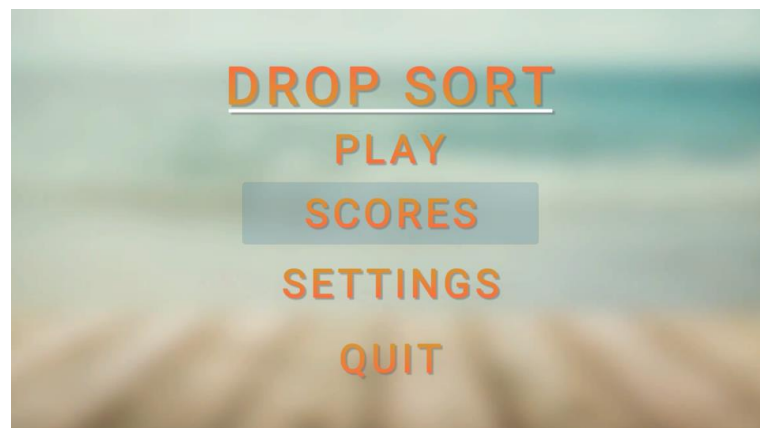


**DROP SORT**

test@essex.com

\*\*\*\*\*

LOGIN CREATE  
QUIT



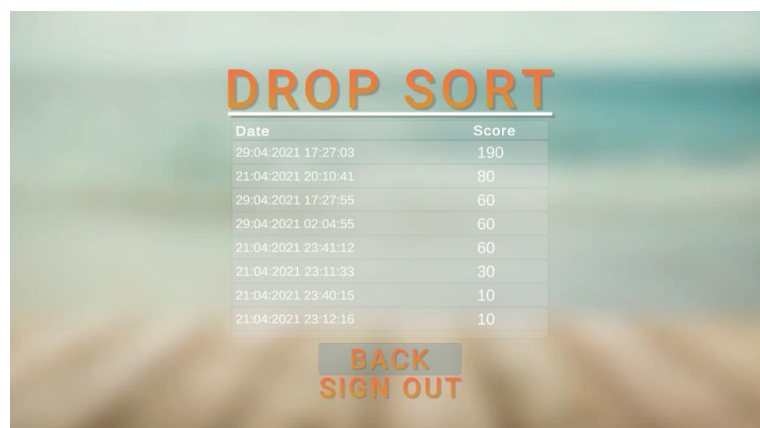
**DROP SORT**

PLAY

SCORES

SETTINGS

QUIT



**DROP SORT**

Date	Score
29-04-2021 17:27:03	190
21-04-2021 20:10:41	80
29-04-2021 17:27:55	60
29-04-2021 02:04:55	60
21-04-2021 23:41:12	60
21-04-2021 23:11:33	30
21-04-2021 23:40:15	10
21-04-2021 23:12:16	10

BACK  
SIGN OUT

## Appendix II



Saleh, Danyal  
Thu 15/04/2021 13:53  
To:



6 others

Dear all,  
For my final year project, I have created a game for children with ASD and would appreciate if you could test the game and provide some feedback on a google forum about the game. Please reply to this email to confirm you would like to test the game and I will forward you the link to the google forum and game. Thank you for your time,  
Danyal.

## Appendix III

Any Improvements/Suggestions?

11 responses

Let the user set a custom background for the game

Have the popup telling the area each colour has to go to on the screen the whole time instead of just at the start of each wave.

Pressing tab could move to next section in form, colour on moving entities has a box with the colour purple it can be confusing initially if this has any correlation between the purple house and the entity

Game can be a little confusing at the beginning, maybe add a slower speed for the start to introduce the users to the game.

When the game gets harder, prompt should be shown for longer as i missed it

It starts too hard need to gradually be that speed

The button needs to be more obvious

You need to change the appearance of the characters in the game

The design of the button and characters

Needs a pause menu

Make ther more obvious ques to respond to, there needs to be more

Do you believed this could be beneficial for children with ASD?

11 responses

Yeah

Yes I believe this could be beneficial for people with ASD because they have to pay attention to the characteristics requested.

Yes I believe this would be beneficial to children with ASD

Yes I believe it would be .

Yes

Yes it makes them tell things apart correctly

Yeah it could be

Yes and no, just could be something alot more beneficial

Yes its like a brain training game but targeted at one area only

Yes he the child has to pick out the color

I get the intent of the game just think it has a long way to go to be able to actually benefit. But has potential to get there.

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