# Video games and the positive effect on cognitive abilities, a look into genre and game loops and applying it to a personal project.

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# Figures

# Introduction

The hypothesis that video games affect cognitive enhancement has been studied as far back as the 80s (Creasey and Myers, 1986), as the media becomes more and more popular, studies are still trying to determine whether there is a link between playing video games and an increase in cognitive ability, but does genre and gameplay loop (Simply put, how does the games general gameplay work and what mechanics is the player expected to learn), matter when it comes to these improvements? I will be looking at the data of multiple studies to determine whether there were any significant differences depending on

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the genre and type of video game used in the research, and if there are genres that stand on top, would I be able to adapt their common mechanics into my own video game of a different genre?

This case study collates the data of such research to try to come to a conclusion whether there is a significant change in cognitive ability depending on genre and to apply any learnings to my own video game development project as mechanics and any projects in the future. I will be pooling together the data from past studies to determine which features and genres of video game have the most positive effect on the brain and how I have implemented features to target these in my own video game development project.

## Getting the Data

My plan was to collate and split study participant results into their relevant video game genres with their mean increase or decrease after testing, a positive increase would indicate a positive, a minus mean would indicate a negative, I used an 'if' function in excel to indicate this as a 1 on either column, however as not all studies provided these numbers, i instead decided to simplify my requirements to either a positive or negative interaction with cognition.

Finding the in depth data and spreadsheets for studies was actually not as simple as I thought it would have been. Many studies just do not supply their raw data (in a free capacity) for their findings. It took me a long time to sift through hundreds of different websites, looking for any data that I could use for this piece.

Many of the studies that did include raw data files, unfortunately didn't split the video game genres and didn't provide the ratios to these either, making it impossible for me to implement them into my worksheet in an accurate manner.

I used data from 63 different studies resulting in usable data representing 2,645 different participants. The genres were split into Role playing games (RPG, including online RPGs), Action/Adventure, Sports, First person shooter (FPS), Racing, Puzzle, Strategy and Simulation. The weighting of this data is shown in Figure 1.

As can be seen, there is not an even split for the different genres, for example, sports and puzzle games represent over 70% of the data, with RPG's being the lowest at 0.5%
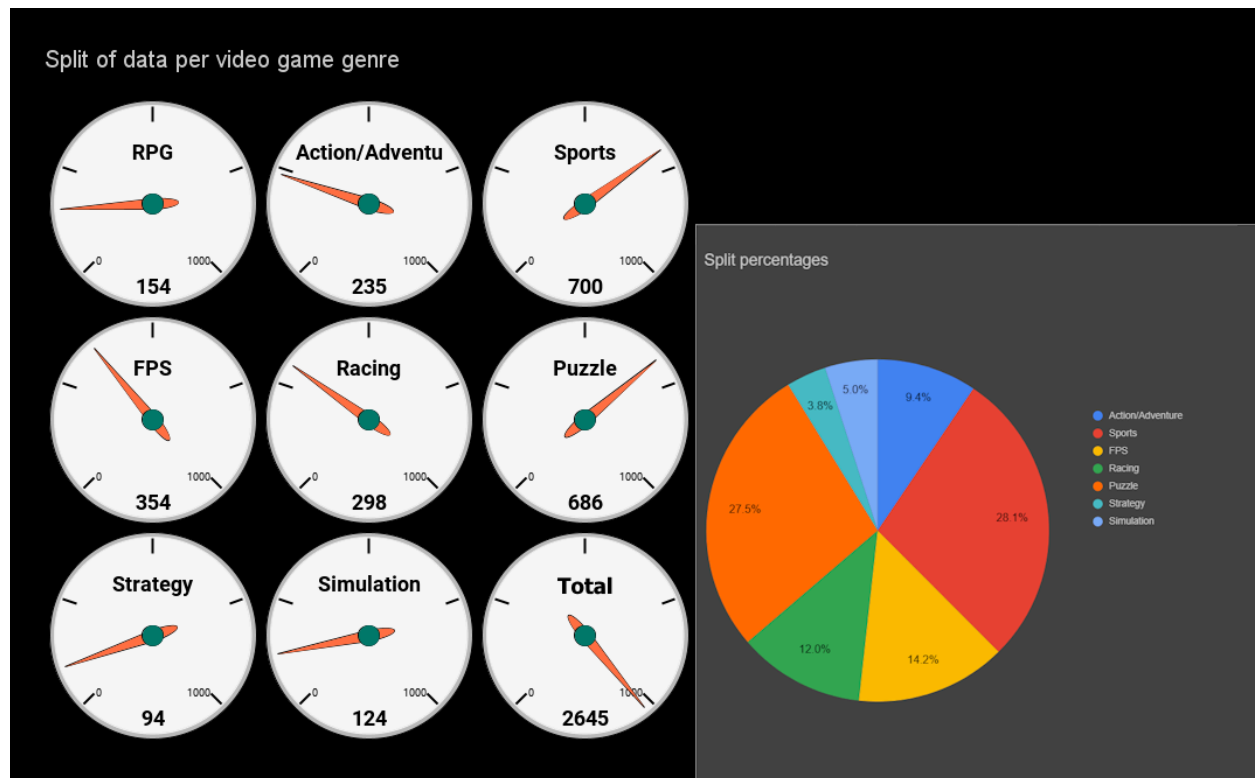
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Figure 1 - Data split per genre

## Data Sources

Below in Figure 2 are all the studies that I was able to find relevant data for.

| Researcher | Study Name |
|---|---|
| Adams, M, 2013 | Exploring the Effect of Video Game Playing on Static and Dynamic Spatial Cognition Skills |
| Bailey and West, 2013 | The effects of an action video game on visual and affective information processing |
| Ballesteros, S. 2017 | Effects of Video Game Training on Measures of Selective Attention and Working Memory in Older Adults: Results from a Randomized Controlled Trial |
| Basak et al., 2008 | Can training in a real-time strategy video game attenuate cognitive decline in older adults? |
| Bejjanki et al., 2014 | Action video game play facilitates the development of better perceptual templates |
| Belchior et al., 2013 | Video game training to improve selective visual attention in older adults. Computers in Human Behavior |

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| Belchior, P. 2019 | Computer and Videogame Interventions for Older Adults' Cognitive and Everyday Functioning |
| Blacker et al., 2014 | Effects of action video game training on visual working memory. |
| Boot et al., 2008 | The effects of video game playing on attention, memory, and executive control |
| Boot et al., 2013 | Video Games as a Means to Reduce Age-Related Cognitive Decline: Attitudes, Compliance, and Effectiveness |
| Calero Valdez et al., 2013 | Increase Physical Fitness and Create Health Awareness through Exergames and Gamification |
| Chen and Hsieh, 2018 | The relationship between internet-gaming experience and executive functions measured by virtual environment compared with conventional laboratory multitasks |
| Cherney, Bersted and Smetter, 2014 | Training Spatial Skills in Men and Women |
| Chiappe et al., 2013 | Improving multi-tasking ability through action videogames |
| Clark, Lanphear and Riddick, 1987 | The Effects of Videogame Playing on the Response Selection Processing of Elderly Adults |
| Clemenson and Stark, 2015 | Virtual Environmental Enrichment through Video Games Improves Hippocampal-Associated Memory |
| De Lisi and Cammarano, 1996 | Computer experience and gender differences in undergraduate mental rotation performance |
| De Lisi and Wolford, 2002 | Improving Children's Mental Rotation Accuracy With Computer Game Playing |
| Dorval and Pépin, 1986 | Effect of Playing a Video Game on a Measure of Spatial Visualization |
| Feng, Spence and Pratt, 2007 | Playing an Action Video Game Reduces Gender Differences in Spatial Cognition |
| Gagnon, 1986 | Interactive Versus Observational Media: The Influence of User Control and Cognitive Styles on Spatial Learning. |
| Gao et al., 2013 | Video Game–Based Exercise, Latino Children's Physical Health, and Academic Achievement |
| Glass, Maddoz and Love, 2013 | Training in action video games can increase the speed of perceptual processing. |
| Goldstein et al., 1997 | Video Games and the Elderly |
| Gonzales, 2011 | How expertise can modulate spatial attention within and across sensory modalities : the case of video game players. |
| Green and Bavelier, 2006 | Enumeration versus multiple object tracking: the case of action video game players |
| Green, Li and Bavelier, 2010 | Perceptual Learning During Action Video Game Playing |

| Shawn Green et al., 2012 | The effect of action video game experience on task-switching |
|---|---|
| Huang, K. et al., 2020 | Stereotype Threat in a Video Game Context and Its Influence on Perceptions of Science, Technology, Engineering, and Mathematics (STEM): Avatar-Induced Active Self-Concept as a Possible Mitigator |
| Hutchinson et al., 2015 | Action video game training reduces the Simon Effect |
| Kokkinakis et al., 2017 | Exploring the relationship between video game expertise and fluid intelligence |
| Kühn et al., 2018 | Fighting Depression: Action Video Game Play May Reduce Rumination and Increase Subjective and Objective Cognition in Depressed Patients |
| Li, Chen and Chen, 2016 | Playing Action Video Games Improves Visuomotor Control. |
| Li et al., 2009 | Enhancing the contrast sensitivity function through action video game training |
| Martincevic and Vranic, 2020 | Casual Game or Cognitive Gain: Multitask Casual Game as a Training for Young Adults |
| McCord et al., 2020 | Short video game play improves executive function in the oldest old living in residential care |
| McDermott, 2013 | A comparison of two video game genres as cognitive training tools in older adults |
| Minear et al., 2016 | A simultaneous examination of two forms of working memory training: Evidence for near transfer only |
| Momi et al., 2019 | Thalamic morphometric changes induced by first-person action videogame training |
| Morin-Moncet et al., 2016 | Action Video Game Playing Is Reflected In Enhanced Visuomotor Performance and Increased Corticospinal Excitability |
| Nelson and Strachan, 2009 | Action and Puzzle Video Games Prime Different Speed/Accuracy Tradeoffs |
| Nouchi et al., 2020 | Dorsolateral Prefrontal Cortex Activity during a Brain Training Game Predicts Cognitive Improvements after Four Weeks' Brain Training Game |
| Nouchi et al., 2012 | Brain Training Game Improves Executive Functions and Processing Speed in the Elderly: A Randomized Controlled Trial |
| Novak and Tassell, 2015 | Using video game play to improve education-majors' mathematical performance: An experimental study |
| Oei and Patterson, 2014 | Playing a puzzle video game with changing requirements improves executive functions |
| Oei and Patterson, 2013 | Enhancing Cognition with Video Games: A Multiple Game Training Study |
| Okagaki and Frensch, 1994 | Effects of video game playing on measures of spatial performance: Gender effects in late adolescence |
| Orosy-Fildes and Allan, 1989 | Psychology of Computer Use: XII. Videogame Play: Human Reaction Time to Visual Stimuli |

| Perrot, Maillot and Hartley, 2019 | Cognitive Training Game Versus Action Videogame: Effects on Cognitive Functions in Older Adults |
|---|---|
| Ruiz-Marquez et al., 2019 | Effects of Nonaction Videogames on Attention and Memory in Young Adults |
| Sanchez, 2011 | Enhancing visuospatial performance through video game training to increase learning in visuospatial science domains |
| Scalzo et al., 2010 | Reducing backward masking through action game training |
| Schubert et al., 2015 | Video game experience and its influence on visual attention parameters: An investigation using the framework of the Theory of Visual Attention (TVA) |
| Seçer and Satyen, 2014 | Video Game Training and Reaction Time Skills Among Older Adults |
| Shute, Ventura and Ke, 2015 | The power of play: The effects of Portal 2 and Lumosity on cognitive and noncognitive skills |
| Strenziok, M 2014 | Neurocognitive enhancement in older adults: Comparison of three cognitive training tasks to test a hypothesis of training transfer in brain connectivity |
| Subrahmanyam and Greenfield, 1994 | Effect of video game practice on spatial skills in girls and boys |
| van Ravenzwaaij et al., 2014 | Action video games do not improve the speed of information processing in simple perceptual tasks. |
| West, Konishi and Bohbot, 2017 | Video Games and Hippocampus-Dependent Learning |
| West et al., 2020 | The Contrasting Effects of an Action Video Game on Visuo-Spatial Processing and Proactive Cognitive Control |
| Whitlock, McLaughlin and Allaire, 2012 | Individual differences in response to cognitive training: Using a multi-modal, attentionally demanding game-based intervention for older adults |
| Wu et al., 2012 | Playing a First-person Shooter Video Game Induces Neuroplastic Change |
| Wu and Spence, 2013 | Playing shooter and driving videogames improves top-down guidance in visual search |

Figure 2 - Table of obtained research data

## Results

When all the data had been collated with their respective 'Positive' and 'Negative' value added to each participant's result, we can see the percentage outcome of each genre below in Figure 2. The majority of the Puzzle genre games were also Mobile games, which may have had an effect on the results due to mobile games being designed for short bursts of play rather than long sessions.

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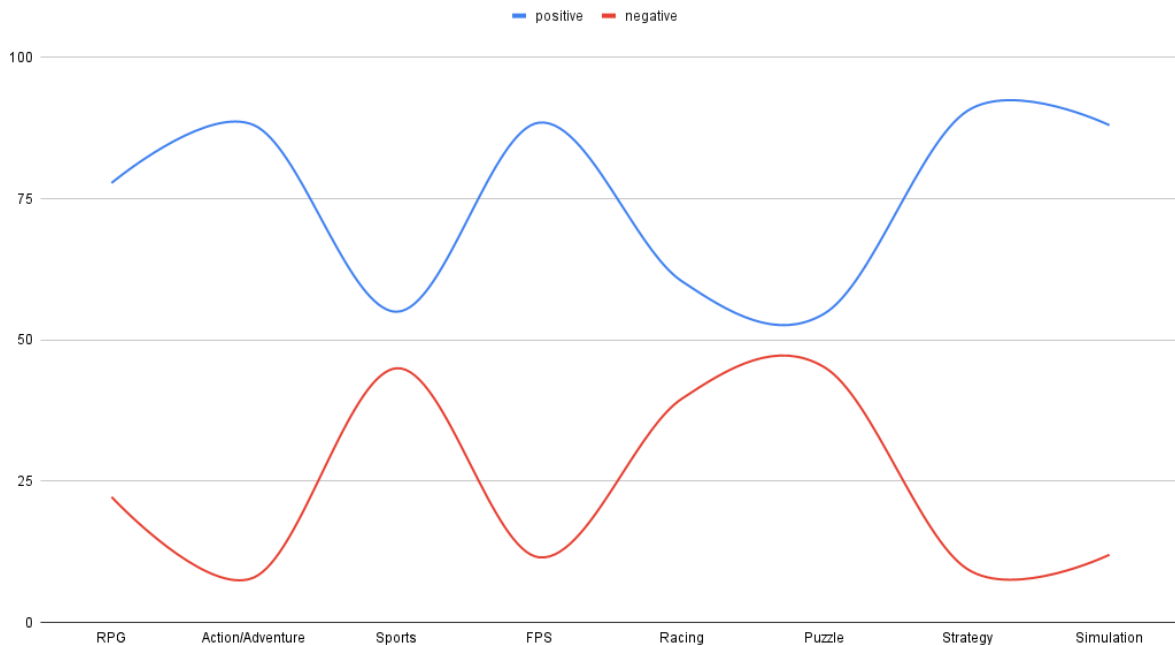Positive and negative result against video game genre

— positive  — negative



Figure 3 - Percentages of positive and negative effects per genre

As can be see, the most significant number of positive effects over negative, are shown in the genres of Action/adventure (88% Positive / 8% Negative), First person shooter (88.46% Positive / 11.54% Negative), Strategy (90.48% Positive / 9.52% Negative) and Simulation games (88% Positive / 12% Negative). Whilst genres that did not have a significant percentage difference were Sports (55% Positive / 45% Negative) and Puzzle (54.66% Positive / 45.19% Negative) with Racing having a semi substantial weight towards positive with (60.40% Positive / 39.60% Negative). I also created the chart in Figure 3 to help display these results more clearly.
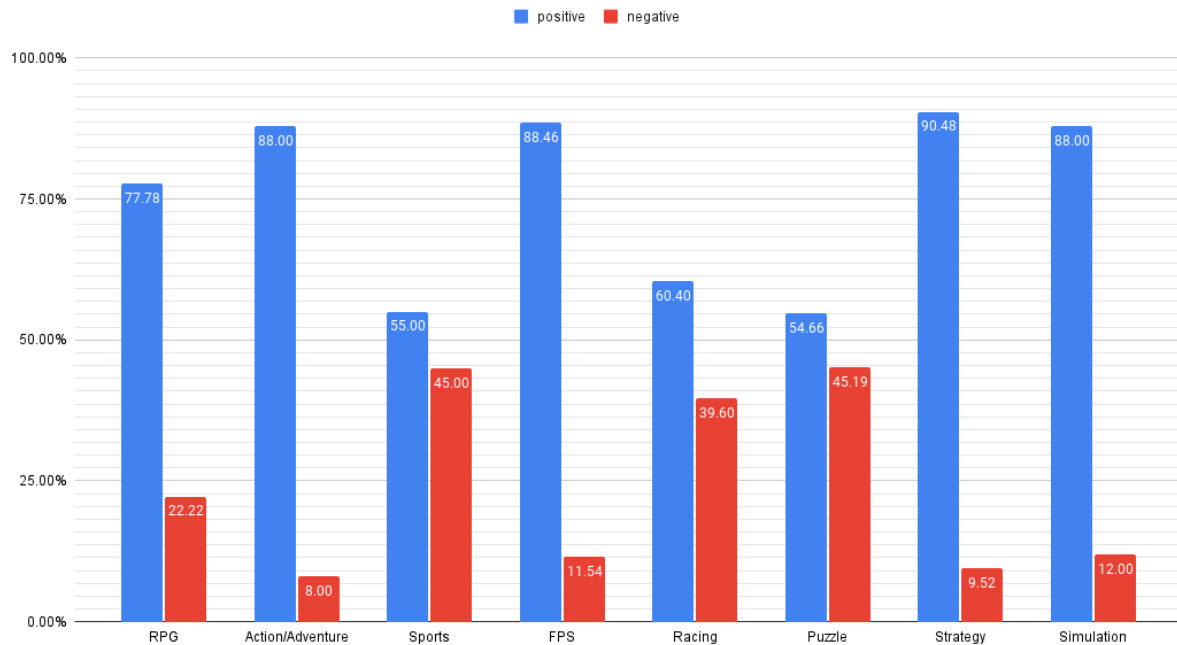
Figure 4 - Percentages of positive and negative effects with values

In certain genres, the percentage does not equate up to 100, this is due to some participants having no change in their before and after results in the tests. It's also noteworthy that all genres had a positive effect on the cognitive abilities of more participants than a negative one.

## Things to take note of

In terms of the different data weights per genre, Sports and Puzzle games make up more than half the entire participant list, with both achieving extremely similar results regarding the positive/negative mix ( Sports 55% Positive / Puzzle 54.66%)

## Applying this to my Project

Collating the results and briefly reading through the research has been very important for my own development project, the video game 'Terra Avoider'. The game itself is an arcade style shooter, which would be a sub genre under Action/Adventure. Being able to create mechanics in the game is important to keep player engagement, if you lose engagement

then they will be less likely to keep playing. Looking at the results of the above research analysis, I decided to develop a Mechanic for each genre that had a significant Positive impact, which turns out to be Action/Adventure, FPS, Strategy, Simulation and RPG. I will not be including Action and Adventure, as my game is already under that genre so already contains relevant mechanics. I will also be combining Strategy and simulation as after research, I found both fairly incompatible in terms of transferable mechanics to an arcade shooter, however I could potentially add something that had a small link to both.

- FPS - A common mechanic in shooters is that some weapons will have an 'Active reload' which is when a 'Quick time event' (player must press a button within a certain time window, AKA QTE) occurs during a weapon's reload. If successful, the weapon will reload faster and in some cases the player gains an increase to their power. Another mechanic used in FPS games is an overheat feature for heavy machine guns and laser weapons, which works similarly like reload, which is to create pause in the player's attacks.

  In the case of my game, I decided to combine these mechanics into a joint one, which ended up being the following. The player's main weapon is a laser, shot from the ship. Shooting increases the 'Heat gauge', which when full, triggers an active reload style QTE. If successful, the ship will shoot a projectile that deals a large amount of damage, it will also add to one out of five shield checkmarks, once the player reaches five, they will gain a shield that prevents a hit. If the player fails the QTE they will not be able to fire again for a second and will not gain the above power increase. Figure 5 shows the UI elements I created for this mechanic, these only appear when the player has a shield charger and has heat. Figure 6 and 7 shows a small part of the blueprinting used to control this in game.
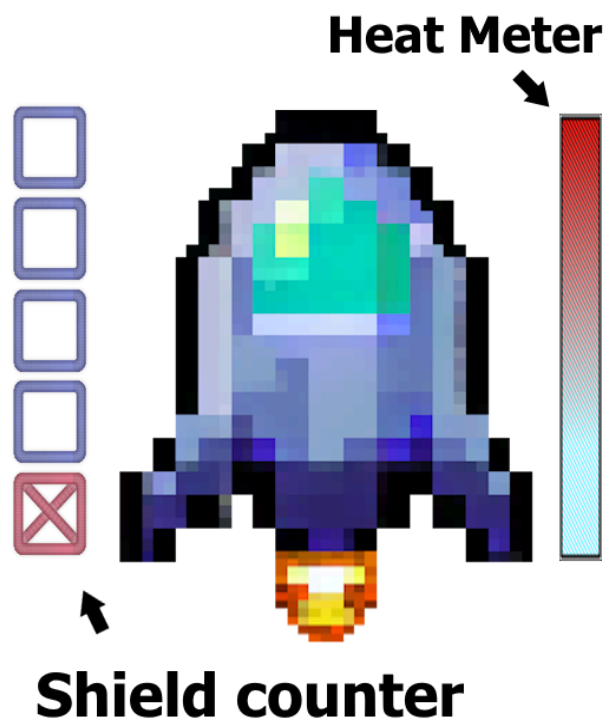
Figure 5 - UI elements created for FPS mechanic function
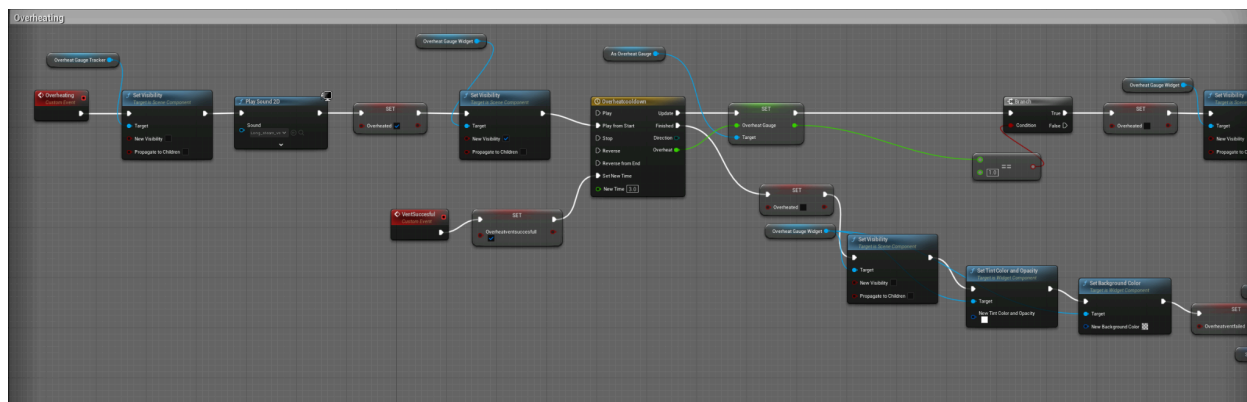


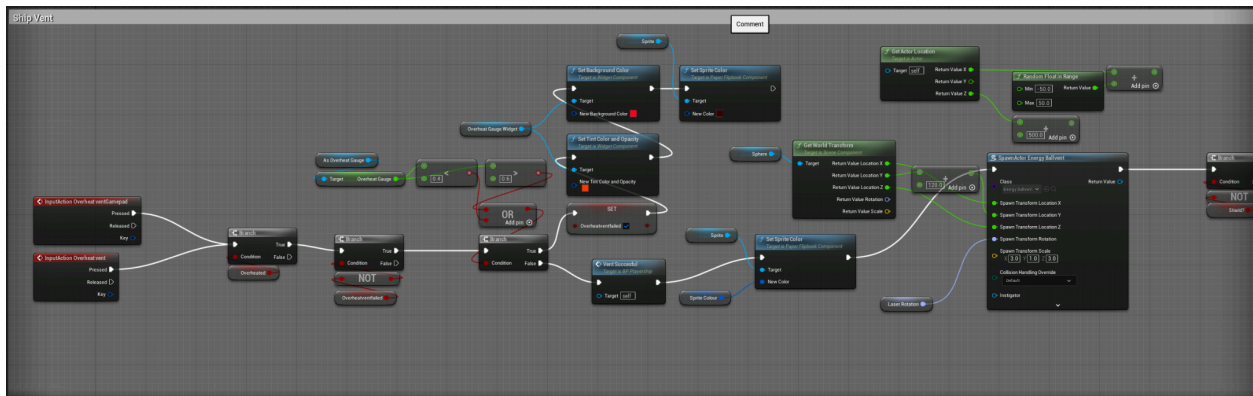Figure 6 - FPS Mechanic blueprinting 1

Figure 7 - FPS Mechanic blueprinting 2

- Simulation/Strategy - Like the Strategy genre, I did struggle to find compatible mechanics to port over to an arcade shooter. However, as Simulation games main appeal is a connection to the world you are involved with, be it racing, house building, ship sailing. As such, I decided to turn the final level of the game into a fight taking place on the bridge of a spaceship on its way to destroy the Earth. I implemented this into  working with the fight mechanics in a number of ways with the aim of having dire stakes that threaten something we all are a part of, potentially increasing engagement through emotional response.
    1. Sim- The different phases of the fight show the progress of travel towards Earth through a large viewing window behind the main boss. Phase 1 has an unknown star system being travelled through (Assets for this still need to be created), phase 1.5 transitions into hyperspace and the final phase shows our own sun being passed with earth slowly coming into range. If the enemy ship makes its way to earth (6 minutes which starts upon leaving hyperspace), it will shoot a huge laser, destroying it, game over. To add some realism, I created the world asset (Figure 8) to spin slowly with clouds that also spin at a slightly slower speed to give the illusion of atmosphere, this can be see on the video https://youtu.be/qM3ONgYyqM0  (Ian Davey, 2024) .
    2. Strategy - The player must optimise damage to ensure they defeat the boss in time. I also created a mechanic that removes the player from the main arena for some time, making them unable to hit the boss. The player will need to effectively dodge these mechanics if they are to beat the timer. These mechanics and the last phase are viewable here https://youtu.be/NiBgVhEOgMw (Ian Davey, 2024), please note it is still a work in progress. Figure 9 and 10 show examples of blueprinting that control some aspects of this mechanic.
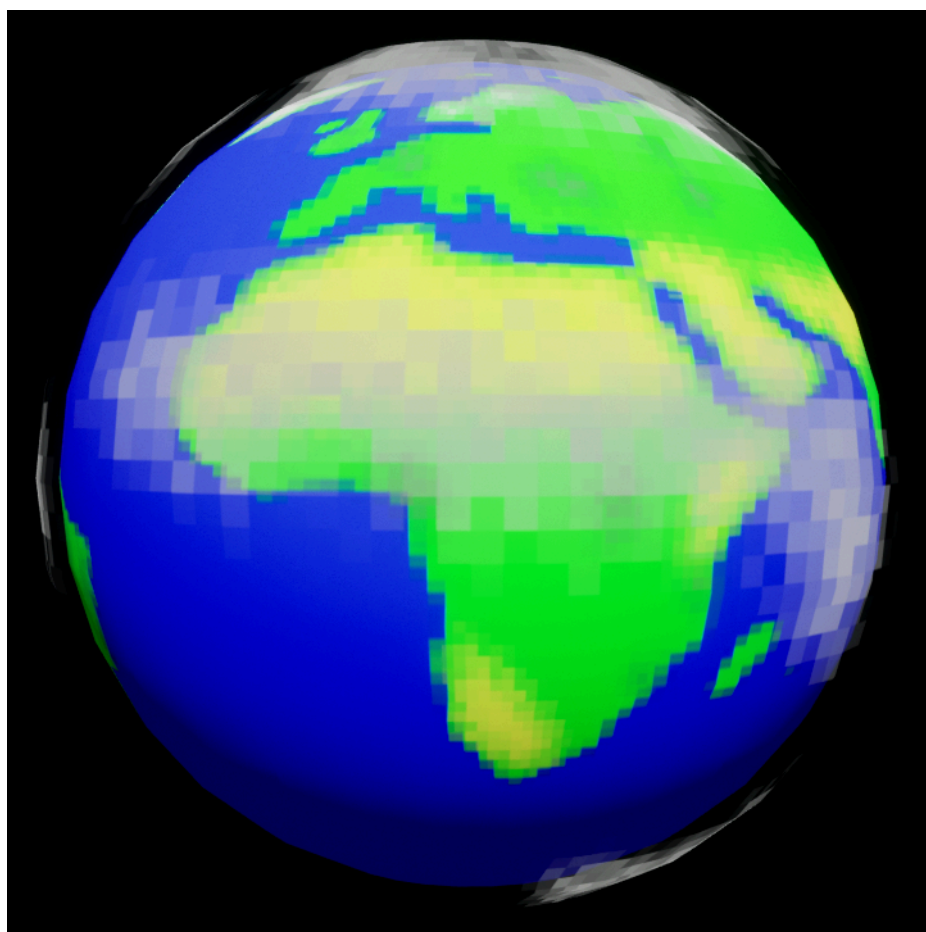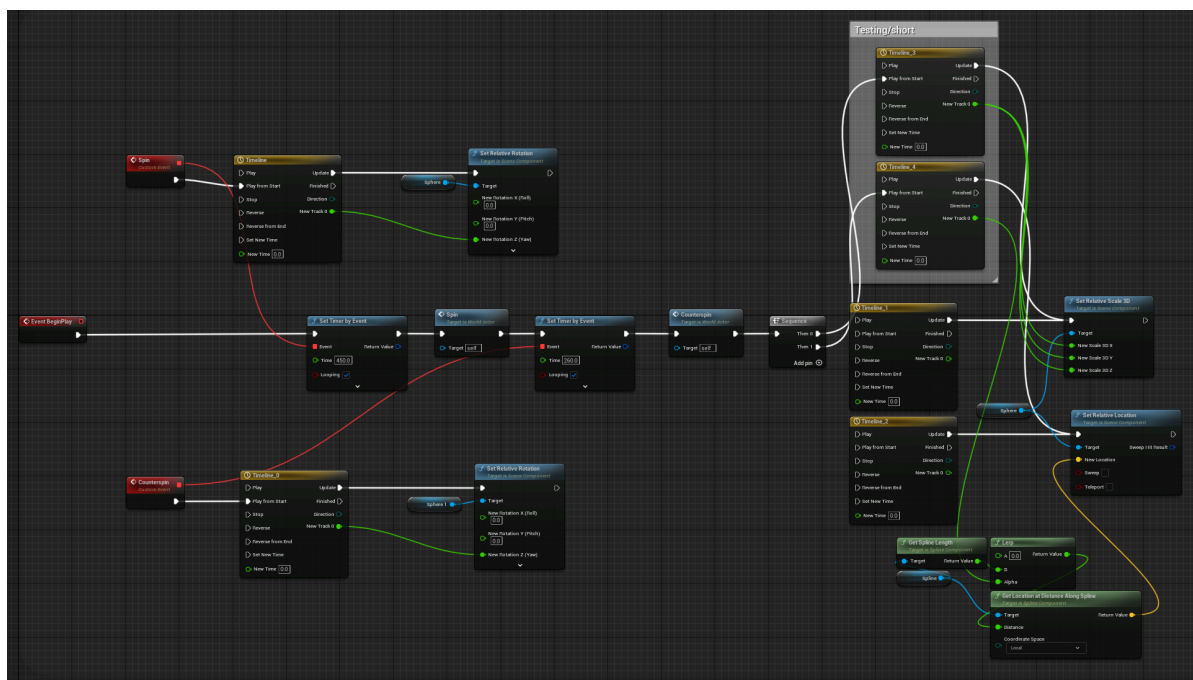
Figure 8 - Asset created of earth

Figure 10 - Sample of Hyperspace Mechanic and last phase beginning sequence.

- RPG - For the RPG mechanic, I decided to tackle it in a particular way.

Alternating dialogue - A common mechanic in RPG games is that dialogue trees can change depending on the player's previous actions. To implement this into my game, I decided to have the Tutorial, where players learn how to play, containing various different dialogues depending on how the player performed certain tasks.

For example, in the previously mentioned overheat mechanic, the dialogue will change depending how many attempts the player needs to successfully perform the action. Figure 11 shows examples of the different dialogue in the tutorial with the different tree responses (numbered 9XX), with Figure 12 contains a sample of the blueprinting to control this.



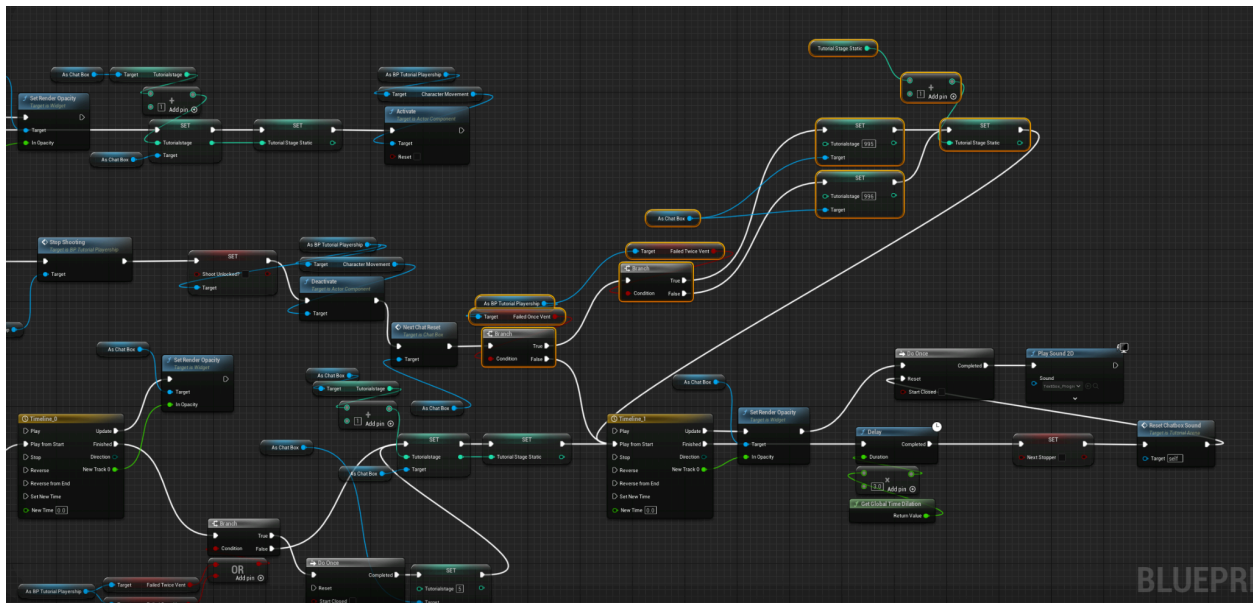Figure 11 - Dialogue data sheet used to input dialogue into UI elements.

Figure 12 - Tutorial blueprint with some of the dialogue branches

## Conclusion

Overall I believe I achieved my goal to determine which genre's mechanics could be beneficial to a player. The data collection and processing took a vast amount of time with a lot of frustration due to not being able to use certain research due to the lack of usable data, even if those studies would have been highly useful to use. However, once I have collected enough data, this project became much more enjoyable. My history of office work helped me a lot in this and the game developer side of me is very fond of working out how to implement new ideas. Some of the mechanics added may be seen as tenuous in regards to what genre they represent, however I am pleased with the results considering the constraint of adding to an already work in progress.

I was able to test some of the added mechanics at the Transmedia 2024 exhibition, where the participants enjoyed the over-heat mechanic and agreed it added another dimension to the combat. Players also pointed out the response given in the tutorial being relevant to their attempt number, which I thought only a small number would notice. Unfortunately as the other mechanics are still a work in progress, I was unable to test these. Though the players did show enthusiasm to the explanation.

Going forwards, I will be using what I learned during the research process to my next video game project which I will be looking to start once Terra Avoider is released. I will also be applying mechanics that cover the genres with the substantial positive difference, however

I will be able to introduce them from the ground up, making them a bigger part with an, in theory, bigger impact in the players cognitive benefit without compromising the enjoyment and fun.

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