OCULUS RIFTS PÅVERKAN PÅ IMMERSIONEN KRING MORALISKA VAL
En studie kring modern VR-teknologi och dess påverkan på en användares spatiala immersion i en virtuell miljö

THE OCULUS RIFT’S EFFECTS ON IMMERSION SURROUNDING MORAL CHOICE
A study of modern VR technology and its effects on a user’s spatial immersion in a virtual environment

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Summary

This report is about VR and the effects the VR technology Oculus Rift may or may not have on the different kinds of immersion possible in virtual environments, or games. The report is based on the premise that modern games have evolved into more story based adventures with better graphics, often with moral choice as gameplay, and theories regarding new mediums and the dangers of not fully understanding them. It is also done in cooperation with a research team at Högskolan i Skövde, with a focus on moral dilemmas, and is using a virtual environment to test this combined effort. The game engine Unity is used to create a realistic environment and together with the Oculus Rift, is testing what kinds of effects the VR technology has on the users. 20 test participants have shared their experiences and the majority, independent of gaming experience, claims it has a positive effect.

**Keywords:** Virtual Reality, Oculus Rift, immersion
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Background
As video games have evolved over time, so too it seems that the narratives told through the medium have as well. Video games have gone from small action games with pixel art to full blown blockbuster adventures of grander scopes than summer Hollywood movies. During the previous seventh generation of video games hardware, an increasing amount of story driven games, especially of the role playing kind, could be seen. But just about all genres, even car racing games, started incorporating a narrative in their cut scenes, see for example Need for Speed: Undercover (Electronic Arts, 2008). With better and better graphics capabilities, video games started having available space for an engaging story to a higher degree than before. With better graphics and more powerful hardware, it became easier to emulate the quality and style of modern movie storytelling. Ever since the fifth generation of video game consoles (Sony PlayStation, Sega Saturn, and Nintendo 64), going by the biggest critically acclaimed hits and sales charts, game developers have been trying to mimic the movie medium. But it was not truly possible to come close to reaching movie quality graphics until the seventh generation.

Whether or not better looking graphics helps to make video game stories more mature is debatable (as in dealing with adult themes and presenting them in a cinematic style), but it seems to be the commonly accepted truth in the video games industry that better graphics is part of the backbone behind creating modern and engaging stories. There is no doubt that more powerful and innovative hardware provide more options for both gameplay oriented development and that it is responsible for the rise of more expansive narratives in games and finally, for the possibility of combining the two in new ways.

There was also an even bigger rise in the first person shooter, or FPS, genre, thanks to commercially successful series such as Call of Duty (Activision Publishing, Inc, 2003) and Halo: Combat Evolved (Microsoft Game Studios, 2001). Previously, it was mostly in the roleplaying genre, with games like Star Wars: Knights of the Old Republic II – The Sith Lords (LucasArts, 2004) and The Elder Scrolls IV: Oblivion (2K Games, 2006), where story and the player’s personal choices were at the forefront of the experience. Shooters like the ones mentioned above were strictly linear; both gameplay wise and in their story structure; staying the same every time the games were played with very limited player choice. When story and personal choice came into vogue in the roleplaying genre, a new form of storytelling came into being by incorporating the gameplay into how the story unfolds, at least by letting the player choose when and how to progress in the still fairly linear and traditionally represented narrative.
**Moral choices**

But then a game called *Bioshock* (2K Games, 2007) was released. With a very unique art design compared to other video games, especially in the FPS genre, the game focused more on storytelling through dialogue and its environments than other contemporary titles. *Bioshock* (2K Games, 2007) also had a unique gameplay system, from its roots as a role playing game, where different guns and magic abilities were to be combined at the player’s leisure. But there was another present gameplay aspect that shook the gaming community.

*Bioshock* (2K Games, 2007) allowed the player to upgrade its magic abilities to new levels at the cost of something called Adam. Adam was a kind of liquid extracted from a fictional sea slug. The problem was that the slugs had become attached to young human children. And if the player wanted to get the most Adam out of each slug, the player would have to kill the children (off camera). Either that, or let the children live and thus not be able to get as much Adam as s/he would otherwise get. This posed a recurring moral dilemma for the players throughout the entire 20+ hour long experience (and in the direct sequel).

Of course, other games have had moral dilemmas for the player to ponder, even some of the games mentioned above, but this was the first time it was so overt, so in your face and in such a large mainstream title that eventually sold more than four million copies. The game got some criticism for being so morally black and white and because the gameplay mechanic barely had any impact on the story whatsoever beyond an altered ending sequence (and being a good person paid off better in the long run through free gifts).

This criticism is again mentioned in detail by Miguel Sicart in his book “*The Ethics of Computer Games*” (2011). Lacking consequences and imprinting the game developer’s own moral code onto the player, made this moral choice less of a choice and even less so a moral one. It was also what Sicart defines as unethical design, something that will be mentioned again in this thesis project report. However, this sort of moral choice and dilemma has become the norm in modern games, even though it is the illusion of choice. As we will see, older games in other genres had previously dealt with the same issue and failed (according to Sicart). But there are however those who see games in a different light, criticizing Sicart’s standpoint. Marcus Schulzke is one of them, with his article “Moral Decision Making in *Fallout*” (2009) where he makes a point of using an Aristotelian viewpoint when it comes to morality in games (by which he means that games and their interactivity provide educational opportunities; chances to learn more about morality and test the consequences of ones actions in a safe environment).

Although a quite unfinished game by the time of its release, *Star Wars: Knights of the Old Republic II – The Sith Lords* (LucasArts, 2004), focused more on the nuances between good and evil in the Star Wars universe and let the player be more neutral in their gameplay style than ever before, especially compared to its predecessor. In fact, the story and characters actively promoted this way of life, which is to this day fairly unique and outside the usual Star Wars box. But as Sicart mentions, the gameplay choices are usually still fairly black and white and lead to very similar, if not even the very same results, making the choices rather pointless. And just like in *Bioshock* (2K Games, 2007), the consequences were next to non-
existent. The game and its world rarely reacted nor changed to accommodate the player choices and behaviors, making both game examples less than ideal as morality driven narratives. Lev Manovich (2002) talks about how different media forms have their own inherent languages to express themselves with. Video games have for a long time had an identity crisis of sorts (where both users and creators compare their product to movies and use that difference level as a quality measurement tool instead of relying on the medium’s own qualities) and this specific language for video games have not yet fully developed. This could be an explanation as to why moral choices in games are not as nuanced and thought through as they could be.

Whether or not Sicart is on the right track with trying to change the game design paradigm into something more ethical, the commercial success of these video games, and because they are still highly revered by gamers today, still paved the way for video games like the The Witcher (Atari, Inc, 2007-) series, another fantasy series where moral choices of different kinds are on the central stage of both gameplay and story, and where seemingly smart positive decisions can have unforeseen negative consequences in later chapters, or even in the sequels, and vice versa. This was actually used as one of the main selling points for the game. Another comparative example would be the Fallout series, particularly Fallout 3 (Bethesda Softworks, 2008) which Schulzke (2009) say uses morality as a major gameplay function, where the player can choose their path through the world, molding the scenarios to their own liking, with unexpected consequences throughout the game.

One other series that take moral choices and its consequences to a different level is the Mass Effect (Microsoft Game Studios, 2007-) trilogy. As a kind of Special Forces commander in space, the player is in control of a massive spaceship that is used to hunt down a traitor from your own combat unit. The player’s actions in combat and dialogue ripple throughout each game if they bring their save file over to the next game. Letting a special person live or die can potentially have severe consequences in the next game and if the player lets their teammates die, there is no way to ever bring them back.

Though Mass Effect (Microsoft Game Studios, 2007) is perhaps not any more nuanced in its moral dilemmas than other video games (moral actions are color coded in obvious ways; blue for good, red for evil and gray for neutral), the consequences of the player’s actions are far-reaching across multiple games, just like The Witcher (Atari, Inc, 2007), and they are such a central gameplay mechanic that no one can avoid taking a stand on both small and large-scale questions of morality. It is also in a completely different genre from the other games mentioned, as an action role playing shooter, which is noteworthy because player action consequences were (and still are) usually absent in contemporary competitors. Bioshock (2K Games, 2007) is also the only game mentioned that uses the first person perspective, where the player sees the underwater world of Rapture from her own perspective. The other games use the third person perspective, literally placing the player at a distance from the actions s/he takes in the games. It is possible that this has an effect on the visceral experience of making a life or death decision in Bioshock (2K Games, 2007).
Other games such as *Metal Gear Solid 3: Snake Eater* (Konami, 2004), forces the player to make a moral decision and kill the main character’s mentor. And in the later installments of the *Call of Duty* (Activision Publishing, Inc, 2003-) franchise, the player is repeatedly forced to watch its character execute the villains. The problem with these games is that these are not really choices. Morality is in play, but choice is not. In *Metal Gear Solid 3: Snake Eater* (Konami, 2004), the game will not proceed to the ending unless the player does what the game designer wants him/her to do; either pull the trigger or turn the game off forever. And in *Call of Duty* (Activision Publishing, Inc, 2003-), it is usually during a non-interactive cut scene where decisions are made for the player for the sake of the narrative. Nevertheless, we have seen that moral dilemmas of different kinds are being represented in more and more kinds of video games, with differing success and intentions. They usually do have two things in common though, and that is that gamers seem to enjoy them quite a bit, even if it is just to discuss their flaws on online message boards, and that the games incorporate the decision making in the gameplay in some fashion.
Immersive worlds

Given the critical and commercial success of all previously mentioned video game titles, it is clear that another aspect of video games and storytelling has become important during the previous generation of hardware, and continues to be now when the new generation has officially started, and that aspect is potential immersion into the game world and its story. Nowadays, many major video game titles mention this aspect in their promotional material prior to release. Immersion is a major selling point. Slowly but surely it is becoming an integral part of the language of video games.

Immersion is a loose game equivalent of the movie industry’s “suspension of disbelief” (though this is not limited to movies) where the viewer/participator accepts what he or she sees and experiences with greater ease even when it is something fantastical and unrealistic. The connection to “suspension of disbelief” is not at all a perfect match to immersion but serves well enough as a starting point to understand the term. The player lets itself become a part of the experience and start living it fully. The player figuratively transfers him or herself from the real world into the fictional one in front of them. With better and better hardware, and specifically better opportunities for lifelike graphics, this is becoming easier and easier for games to achieve than ever before, and the mainstream industry has really taken this aspect to heart as most popular blockbuster developers strive for this as a way to prove that their game is worth buying. Exactly what immersion is and how it is accomplished is still debated today and the opinion on how to best produce this effect varies between companies and genres. When this thesis project report is talking about immersion, this is what is to be kept in mind.

A commonly accepted definition of immersion would be Ernest W. Adams’ (2004) where there are three different types of immersion: tactical, strategic and narrative. Tactical and strategic immersion are related to gameplay mechanics where the player feels like one with the game or where s/he has achieved a certain flow. Flow is a psychology term coined by psychologist Mihaly Csikszentmihalyi (1990) to explain the connection between player and gameplay systems. There are however those who disagree with this connection between flow and immersion, for example Diane Carr (2006). She argues in “Space, Navigation and Affect” in “Computer Games: Text, Narrative and Play” that it is only possible to understand player absorption into a fictional world through three different aspects, where flow is just one of them, together with immersion and engagement. She presents the notion that a player can be engaged in gameplay and yet not be immersed. It is not yet fully known or understood how all this is connected.

Narrative immersion is simply when the player feels engaged with the story presented, thus the connection to suspension of disbelief. Additionally, after Adams coined these terms, a fourth kind of immersion was established in the form of spatial immersion (Björk & Holopainen, 2004), which is the immersion that occurs when a player feels that the presented world is a convincing and believable environment, which is something of great importance to this thesis report. This report will be basing its research on these four kinds of immersion established by Adams, Björk and Holopainen, regardless of whether or not flow can be connected to immersion. The reason for this is because these definitions seem to be the most
commonly used terms in both game development and in academic research. An example of this can be found in the explanatory article “Different types of immersion and how they work” by Daniel Moeller from the International Society for Presence Research (2012) where he uses all four definitions to describe immersion in video games. Other examples are Howell (2012) who use the same four definitions. Babu (2012) also references Adams in his thesis about video game HUDs. Jan Torpus and Beatrice Tobler (2011) also mention Adams and the different types of immersion in their lifeClipper 3 media art project field evaluation report. So it is clear that the definitions are being used by a multitude of different people in different fields, making the definitions viable for research use.

Some examples (based on Adams’ definitions, 2004) of things that help create immersion are the following: a good story that is told well, high quality voice acting, good and fully functional gameplay, good controls, no bugs or crashes, suitable music and visuals etc. These are also the things that can destroy immersion if they are not handled well (The Game Station, 2011). A low quality story, bugs and game crashes are usually the biggest pet peeves among gamers these days (see for example NeoGAF, 2012). So immersion can be created and destroyed with a combination of the mentioned aspects, only a few or almost none of them.

In 1998, Bob Witmer and Michael Singer devised a research method for measuring different kinds of immersion via a couple of questionnaires. They did not use Adams’ or Björk and Holopainen’s definitions since they came around a decade later, but in terms of what they measured, the similarities are extensive. Without using the same terminology, Adams, Björk and Holopainen all talk about the same kinds of immersion as are described in the Witmer and Singer questionnaires, where words such as compelling, natural, engaging and involving are used to pinpoint just how well the participants immerse themselves in whatever fictional world they are presented with. The original four tests with these questionnaires looked at participants performing psycho-motor tasks and learning to navigate a virtual office environment. That research (Witmer & Singer, 1998) showed that these two questionnaires about presence and immersive tendencies were a good fit, and therefore they are used together here as well.
New immersive technology

In 2012, a redevelopment of the old VR technology was announced and shown to the public. Not yet finished, the company Oculus VR asked for donations to finish their Oculus Rift (also known as the Rift) HMD helmet (head-mounted display, see Figure 1). From the beginning, multiple famous game developers stood behind the project. VR technology is not something new, even Nintendo sold one such system in 1995. But why was this VR helmet a success when so many others have failed before? How is the Rift any different? The truth is in the technology itself. Both developers and users understood that the technology inside the Rift had matured (and was affordable). With the endorsements of many high level and famous industry veterans, it was also clear that the industry itself was enthusiastic about the hardware.

So what exactly is the Rift and why is this important for this thesis project report? The Rift has many features. It is a fairly light weight helmet the user wear as goggles over their eyes. It contains two small LCD screens with interchangeable lenses for those with faulty eye sight. Two screens also bring with it a 3D effect like in 3D TV’s. Gyroscope technology also lets the player use the Rift to look around in virtual environments without the need of external peripherals. Another aspect of immersion is the fact that compared to a TV screen or computer monitor, the Rift does not create a physical barrier where the virtual environment ends (Manovich, 2002). There is no black bar on top of or below the virtual world that separates the virtual world from the real one. The user feels like they really are inside the virtual world and not just looking into it from the outside, something Bolter & Grusin (2000) refers to as immediacy. This aspect alone helps expand the technology’s capabilities from a spatial immersion perspective, but also provides unique potential for narrative and gameplay related perspectives as well.

Of course, the Rift does have its set of problems; a currently low screen resolution and not being able to move inward and outward with your head. And it inherently works the best with the first person perspective, making it potentially a very niche product since it is not entirely suitable for all game genres. Many early users have also reported getting motion sickness and feeling dizzy from no more than 15 minutes of usage, even people with no such prior negative experiences with gaming, which is potentially disastrous for the product. However, the final product is a long way off and while the development kit version is available for $300 today, the final product will hopefully change a lot. By now, the second released development kit is already showing improvements in all of these areas. As it stands though, today the Rift is the most suitable VR helmet to use and to many people, the positive far outweigh the negative. The ease of use via a simple USB cable to a computer and an already very long list of fan created Oculus Rift patches for popular games, and hobby projects, make it a viable product before it is even properly released.
From a spatial immersion perspective, it would seem that the video game industry has already decided that the Rift will be the next big thing. The amount of endorsements, the money received via crowd funding, and the recent company buyout by Facebook can be interpreted as that the fascinating immersion potential of the hardware is exciting to many people. But since VR technology have failed in the past, very little information on how to properly utilize the technology is known. There is a chance that video game design, unethical or not, will need to evolve to compensate for this new way of experiencing video games. From the moral choice perspective, immersion is also important because with the new potential of being transported to another virtual world, having interesting and ethical moral choices in games, and in simulators, with consequences, the quality and design of the games need to be handled with extra care since we become more invested in the choices and dilemmas presented if we are more immersed.
**Theoretical starting points**

These three aspects: The Rift, immersion and moral dilemmas, are all important cogs in the machinery of the research project presented in this paper. In cognitive neuroscience and moral psychology, the brain is at the forefront of research. And one important area of brain study is of course the moral center. One famous moral center test is quite simple.

A group of participants are each given a paper note with a moral dilemma written on it. The dilemma can be described as the participant is standing at a railroad crossroads. On each side of the tracks, there are people lying down, five on one of them, and a single person on the other. There is a train fast approaching and nothing can stop it. The participant can however decide which track the train is switched to. To do this, s/he can simply pull a lever in front of them. People are going to die no matter what they do; it is just a question of how many they sacrifice. They cannot choose to stand idly by. They have to make a decision, so what do they do?

This is known as the “Trolley Problem” (Thomson, 1986). There is another side to this problem, which is that most people agree that there is a difference between pulling a lever to indirectly save five people, and to actively push a person onto the train tracks to stop the train. But the results are the same: Five people live and one person dies. It has been accepted in the science community before this that what we call reasoning is the primary human function that govern our morality and decision making, but recently, and thanks to these different results in the trolley problem, researchers have suggested that this is not the whole truth. Rather, our emotions also play a part in how we react to a moral problem.

Recent **fMRI** (functional Magnetic Resonance Imaging, a brain activity measurement tool) research seems to have proven this connection between emotions and reasoning (Greene, Sommerville, Nystrom, Darley & Cohen, 2001). The hypothesis was that certain dilemmas like the trolley problem evoke less of an emotional stimulus than other dilemmas, making it easier to make a rational decision. In the test, 18 participants were shown 60 different dilemmas each, of varying moral difficulty, on a monitor in text form. As expected, the reaction times it took to respond rationally to something more morally gray were indeed longer than other dilemmas. In 2004, the results were double checked with and without the same participants and the results held up once again. Emotional centers in the brain lit up on the scans to a higher degree than other areas during tougher dilemmas than during less intense ones (Greene, Nystrom, Engell, Darley & Cohen, 2004).

But there is an obvious and important distinctive aspect here that is lost. Reading and contemplating about a fictional scenario, which is not even very realistic, is an entirely different thing from experiencing it yourself in real life. Making up your own mental image of a situation based on a piece of text is very different from seeing it with your own eyes and having a situation happen directly to you. For the longest time, the general idea was that it was purely logical reasoning that is involved in decision making and moral choices (Greene et al., 2004). But in modern times, it has become more and more accepted that our own emotions affect our reasoning (Greene, 2003). So how can we truly trust these test results? Are they really representative of real world scenarios?
This is where an immersive game experience and the Rift can come into play. The research in this paper aim to test if the results of the same train dilemma ("Trolley Problem") will differ from previous research when the situation is recreated in a game world environment and the participants are placed in a “real” version of the situation thanks to the Rift, an HMD known for creating immersion with extraordinary ease as explained earlier. Will this affect their decision making when they can see the people in front of them, and also see the dire consequences of their actions with their own eyes? It is generally assumed that actually being “present” during said dilemmas ought to be more emotionally draining than simply contemplating them.
Previous research
As previously mentioned, this test is a development of an older and more significantly, analogue test. The goal is to determine whether or not the new results will differ due to a deeper spatial immersion in the moral decision making thanks to actually being present in the situation (through Virtual Reality) previously only described on a piece of paper (or TV text). When presented with the choice of sacrificing one person to save five others, most participants looked at it objectively and chose to sacrifice one individual for the greater good. But when given the dilemma of either doing nothing or actively push a person onto the tracks to stop the train entirely, noticeably fewer participants chose this course of action even though the end results would be identical compared to when all they had to do was pull a lever or push a button. Thus, participants did not feel as much guilt about pulling a lever to kill one as to push them themselves.

Several other areas of interest for this thesis are as follows: Game ethics, misuse of new technology due to lack of information, and the possible effects the VR form of new media may have on both video game narratives and storytelling and its spatial immersion potential and gameplay systems.

Game ethics is relevant thanks to the morality aspect of the thesis and prototype, and because many modern video games, especially role-playing games as mentioned earlier, tend to revolve around moral decision making in one way or another. Miguel Sicart’s ideas (2001) on what makes a video game or gameplay segment ethical or not is worth mentioning since what seems to be a moral choice in games like Star Wars: Knights of the Old Republic II – The Sith Lords (LucasArts, 2004) and Bioshock (2K Games, 2007) may actually not be moral choices at all, due to their lack of real consequences, both inside, and outside the games (Schulzke is of a different opinion as mentioned before). While it is likely that translating the “Trolley Problem” into a VR environment will generate different kinds of results, it is a good idea to ponder the question of whether or not the moral decision needed to be made is truly a moral choice at all to begin with. And while players seem to like the moral gameplay choices given in the examples mentioned, will their effects on players change when viewed through the Rift, if the Rift is confirmed to be having a positive effect on immersion? Sicart is of the opinion that gameplay should be constructed in a different way compared to standard praxis if it is truly to be considered ethical design. The question is if the Rift and similar technology down the road need to be taken into consideration when constructing an ethical game design, since higher player immersion (all kinds) might have more significant effects on players than before.

In the second part of Sherry Turkle’s book “Alone Together: Why We Expect More From Technology And Less From Each Other” (2011), she talks about the dangers of misusing technology, or technology being used with unintended purposes. People of all ages hide away from each other, instead of connecting deeper, with the help of smartphones and video games. While her examples given are not really comparable or relevant here, misuse of technology is always a danger, even more so when the technology is new and not yet fully understood. This goes hand in hand with the statement about Sicart’s ideas, that the presumably spatial immersion enhancing capabilities of the Rift and similar technologies may have considerable
side effects not yet seen because it is not yet known how game design need to evolve, or not, to accommodate this technology’s new features. A better understanding of how the technology affects its users is essential to make video games of the future, and its creators, ethical in a broader sense, so the technology is not misused as yet another tool for escaping reality in a destructive manner. It may not be a game designer’s responsibility that their games cannot be used for illegal or harmful activities, but if it is possible to gain new knowledge through experiments and research about modern VR technology, from a moral standpoint, it is essential to do so.

Lev Manovich writes about new media’s history in his book “The Language of New Media” (2002). Just as mentioned before, Manovich discusses how we as humans take in paintings, television and computer data through a literal framework, thanks to the TV/PC screen and picture frame. This creates a sort of window into a different reality within our own. One of the biggest reasons why VR technology is so successful immersion wise, even with decades old technology, is because for the first time in recorded human history, this window is removed from this simulated reality. While the user is still not able to physically move around completely when using VR technology, like in Star Trek’s Holodeck (the VR holy grail of sorts) (see “Hamlet on the Holodeck: The Future of Narrative in Cyberspace” (Murray, 1997)), the lack of a black border around the presented environment transports the user into said environment to a much higher degree than what was previously possible. The Rift’s further enhancements with head tracking and 3D displays only helps with this even more.

As Manovich’s book title suggests, every media form comes with its own form of language, derived from its media predecessors. Current VR technology stems from the old versions but also from computer screens and TV’s, and so far, the same language for how the technology is to be used is in effect. Whether or not this is a problem is yet to be fully realized since the Rift and similar technologies have not yet been released for sale. But research into this can only help creators make better and more immersive games. It is also essential knowledge to find or create as an industry standard if the worrisome aspects of video game ethics and technology misuse previously mentioned are to be minimized or avoided altogether in the future. It is also one of many important factors to consider if the new VR boom is to become a widespread phenomenon in the coming years. Lastly, the number of question marks regarding this new technology need to be answered, if only to either verify or falsify the notion of redesigned game development.
Aim, question/hypothesis
This research was done in a partnership with an outside party. This outside party is a scientific research team at HiS (Högskolan i Skövde). This team has different goals co-dependent of the help and findings of this master one year thesis project. As explained earlier, this project revolves around an updated version of the “Trolley Problem”. The research team wants to test if the previous results by Thomson (1986) and Greene et al. (2001; 2004) stay the same in a “real” (virtual) environment. They are of the opinion that reading about a crisis situation is not the same thing as actually experiencing it in real life, and they needed outside help to create a virtual environment they can use to test their own hypotheses in, and down the line manipulate in different experiments. To make the VR environment as lifelike as possible, the use of the Rift was a requirement as it is believed that this technology will help participants transport themselves into the VR environment more easily.

While this thesis report strives to help this research team with their field of interest in neuroscience, this thesis also has its own hypothesis. Video games of the modern age aim to achieve a high level of player immersion in the game worlds. The idea here is to look at how the Rift affects this immersion, if at all. The starting point assumption is that the Rift has a clearly positive effect, but just how much and in what way does this present itself? This area of research is important and it goes hand in hand with this Master thesis program about narratives and storytelling, as it is likely that the Rift may help users get more involved in the stories told in video games, as explained in earlier chapters.

Thus, the question at the center of this paper is as follows: If any, what kind of effect does the Oculus Rift have on the spatial immersion?
Prototype
The first part of the “Trolley Problem”; a speeding train or trolley is approaching a railroad track crossroads, was created in Unity Pro (www.unity3d.com, 2014), a game engine with Rift support “out of the box”.

The basic VR environment functions that were required by the research team were as follows: Rift support, which comes naturally in Unity Pro, and the walking ability disconnected. The participants were only able to look around and press a simple button. This button will have to activate a switch of some kind for the railroad. Another important aspect is to draw the participant’s attention to the correct things at the correct time and make sure they understand what to do without displaying text based hints on the screen. Three environmental aspects are essential that all participants notice without fault; the split railroad and its potential victims, the button to switch the tracks and the incoming imminent threat of the train, in that order. If possible, the idea was to create this crisis scenario in a city environment, such as San Francisco with its steep hills, in order to make the scenario as plausible as possible.

To make sure the participants notice all these environmental aspects, the environment will at first be dimly lit or entirely dark, possibly due to night time. That way, when lights turn on with the help of a timer, each aspect will be shown to the participants for a short while until it is time to make a decision. This is the prototype’s baseline that will be further developed later on in the project. In the final prototype version, a nondescript cityscape at night time was used. Street lights are the main light sources for highlighting the important aspects.
Method(s) of evaluation

This study focused on two groups of participants: primarily game development students at HiS but also individuals with a self-acclaimed high degree of video game experience, and a “control group” containing individuals with little to no video game experience (according to themselves). Going forward these groups will be called “Experienced User” (EU) and “Inexperienced User” (IU) respectively during the results presentation and analysis. Each group contained ten (10) participants within the target demographic of 19 to 25 year olds. Thus, this study acts as a pilot test, scale wise. It was decided that two test groups would be included because the research team did not think game development students were truly representative of the general population and therefore wanted a more varied sample size. At first, due to time constraints, finding a population sample size that was large enough to validate drawing specific conclusions from was deemed unlikely. Finding willing inexperienced participants seemed a difficult task at first, but in the end, there were enough people available to meet the sample size demand.

All participants were informed that they would be anonymous and that they were allowed to abort the tests whenever needed. They were also informed on what kind of data would be gathered and how it would be analyzed. Also, they would not be recorded in any fashion during the tests. Any potential notes by the author would be done on paper and for them to read afterward if requested. To avoid scheduling conflicts and make each test/interview as hassle-free as possible, all tests were conducted individually at the author’s home, instead of at HiS. HiS was part of the plan because it has a furnished experiment attic where the laboratory feel can be avoided. But relocation and transferring the technology there was deemed an unnecessary time sink, and each test was conducted on the PC used to create the prototype environment, further ensuring computer performance etc.

It was also suggested that only one group would actually use the Rift and any differences between the two groups should be recorded. A sound strategy in theory, but since participation rates was already difficult to reach, this concept was scrapped and all participants were welcome to use the HMD. This also turned out to be the biggest draw for participants so it was the correct call to make in the end. Each participant was asked to fill out a questionnaire about their immersion tendencies (Witmer & Singer, 1996).

Based on the participants’ responses in this questionnaire, each participant was asked to partake in an interview about their game world experience and the moral dilemma presented. They were also asked to fill out another questionnaire about the presence (see spatial immersion earlier) (Witmer & Singer, 1994) they felt during the test. Interview focus was primarily on how they felt about the environment’s immersion factors and just how present they felt during the crisis situation in comparison to ordinary video games based on how present they tend to feel in for example movies and books. The assumption was that there would be a clear difference regarding how the environment was perceived, with the Rift having a positive effect on participant presence. Whether or not the different test groups’ experience, or lack thereof, with games would have any effect at all was unknown. The data collected was in the form of verbal interviews and 20 pages of questionnaires per participant, ten pages per questionnaire.
Survey drafting

While this research is not entirely connected with the research team’s own aims, the purpose was to create a useful and reliable pilot test bed for use in further studies in the near future. Thesis project time constraints required that a small-scale interpretivistic test was constructed that could show whether or not the research team is on the right track with their own field of interest and methods decided upon.

Therefore, finding evidence that proves or falsifies the idea that the Rift has a positive effect on participants was of the utmost importance. This was mainly being done by using the already created and field tested questionnaires by Witmer and Singer (1994; 1996) mentioned above. Adding, removing, and perhaps even translating these questions could have severe impact on the research quality.

Having English questionnaires in a Swedish research project was deemed irrelevant since the participants have many years of exposure to the written English language thanks to for example having played video games for many years and being exposed to English television to a high degree throughout their youth. The thesis author was also present to answer any translation questions. The interviews used these questionnaires and answers given as the starting point for a more semi-structured dialogue, something that fits well with the interpretivism paradigm and such subjective things as participant opinions. It was also a recommended method by Østbye, Knapskog, Helland and Larsen (2002).
The prototype

As mentioned before, this project is done in cooperation between the author and a research team at HiS. Based on their research topic, a prototype virtual environment was requested. The exact details regarding the contents of this environment were not decided beforehand. Instead, as long as the environment was relatively realistic and believable with lifelike graphics, and the created world dealt with the research topic at hand, nothing was off limits. The original scenario in the prior tests dealt with trains potentially killing pedestrians and it was decided in a meeting that the virtual environment would best match previous results if it was as similar to this as possible. A few major factors also had to be addressed in the prototype, namely: The environment required Oculus Rift support, help text explaining the test had to be absolutely minimal, preferably non-existent, and thus certain aspects had to be explained quickly in other ways. Moving around like in an ordinary video game was not allowed either.

Due to little experience with the environment tools and a tight time schedule and only so many work hours available, it was suggested and decided that the environment was to be built using already created graphical assets found online, and light sources of different kinds would be used to highlight the most important aspects of the environment. Almost all assets used in this environment are free to use, and all operate under the same open source standard. The planned schedule for learning the tools and creating this environment with fully operational functions was two work weeks. In the end, it took about three weeks due to an extraneous learning curve programming wise, with about half the time focused on the tools and the other half on actually finding the assets and putting them to use, creating the virtual world. The tool itself used was the game development engine Unity Pro (www.unity3d.com, 2014).
Prototype construction
As can be seen in Figure 2 below, the final prototype product is an urban cityscape at night time. The cityscape was chosen based on its street layout being suitable as a train track cross roads substitute, with roads turning in a favorable fashion, but also because it was the most realistic and feasible environment available on the online Unity asset store. The original test dealt with fictional yet normal train tracks and injured pedestrians, making it easy to imagine an old Western movie, an unlikely scenario in the modern world. It was also suggested that we change the train into a mining cart, but the same problem rears its head there, because not many people today have experience of being in a coal mine or similar, making the virtual world less realistic etc.

![Figure 2. An overview of the unfinished VR environment inside the engine Unity Pro.](image)

Since highlighting important aspects was crucial to the prototype’s success, light sources was decided upon as the optimal method. It was also the easiest method to create quickly within the time frame as Unity’s lighting tools are of high standard. Lights also have a tendency of drawing attention to them so it was an obvious choice. Therefore, night time was chosen for the environment as this would make the light sources stand out even better, minimizing the risk of the participants missing what they must notice. The environment would need light sources among other things anyway to give it a more realistic look so it was clear from the get go that this way was the best approach.
To get the best overview of the area and to perceive the moral dilemma of the test as easy as possible, the participant starting position was set in stone before the work started. On a sidewalk in the middle of the environment next to the cross roads, the participant would get the perfect viewpoint of the world they are in. Looking straight forward with the Rift, the participant would see this cross roads and big road signs in front of them, lit with street lights throwing circles on the road. In the distance, the train, with its white headlights, comes out between two buildings, soaring down the street toward the participant. See Figure 3 below for an example of this.

![Figure 3. An unfinished frontal view of the VR environment, without the night sky.](image)

To the right the participant would see a woman standing in the street looking toward the cross roads, with her car parked behind her down the road, still with its lights on (see Figure 4 below for an example). To the left the participant can see four men standing on the road facing in different directions, with two old cars behind them, also with their lights on, see Figure 5 below. Scattered across the cityscape are more street lights where appropriate (since each participant can be looking in whatever direction they please during the test).

25 seconds after the environment has loaded, the train starts moving from outside the city onto the street ahead of the participant. At the street signs in front of the participant, an invisible trigger box is located, checking whether or not the participant has pressed the space bar used to intervene in the moral dilemma presented. This seemed like the optimal spot since it is just ahead of the cross roads where the train must make a turn or not. If the space bar has not been pressed, the train will run over the men on the left side, only stopping because it hits the cars on the road. If the space bar has been pressed prior to the cross roads, the train will make a turn and run over the woman instead, stopping at her car.
Figure 4. The woman and her car are located on the right side of the environment.

Figure 5. The four men with their cars can be seen to the left in the environment.
In the two above images the different characters are visible from different angles. Figure 4 shows what the user would see if they look to their left while Figure 5 shows the right side of the cityscape. The sky is only gray inside the Unity editor, not when the game is actually running. Same thing with the character T poses. They fully animate properly once the game is running. The cars were added for two reasons: to contextualize the environment slightly and to add believable reasons for the train coming to a halt in the middle of the road. Without the cars to hide the train, it is obvious that the train’s animation is just stopping suddenly without reason. With the cars, it at least looks like the train is colliding with the vehicles. The same goes for the car in Figure 5. Light sources for the head and tail lights were added manually to make the environment more realistic. Based on the cityscape and character looks, the cars were a good match for the overall art style.

Thankfully, the characters found were also of relatively high quality and had several animations built-in, making them a perfect fit with minimal extra work required. Other assets were located and installed as well, such as telephone booths, trees, cars and trash bags. Realistic trains were very difficult to locate, and thus an overly large subway train had to be used as a substitute. Its size was downscaled slightly in the environment though, making it easier to navigate and fit on the streets. Unfortunately, no actual train tracks could be located properly and seeing a runaway train in a city is a rare sight to say the least, making the environment less than optimal from a realism perspective. Train tracks inside a city would look a bit strange as well though on the other hand. Neither the train nor the cars have any sounds playing which also turned out to be a problem and something that could be fixed in the future.
Prototype work process

The work process for this project was quite iterative, with the cityscape working as the foundation for the rest. Finding a train of some sort and making it function at all was the biggest hurdle to overcome. Placing the buildings, characters and assets in the virtual space inside Unity was by far the easiest part as it does not require any coding experience and the tools themselves are fairly self-explanatory. The actual functionality was what required the most attention, as expected. Therefore, after purchasing the environment, work had to begin on making the moral dilemma work as intended. Without that aspect, the research team would not be able to use this prototype in their own tests later on. And without that aspect, the environment would not resemble a game either, something of utmost importance for this report.

After finding the animation tool in the Unity asset store, it was decided thanks to some programming advice, that the train would require three separate animations to simulate its movement through the city. The first animation had a delayed timer, giving the participant enough time to get comfortable with the Rift and what they could see. After 25 seconds, the first animation would play and the train would move towards the cross roads, stopping just as it hits the trigger box mentioned earlier. The second animation would then play automatically from that location, making the train move forward and running over the men on the left street and finally stop at their cars, all in one single motion. The third animation would also start at the trigger box, depending on a coded variable checking if the space bar had been pressed, and would make the train turn to its left making it move down the right road, killing the woman on the street.

Getting all three animations to work was not very difficult, even though the train movement still looks a bit strange especially without any train tracks. However, making them fit together, and function properly code wise, was a different story. By default, each animation would have a speed variable that made it look as if the train was slowly accelerating or decelerating depending on its position. An accelerating train was no problem since the participant could not see the train in the beginning anyway, but at the animation junction on the street, this would make the train fly forward to catch up with its own intended speed, making it look like it hit a speed bump or similar. With an unfamiliar animation tool, finding the right movement settings was difficult, not to mention not knowing how to properly code these three animations together into a seamless transition.

By the time the train was finished, making the train register that it had hit the characters was the next problem. For the longest time, the train would not register that the characters had collided with it, and even when it did register, the expected consequence would not execute properly. The code for deleting the human figures (or simply turning them invisible) was not functioning as intended. Thankfully, advice given by others and the speed and size of the train hid the fact that the train simply removes the human figures altogether when they get hit (and in the case of the men, the train stops over the bodies, or so it would seem).
Since the requested environment could not use text to help the participants understand what was going to happen or how to control the game, lighting was decided as the highlighter of important aspects. One of those aspects was the “gameplay” or how to affect the train and the moral dilemma presented. In the original tests, the active train track was changed via a switch or lever in front of the participant, which makes sense for that scenario. Unfortunately, no suitable graphical asset could be found to emulate this aspect. Instead, the author had to verbally explain the controls and hint at what to do in the environment to each participant instead of letting the game explain this itself. This could potentially break the spatial and tactical immersion of the environment since there is no logical reason why the space bar would make a train move in a different direction.

Another unexpected issue was with the skybox. After finding a free set of five skyboxes, a night sky was chosen and placed in the environment. A light color scheme and light directions for shadows and highlighting was chosen based on the sky's look. But when the Rift code base was installed in Unity, the sky disappeared (as seen in Figure 2 through 5). After some online troubleshooting, it turned out to be as simple as that the Rift does not support traditional skyboxes, making it all tricky to correct. The Rift code base also came with its own set of unexpected problems, for example making it seemingly impossible to test the game without using the HMD, since the Rift code base splits the image into two smaller and slightly distorted images in 3D.

Another problem was that the player character the participant assumes the role of, would roll around on the ground in-game for unknown reasons. Exactly how this issue was resolved is also unknown, but the lack of controls besides head movement might have had a positive effect on this. Interestingly enough as a positive side note, even with the power supply turned off, Unity could sense the Rift movements perfectly. This made it easy to turn around in-game when needed without having to put the HMD on one’s head. Instead all you needed to do was to place the HMD horizontally on a chair or table and turn it with your hand. The graphical changes would then appear on the monitor instead of inside the Rift, which helped when minor lighting or geographical changes were made, such as detailed positioning of trees along the roads.

As mentioned above, apart from having to program the required functions and downloading the assets and so on, a lot of work had to be put into making this cityscape look believable and seem to be of higher quality than it truly is. Made by unknown amateurs, it was clear that this environment was not meant to be used in any serious projects, and certainly not under such graphical scrutiny as the Rift requires. With the Rift, graphical fidelity seems to require a higher degree than in ordinary games, even though it is easier to become immersed in the environments regardless of graphical style or quality. But the technical quality shines through much easier, making graphical bugs and glitches stand out even more than usual, and it was clear from the small pictures online that this environment was not of the highest quality.
The cityscape was also quite barren beyond buildings, street lights and signs. It did not look believable and certainly not lived in by real people. Therefore, an equal amount of time as it took to program the functions was required to make the environment look realistic. From a level design perspective, this was quite easy as there was no gameplay to take heed of. In essence, from one particular perspective based on the participant’s position, the world had to look like a real place, as if one had stepped out the door and onto a real street (that is, the entire city did not need to be decorated; only the parts the participant could actually see).

That meant searching the *Unity* asset store for suitable assets that would not look out of place in an urban city. English telephone booths, some trash bags, outdoor benches, various trees, a radio tower, the skybox, tree fences and additional street lights were eventually discovered along with the human figures and their cars. Positioning and scaling these assets in the right places so that light sources would still look good and be visible was the most interesting part. None of these items came from the same creator and they were of different scales and quality, making it tough to find good enough assets that fit the theme. In truth, all this work and the programming was done in tandem, but with different amounts of focus depending on the time left on the schedule. Most of the minor environmental details and image quality checks were done at the end. A picture of the final prototype version can be seen below in Figure 6.

Not thought of at first, it was made clear by the end that the environment had too many light sources in it and by default, it had no good filtering process for the rendering, making the performance of the albeit pleasantly looking world absolutely terrible with a frame rate of around 15 fps (recommended frame rates for Rift games is 60+, as a lower frame rate can make the users nauseous and experience motion sickness). Prior experience with game engines made long light rendering times expected, but *Unity’s* was beyond anything experienced before, making the testing of different light qualities very detrimental to the scheduling at the last minute. In the end, with less rendering quality, the frame rate was doubled to 30, but it was decided that the first version with the best settings would be used in the real testing later on, as graphics quality was of the utmost importance. Since the play time length was less than one minute, the risk of participants feeling motion sickness was assumed to be minimal as well. Additional versions were made for the research team however, to be used at their own leisure, depending on what kind of computer hardware they have available.
Figure 6. The final prototype environment with decorations, dynamic light sources and its night sky are in place.
Test results

In this chapter, collected test results from the interviews will be presented. The amount of data is extensive, 20 pages of questionnaires per participant, totaling 200 pages. Since each participant is anonymous, each individual will be presented as EU 1 through EU 10 for the Experienced User group, where necessary, from here on out. The Inexperienced User participants will be referred to as IU 1 through IU 10 where necessary. Considering the amount of data per participant, it is unfortunately not feasible to attach all documents as appendices to this report.

The sex distribution within the groups were nine (9) men and one (1) woman in the Experienced User group, with the Inexperienced User group consisting of two (2) men and eight (8) women. Although unfortunately expected, given just how popular video games are among males, and though the total numbers are fairly equal, this clear imbalance among the sexes is unfortunate. A more even balance between the two groups would have been preferable and is potentially something to look at in the future if further testing is desired.

However, the test results should still be reliable regardless of the test participants’ different sexes and the difference between the two groups. This is simply because of the fact that sex has no known effect on one’s ability to navigate an environment, be it virtual or real. Every single participant found the Rift to be easily understood and quickly became second nature due to its position on their heads. And moving one’s eyes and head is something that anyone can do, regardless of sex. There are no known connections between immersion, or lack thereof, and sex.

For interviewing purposes, all participants were asked if they wanted to play other Rift games after they had experienced the thesis related environment and had filled out both questionnaires. That way, the data values gathered are not affected by more than one encounter with the technology. But with more experience with the Rift, the hope was that the dialogues between participants and author would expand. Not everyone wanted to participate in more games for various reasons however.

There are 33 questions in the Immersive Tendencies Questionnaire (ITQ) (Witmer & Singer, 1996) and 32 in the Presence Questionnaire (PQ) (Witmer & Singer, 1994). See the references provided for the actual questions. In short, each question requires a response value between one and seven, depending on the question context. These values are then added to a total value and can then be compared between participant groups depending on their PQ responses. The same value concept is applied to the PQ questions. For ease of calculation of the given values, all questions in the questionnaires will be taken into consideration during the evaluation even if not all had been field tested in the ‘90s, per the suggestion of Witmer and Singer.
The total values for both questionnaires are presented here, with each questionnaire being separate for each group and individual. More in-depth looks into individual response values will be presented in the analysis chapter if required. Minimum and maximum scores for the ITQ are 33 and 231. The PQ score limits are between 32 and 224. It is worth noting that certain PQ questions deal with auditory and haptic feedback, something that the prototype is not designed to take advantage of. Thus, these questions have been automatically graded at their lowest possible score of one each (it was not recommended to omit them entirely). Because of this, the effective max PQ score is diminished to 194 instead of 224 (five questions times six lost points each). A higher score is better than a low one.

Table 1 A list of the collected scores for each participant in their respective groups.

<table>
<thead>
<tr>
<th>Experienced Users</th>
<th>Inexperienced Users</th>
</tr>
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<tbody>
<tr>
<td>ITQ</td>
<td>PQ</td>
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<tr>
<td>EU 1</td>
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<tr>
<td>EU 2</td>
<td>163</td>
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<td>EU 9</td>
<td>116</td>
</tr>
<tr>
<td>EU 10</td>
<td>148</td>
</tr>
</tbody>
</table>
Test results analysis

First off, the sample size in this thesis research is quite low for drawing any major generalizable conclusions from. It would most likely be detrimental to make any judgment calls of any considerable scope based on this small amount of data. But, hopefully the data can tell us something anyway, at least showing the way forward, giving us an inkling of how the real world scenario would show itself. This is a small scale pilot test in every sense of the word. That said, the results are quite interesting and somewhat unexpected.

Finding so many women and inexperienced users willing to participate so easily was a positive surprise. However, as mentioned earlier, an unfortunate side effect of this was that the gender balance between the two groups is perhaps too uneven. The fact that zero participants felt any degree of motion sickness despite the low frame rate was also positively surprising. Nevertheless, the IU group’s enthusiasm and excitement for the project concept was fortuitous and prosperous for the report’s success. Perhaps a minor difference in total values, but the IE group’s PQ value is around 10% higher than the EU group’s.

Even though both groups were clearly infatuated with the new technology, the novelty of it probably gave it a slightly higher “wow factor” (as phrased by a participant) for the inexperienced users. A common complaint from the experienced group was the lack of gameplay and to some extent, the less than optimal screen quality. The technical competence in said group also made it possible to verbally identify issues such as display lag. On the other hand, the EU PQ numbers are more evenly spread across the chart than the IU’s for some reason. Same goes for the ITQ numbers.

Looking at the total values alone, they seem to indicate that video games experience or lack thereof have no visible impact in general on people’s ability to immerse themselves in environments and storylines in whatever form. It was assumed that participants with gaming experience would have a much easier time getting immersed in both games in general and in this test environment, but that does not seem to be the case at all. This was a surprising secondary finding. As is shown in the Table 1 above, although there are a couple of discrepancies, higher PQ scores in both groups are usually connected to a higher ITQ value, and vice versa, and while the EU group show higher ITQ values in general, they compare fairly well with the IU results, meaning that if the ITQ is high or low, the corresponding PQ is the same, comparatively.

It was unexpected to find that even those participants who scored themselves low in the ITQ still showed relatively high PQ values, more so in the IU group. That might tell us that inexperienced users find themselves easier immersed than others for some reason when using HMD’s. Perhaps it is the pure shock and awe of having this experience that makes this happen, as it happened with the entire group more or less. Either way, the fact that gaming experience did not show to be of any particular significance when it comes to our ability to immerse ourselves in something is surprising to say the least.
Interviews

The dialogue between the author and each participant came in several parts. As mentioned before, what the test was about beyond the use of the Rift was concealed until the HMD was put in place on their respective heads. However, basic knowledge about what they could expect, that they would end up in a moral dilemma and what controls to use was explained prior to them seeing the actual VR environment. Explaining the keyboard controls while wearing the HMD seemed like a bad idea since the participants would practically be blind while wearing it, and finding the correct buttons was hard enough as it was with it on for them, so information had to be given before they put the HMD on. The bulk of the dialogue happened during the questionnaire session, both before and after using the Rift. It was made clear that not many people actively think about their ability to immerse themselves in fiction because several ITQ questions were difficult to understand and it seemed like a very difficult thing to quantify on the scale provided.

This was a universal occurrence independent on the amount of video games experience. The issue seemed to stem from several aspects, in large part due to performance anxiety and lack of English skills, mainly in the IU group. The questionnaires had questions that were worded strangely and with difficult words, making it hard to understand what they meant. The fact that the questionnaires were two decades old made it difficult to understand the connection between the Rift and the original questions as well. Unexpectedly, a lot of translations and interpretations of the questions had to be given on the fly (the same interpretations were given across all participants where it was needed), which suggests that the questions were perhaps outdated and irrelevant (a lot of questions deal with things not available in this project, like sounds and haptic feedback). A proper Swedish translation was ignored at the start of the project but might have been a good idea in hindsight. The language barrier was there for both groups but was more prevalent in the IU interviews. Putting a number of each of the questions in both questionnaires also proved difficult for both groups, suggesting that immersion is difficult to quantify, as was suspected from the start.
**Experienced User interviews**

Three of the participants in this group had tried the Rift themselves prior to the test. This was unknown before the test started but should not pose a problem. All participants knew what the technology itself was beforehand so there was no need to explain that part to this group. The most obvious theme was the excitement to finally get their hands on the Rift themselves since they had all heard so much about it online. Even without the new unreleased model’s improvements, the group was thoroughly impressed with both the light weight and the performance. A few participants noticed and mentioned that the screen had a low resolution but it did not have any noticeable impact on their enjoyment. Only one person made a comment about the apparently noticeable 3D effect, but it was in another demo unrelated to the research at hand.

As a discussion point, it was brought up that traditional video games are probably not entirely suitable for use with the Rift, as many modern games are played through the third person perspective. Perhaps not always thought of at first by the participants, regardless of academic background, given some thought they agreed that the Rift could present new challenges for game developers down the road when trying to build new games around this technology instead of just connecting it to an ordinary video game. The notion that the technology allowed for easier spatial immersion, yet also breaks the same immersion easier was also accepted as most likely true after experiencing it themselves. Nevertheless, the enthusiasm within the group for the future was high.

As mentioned earlier, the environment created features no audio or touch capabilities. This automatically brought the score down a fair bit and was a constant complaint in the EU group, especially the lack of sound and gameplay aspects. While the use of the Rift itself had no impact on this, the overall feeling of immersion in the environment suffered because of this. This was expected and most definitely affected the scores in more ways than just lowering the maximum score possible. Touch may not be as important (touch is so rarely used in modern games that it is not so missed) but sound really should have been a part of the environment.

But while it is easy to just assume that this misstep is severe, and it most likely is, it was admitted by one participant that he or she had made up their own sounds in their head to fill this blank space, thanks to the immersion created by the Rift! And one other accidentally heard street sounds through a real life window and had to ask if these sounds were in the game or not, suggesting that the Rift created immersion got compensated by the visual experience. It was also recently found in a study that these auditory hallucinations are fairly common as well in ordinary games, but when playing for many hours straight (Ortiz de Gortari & Griffiths, 2014). Perhaps the Rift has an effect on this as well?

Complaints about the lack of sound effects were not as common during the actual tests as during interviews. The original tests by Greene et al. (2001; 2004) were done with contemplating moral dilemma via text on a monitor, so they did not use sounds or even graphics in the same sense either, so the same senses would have been active in both cases, so perhaps this is not so significant of an issue as one could imagine.
On the other hand, while most participants in both groups did not understand what they were supposed to be doing in the environment, despite supposedly clear instructions, they were sufficiently immersed in the world presented to just stand idly by while the train ran over the virtual people in front of them. This was explained during the interviews as partly not understanding how they were supposed to behave but also because they expected to see regular video game-like instructions on the screen. But this can however also be interpreted as a deep sense of spatial immersion. In that regard, the lack of gameplay and sound did not seem to affect their ability to immerse themselves in what they saw.

Regarding the actual moral dilemma, even if not all participants managed to press the space bar in time to change the train direction or did not understand in time that the train was what they were supposed to react to, all participants did or said they would change the train direction to only kill one person instead of four. This seems to suggest that the sheer mathematics of that equation was enough to make that decision, both on paper (as in the original tests) and in a virtual world.

On the other hand, the lack of gameplay functions and knowing that the space bar does something, compared to all the other buttons, made it seem like some participants pressed the button just to see what it did since it was not clear from the start what the button does, as if they were compelled to press it no matter what. All participants rested their hand on the space bar in anticipation of something happening on screen (this was suggested since finding the space bar in the dark would prove too difficult since timing was required). They knew that the space bar indicated a decision on their part, but since nobody knew what the decision was going to be beforehand, or rather what the two options were, some seemed surprised by the results (indicated by their reactions). That indicates that there was a severe lack of information that hindered the test somewhat. Perhaps a regular controller would have been a better choice than the keyboard. The lack of a virtual button is probably another cause of this confusion.

Also, with the way the environment is constructed, some participants were looking in the wrong direction entirely, in spite of knowing that the actions would take place in front of them, when the train appeared and ran over the people. So around half of the participants had to redo the test and be given slightly clearer instructions (six from IU and three from EU), which suggests that the research team’s own tests would gain better results from more clear instructions. Just saying that something would be happening after 25 seconds of being in the world and that the participant could make a choice by pressing the space bar was hardly ever enough to produce proper results for either group. The interviews confirmed this problem numerous times. The participants’ in-game behavior suggested that their sense of time was diminished and it was difficult to know what 25 seconds actually mean.
However, the problems mentioned above did not seem to hinder the spatial immersion. In fact, using the Rift was unanimously praised as a clearly better alternative where appropriate compared to playing an ordinary first person perspective based game. It is difficult to tell here if the Rift has any impact whatsoever on Adams’ narrative, strategic and tactical immersions (2004) but the Rift is most likely affecting the user's immersive capabilities in regards to spatial immersion. The participants who tried various roller coaster demos and small horror games confirmed this not only through body language (screams, jumping, laughing, following the roller coaster track with their bodies etc.), but also during the interviews. No matter how they felt about their immersion capabilities in regards to movies and TV according to the ITQ values, they agreed that they really did transport themselves into another world with the Rift.

Given time afterward, several complaints were brought to light as mentioned above, but during the actual use of the technology, all participants seemed to accept what they saw as reality. Neither the technology nor the environment is flawless, but this group of experienced video game users was at least during use forgiving of these flaws. Humorous quips about the train animation and lack of gameplay were mentioned several times during the interviews but these aspects did not seem to impact their enjoyment while actually wearing the Rift. In the end, the consensus was that gameplay was required to bring all of the Rift’s capabilities to its true level of immersion enhancements. Unfortunately however, the interviews and the created environment did not seem to be able to bring forth any game changing ideas on how to evolve game design for the future, leaving the background thesis mentioned in the early chapters of this report potentially unresolved.
Inexperienced User interviews

None of the participants in this group had any comments regarding the physical technology side of things at all, and only one individual made a short comment about how it was lighter than anticipated. Two participants were surprised at the low price point, thinking it would at least be in the 10 000 SEK range. On the other hand, the range of general enthusiasm and excitement was wider here than in the EU group.

The person who at first was the most skeptical and anti-video games, had the most trouble getting immersed in movies and was the most easily distracted according to themselves was in the end the one who showed the greatest signs of actually being transported into a new world, both when riding a roller coaster and being scared for the virtual characters’ safety in the VR environment. Going from skeptically optimistic and curious to overjoyed and screaming in sheer panic could stand as a testament that the technology is not just for video game players but is actually interesting for all kinds of people. The ease of use was also palpable in this group in general as none of the participants misunderstood how it worked and could use it flawlessly and intuitively, especially without feeling any motion sickness, and enjoying the intense stomach feeling during for example the roller coaster demos.

In regards to the VR environment created, five of the participants managed to press the space bar in time for the environment to react to it, and all of them said, just like the EU group, that they would have pressed it and made that choice if they had understood it better. Disregarding the fact that the test groups were indeed small in size, there does not seem to be any difference in the amount of enjoyment gained from the technology usage. Same thing goes for the test results with a 100 % in both groups suggesting they would have made the “proper choice”.

Just like in the EU group, participants voiced their concerns over the lack of sound effects, but not the lack of gameplay as much, perhaps due to their fear of failure that many were nervous about at first, or because they were aware of how little gameplay content they would need to get used to. Lack of sound was therefore a much bigger problem for immersion. Lack of touch capabilities and vibrations in a controller was noted during the questionnaire fill-outs and brought down the scoring a fair bit but the entire group agreed that this did not have any actual impact on their enjoyment, least of all during use.

The participant example given above might have been extreme but also telling of the overall attitude towards the experience. Wearing a “heavy” device and blocking out the outside world even more than what ordinary video games do were sources of skepticism for some at first but after actually trying the device they all agreed that it was a pleasure to experience it. The health and antisocial concerns did remain lingering during some interviews though, giving slight credibility to the notion presented earlier that game developers need to figure out the peculiarities of this new medium to prevent user harm.
**Notable individual data**

One of the participants who seemed the least interested and most skeptical towards the whole thing turned out to be one of the more interesting participants, results wise. This person was IU 9. As can be seen in Table 1 (on page 25), her PQ value is the highest together with IU 4, beating all of the other 18 participants. Her ITQ score is also one of the lowest among all 20 participants. At first this seemed like a mismatch and should be redone with another person, but she shows that even though she herself said she has severe trouble concentrating or getting interested in TV series and movies, that turned out to be completely false while using the Rift. The range of emotions was wider in her than any of the other participants, both in the additional virtual environments not part of the test and the one created for the project. The skepticism soon turned into pure enjoyment even though she felt quite scared during the test.

She may be only one person but she still shows that even though movies, TV and books can be poor immersion tools for some people, HMD’s could potentially be much more effective. She also mentioned feeling completely drowsy mentally but this didn’t show at all during the test. Among the screams and laughter from earlier environments and trying to find the moral dilemma in the now more suspenseful environment comments like “Wow, this looks real”, “This is so cool” were spoken. Laughs also came when she tried to ask questions while turning her head in one direction only to realize that she did this automatically although she could not see anyone in the virtual environment. This suggests a deeper immersion than usual. The transportation to a new world was more effective than she had anticipated and the final words were “How do I save those people? I would have done so if it had happened in the real world”.

Another interesting person was the person who had to double check if sounds in the real world were in fact there. This EU member heard some street noise from the right and automatically looked in that direction at the woman and her car in the virtual environment. Then the question came, even though he knew beforehand that sounds were not in the environment, “Did those sounds just now come from outside or from the environment? I could not tell for sure”. Had the Rift not had a particularly strong effect on spatial immersion, this question would most likely not have happened. The fact that he had to ask to be absolutely sure and also looked in the sound’s direction and still was not sure without outside reassurance suggests this. “I definitely want one of these for myself” is a quote that resonates with most participants and is something that suggests that the product is at the very least interesting to a wide mix of people.
Implications and conclusions

While keeping in mind that the sample size of this thesis is small, implications can be made regarding several aspects of the test and the theoretical starting points. Whether or not “morality gameplay” of yore consists of true moral choices or if such gameplay is ethical or unethical in its design as Sicart classify them (2011), has little to do with the participants’ enjoyment of this new medium or the moral dilemma they were presented with. And a new medium it is. HMD’s like the Oculus Rift and its future successors and competitors present new challenges for the developers who work with the tool, both technical and design wise. This thesis may not present a clear cut blueprint to follow but it does provide knowledge that these test groups agree that games need to accommodate the technology and not the other way around from now on. The Rift gives the user a new kind of window into the virtual world, a window without borders and the inherent limitations of regular monitors.

Participants agreed with Bolter’s and Grusin’s immediacy notion (2000) that while monitors are windows into a fictional world; HMD’s are a transportation vehicle with their own set of rules and mannerisms. While still expensive in itself and requiring a modern computer to use properly, the enthusiasm from both test groups is potentially groundbreaking and suggests a commercial success and a new boom of technology that might be unstoppable, which means that more knowledge and understanding is of the utmost importance going forward. And this enthusiasm is based on using now already slightly obsolete technology, with new Rift versions and unreleased competitors’ technology already heading our way.

And if even inexperienced users can detect the antisocial and health concerns that this technology creates, credence is given to Turkle’s notions regarding the misuse of social technology and it’s effect on user health, both mental and physical. It is impossible to tell just how big of a threat this is, it is hardly going to affect sales negatively, but it does exist and needs to be addressed, and not only by academics, but in practice as well. With the technology schematics being set in stone by its creators, it falls on the game and content developers’ tables to make sure they fully understand the technology and its potential effects on their users.

Some developers are in fact already trying to figure this out on their own. Sony Computer Entertainment, the developer of the Oculus Rift competitor “Project Morpheus” recently showed their own set of guidelines for future game development in VR environments (Handrahan, 2014). In the article, Sony employee Jed Ashforth presents five guidelines for creating immersive VR experiences (related to actual design, user expectations, levels of immersion and the destruction of the same, and finally user comfort). While they may not directly address user health concerns the article proves that game companies and creators are at least trying to do their part and figure out how to properly use this new medium.

It is impossible to say with this particular test what kind of effects the Rift might have on the additional immersion types described by Adams since the created environment does not contain ordinary gameplay. But it is clear from these 20 participants that regardless of gaming experience, the Rift has a tremendous effect, and a positive one at that according to the users, on spatial immersion. With at least one participant placing their own placebo sound effects in
the environment thanks to the Rift, it is beyond reasonable doubt that this is something new that is here to stay. Lack of gameplay had no tangible negative effect to speak of for any participant when it comes to feeling like they are inside a new world.
The virtual environment and thesis work process

It was believed early on that the work process and level design of the virtual environment would be fairly painless, and that it would be particularly easy to find the material needed to create the desired kind of environment requested by the research team. Scheduling wise, this turned out fairly well with only a few slight alterations. It certainly would have helped to have more time available and/or more people helping with the creation though.

One idea on how to solve this and at the same time make a more fully fledged product, a team of students could have worked on the project, each with their own skill sets, especially in the graphics department. More time and expertise would have been preferable to really make the environment stand out quality wise. All in all however, the end result is something to be proud of.

Lack of expertise, staff and time made it necessary to be very flexible with what kind of environment could be created within the time frame. There was only about one work week available for finding the art assets and putting them together in a believable fashion. In the end, even though the runaway train inside a modern town without any railroad tracks is quite far from a realistic scenario, it looks plausible and does its job well enough, all things considered.

Thanks to the research team being flexible with the project scope, a satisfying environment that works as intended was a possibility. Unfortunately there was a lack of content available which had a major impact on what kind of environment was feasible to achieve for the team. Luckily, they gave their blessing on the plans to create a cityscape with a runaway train. Given the circumstances, the project turned out well.
Research project connection

The research team granted free reign over the creation aspect of the project and has had very little to do with this report’s own hypothesis area. While the environment was commissioned by the team, the hypotheses are fully separate. As long as the environment could be used in their own neuroscience research, this report’s content could be about anything, from their perspective. It seemed like a natural choice to make a study about the Rift’s effects since the team had requested its use and had already assumed that it would have a positive impact on their own research. So that’s the real connection between the two, the technology used, even though the research topics are vastly different.
Ethical discussion

During the process of figuring out how to put this project together, there were some ethical concerns voiced, namely about the implications of not telling the participants what they would experience, considering the subject matter of life and death. Usually it is critical that participants are made aware of what the test is truly about, what they would be doing and what the researcher is looking for. In this case though, that would have tainted the results entirely, making the tests unusable. It was decided early on that this was unavoidable and the research team gave its blessing regarding this approach.

Another issue would be the fact that participants are anonymous, making it impossible to replicate the results presented here. This certainly affects the validity of the research conducted. While the names of the participants would not serve any purpose in the report itself, being known would make it easier to recreate the experiments for others and beyond participant comfort, anonymity might have been unnecessary for this research. On the other hand, a couple of participants did ask not to be revealed, regardless of test results, which might also prove an inconvenience if revealed given the subject matter in the virtual environment.

Creating a “murder simulator” as was done in this project (debatably more so than in an ordinary video game due to rules systems) comes with its own set of ethical questions as well, both for the author, the participants and the test itself. While the environment is dressed up as a moral dilemma of right and wrong of sorts, it is indeed nothing more than a tool for fictional murder. Is it okay to create such a thing, even for empirical research? Perhaps it is a question for philosophers, but it is worth thinking about the consequences for the participants at the very least.

The graphics in this virtual environment were not as realistic as the real world by any means, but video games are getting there. If the test was to be performed again in the future, could the results change due to even better graphics? It is likely as graphics are a major part of creating all kinds of immersion, especially spatial immersion. But would the participants be affected negatively if the virtual environment was as lifelike as possible? It would not be especially ethical to cause mental trauma in the participants for the sake of a test. But on the other hand, the test’s reliability is also guaranteed to being negatively affected by the still obviously video game looking environment. Even though it feels like one is being transported to a new fictional world, all participants are aware of the fact that they are not anywhere else than in the real world. In the end, this might be a bigger moral dilemma than the recreated trolley problem itself.
Another issue is the fact that the author is friends and/or acquaintances with all of the test participants. It was deemed unrealistic mainly due to the time span available that complete strangers would be found and convinced of helping with the experiment, but it is nevertheless a concern that there is a personal connection between participants and author. There is no way of knowing if/how this has affected the answers given in the questionnaires and the following interviews. But on the other hand, the friendships were what made this project a possibility at all in the first place.

There is also an issue with the author being a game development student himself and only half of the participants being well-versed in video games. This almost certainly guarantees that the interviews with the EU group would have a different tonality compared to the discussions with the IU group. This would most likely explain the difference in amount of data collected from the IU group. It might also explain why the IU group had significantly more trouble understanding the questionnaires and its questions due to the language being more formal compared to everyday use.
Societal implications and usage
This research can be used for a plethora of areas. While a small sample size, it proves that virtual reality and HMD’s are the next big thing, especially in video games, but also in other areas, be it neuroscience research or guided tours of tourist attractions or hostile locations. Virtual environments can be used in all kinds of purposes, and while graphics keep evolving towards realism, people are already excited about the technology we have today, even with the issues that come with unfinished technology.

It was presumed from the start that contemplating a moral dilemma versus “actually experiencing it” (or as close to that as VR can make it seem) would show different results, yet this test did not. What this means for neuroscience going forward is beyond the scope of this report but it is saying something for sure. The results presented here do prove one thing though: the Oculus Rift and its upcoming competitors are surely here to stay. The excitement and research about it points in that direction. The ease of use for all participants regardless of video game experience proves that this has mass market potential beyond all prior video game technology, especially since it can be used in other ways as well, not just with video games.

Since there are already guidelines available on how to create the best kinds of immersion using VR, it is clear that this technology is different enough to warrant further research, and this research in particular also proves that HMD’s do have a positive impact on the users, even when there is little to no gameplay available. That makes the report useful for further studies and for product development.
Future research

Even though better graphics could have other severe effects on both participants and results, more advanced graphics and especially sound effects are clearly something that is missing from this project. A better scenario than a speeding train inside a city would probably be a good idea as well. As it stands, the test is also only testing one part of the original test, the trolley problem. It was suggested during the initial talks with the research team that the other part where the participant contemplates pushing a person onto the train tracks should be recreated as well, perhaps with a real physical boxing bag as a stand-in for a human being. Whether or not this would be possible, two tests would certainly aid the results, if the previous tests need to be recreated more precisely.

It would also help the results if a higher number of participants had been available. In this test, 20 individuals helped with one dilemma. In the original from 2001, 18 individuals helped with 60 dilemmas. The follow-up experiment had 41 participants, so it is clear that the sample size here is too small for any real conclusions. The research team is pleased with this current amount however as it serves as a starting point in the form of a pilot test, but for this particular paper’s hypothesis, 20 people is too low a number to be convincing enough and usable in any real world scenarios.

As for the actual content created here, it can be discussed if a virtual environment without any gameplay whatsoever is applicable as a stand-in for real video games. This performed test is good for the research team’s hypothesis and works with this report’s hypothesis as well, but for game developers worldwide, perhaps not so much. Most participants in the EU group made comments about the lack of gameplay so there must be something to it. Sony has already presented their own guidelines based on their own research so this small-scale research might not be as useful as intended. They seem to prove the same points however and if several sources arrive at the same results, all the better. For future research though, cooperation with the video games industry might be a good idea.
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