THE INFLUENCE OF VIRTUAL REALITY EXPOSURE ON SOCIAL AND PHOBIC BEHAVIOURS

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Abbreviations
AQ: Acrophobia Questionnaire
ANOVA: Analysis of Variance
ATHI: Attitudes Towards Heights Inventory
AVPR1a: Arginine Vasopressin 1a Receptor
BAT: Behavioural Assessment Test
CAST: Comprehensive Assessment of Sadistic Tendencies
CAVE: CAVE Automatic Virtual Environment
CBGT: Cognitive-Behavioural Group Therapy
CBT: Cognitive-Behavioural Therapy
CERO: Computer Entertainment Rating Organization
CGI: Clinical Global Improvement
CM: Catalyst Model
CPU: Central Processing Unit
DCS: D-cycloserine
DotA 2: Defense of the Ancients 2
DRD2: Dopamine D2 Receptor
EGT: Exposure Group Therapy
ESRB: Entertainment Software Ratings Board
FPS: First-Person Shooter
FtF: Face to Face
GAM: General Aggression Model
GEQ: Game Enjoyment Questionnaire
GLM: General Learning Model
GPU: Graphics Processing Unit
HIV: Human Immunodeficiency Virus
HMD: Head Mounted Display
HSP: Hot Sauce Paradigm
IED: Improvised Explosion Device
IPT: Immersive Projection Technology
ItI: Immersive Projection Technology to Immersive Projection Technology
ItD: IPT to Desktop
IQ: Intelligence Quotient
MMAT: Mixed Methods Appraisal Tool
MOBA: Massive Online Battle Arena
NRA: National Rifle Association
OCD: Obsessive Compulsive Disorder
OFLC: Office of Film and Literature Classification
OXTR: Oxytocin Receptor
PAE: Patent Assertion Entities
PEGI: Pan European Game Information
PQ: Presence Questionnaire
PSA: Prosocialness Scale for Adults
PTG: Posttraumatic Growth
PTSD: Posttraumatic Stress Disorder
RAM: Random Access Memory
RGR: Remote Graphics Rendering
RRTT: Retaliation Reaction Time Task
SD3: Short Dark Triad
SLT: Social Learning Theory
SSQ: Simulator Sickness Questionnaire
SUDS: Subjective Units of Discomfort
TAU: Treatment as Usual
TM: Trolling Magnitude
TME: Trolling Magnitude Evaluation
VE: Virtual Environment
VR: Virtual Reality
VRD: Virtual Reality Distraction
Abstract

**Background:** For decades, researchers and therapists have attempted to utilize virtual reality (VR) technologies for therapeutic use, most notably for treatments regarding specific phobias and anxiety disorders, but implementation of VR-based therapies was largely held back due to factors such as cost, accessibility, and technological limitations. Modern VR, however, appears to address many of the issues from older VR models, making the technological medium more affordable, accessible, and powerful than any previous VR iteration. While modern VR was largely designed for entertainment purposes, the features inherent in modern VR systems, such as online storefronts, stereoscopic displays, and tracking capabilities, may prove to be invaluable to advancing the implementation and delivery of VR-based therapies.

**Objective:** The aim of this thesis was to evaluate the influence of repeated VR exposure on both phobic and social behaviours to inform the development of a self-directed VR exposure therapy (VRET) procedure that appropriates VR programs that were not specifically designed for therapeutic purposes, such as VR games, for therapeutic purposes.

**Methodology:** A systematic review and three experimental studies were conducted as part of the present thesis. The systematic review examined a total of 88 studies obtained through multiple databases, with findings from the review serving to inform the efficacy of VRET, application of VR technology in therapeutic and experimental settings, and the advantages and disadvantages of utilizing VR technologies. The first experimental study (N = 3) was a case study that examined the effectiveness of a self-directed VRET in which patients were randomly assigned to either a Pure Self-Help (PSH), Guided Self-Help (GSH), or Waiting List group. Both PSH and GSH patients were allotted up to 12 1-hour treatment sessions, with the only difference between the groups being the amount of interaction with the lead experimenter during the treatment sessions. The second experimental study (N = 21) sought to examine the influence of repeated VR gaming on cyberaggression, with participants being randomly assigned to either a Violent,
Non-Violent, or No Game group. Participants in the Violent and Non-Violent group played a selection of three games related to their group category over the course of six weekly sessions, with measures for aggression being conducted through questionnaires and a YouTube commenting task. Lastly, the third experimental study (N = 20) was conducted to reinforce findings from the second study by evaluating potential changes in prosocial behaviours. Participants were randomly assigned to either a Violent Competitive or Non-Violent Cooperative group, each playing a single game over the course of two weekly sessions, and prosocial behaviours were measured via a questionnaire.

**Results:** Findings from the first experimental study showed promise towards the effectiveness of self-directed VRET, but with a few caveats. While both the PSH and GSH patients experienced improvements at the post-treatment phase, the PSH patient was still within the clinical average across each measure for acrophobia. Objective measures such as heart rate and self-report questionnaires did not appear to indicate significant improvement for the PSH patient, but the patient believed significant improvement had been made during post-treatment and 6-month follow-up interviews. As for the experimental studies regarding VR gaming’s influence on aggression and prosocial behaviours, there were no significant differences in behaviours between each group.

**Contribution to Knowledge:** The present thesis has created a foundation to build a self-directed VRET procedure by appropriating non-therapeutic VR applications for therapeutic use, while also demonstrating that while repeated exposure to VR experiences can reduce acrophobia-related fear and anxiety, it cannot amplify or diminish the individual’s aggression and prosocial behaviours, respectively.
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Chapter 1: Introduction

Worldbuilding has long been one of humanity’s longest pursuits, defined as an art of detailing the culture, language, physics, geography, and other worldly aspects to bring an imaginary universe to life (Butler, 2013). These worlds can vary drastically from one another, ranging from the rustic medieval world of *A Song of Ice and Fire* to the futuristic cyberpunk world of *Blade Runner*, and whether these worlds were created to mirror reality, entertain, or make a statement, these universes are brought to life due to the painstaking attention to detail that its creators breathe into them. As time progresses, new mediums arise to allow worldbuilders to carry out their visions in new ways; whether the world is detailed orally or enacted within a multi-million-dollar Hollywood movie production, worldbuilders have embraced new mediums to make their worlds feel more immersive. This is evident with *The Epic of Gilgamesh*, a story that has existed for at least 5 millennia in written form, which was also depicted in a 2009 television short (Sadigh, 2010). Each new medium allows for a progressively new dimension to introduce the worldbuilder’s creation, but it has long been a struggle to bring the imaginary world to parity with reality—to create a sense of presence within the individual to make them as if they had been transported to a new reality. While humanity is still far from being able to achieve this, a promising new medium has taken the first step towards making that experience possible, and its implications can go far beyond telling a narrative: that medium is virtual reality (VR).

The present thesis aims to examine the implications of VR in therapy as well as its impact on social behaviours, specifically in relation to acrophobic (i.e. fear of heights), aggressive, and prosocial behaviours. One of the main forces driving the advancement of modern VR is the video game industry, but the present thesis posits that VR can be utilized for self-directed (i.e. self-help) therapies, not just for entertainment purposes. Furthermore, there stands the possibility that even VR games can be used for the proposed self-directed therapies. The use of video games for therapy has largely been successful for physical rehabilitation (Lohse, Shirzad, Verster, Hodges, & Van der Loos, 2013), but as VR gaming is
relatively novel, there has been little to no documentation of its efficacy as an effective therapeutic tool, as well as whether there may be any adverse social behavioural effects from playing VR games. Based on this premise, the present thesis seeks to answer two main questions across three separate experimental studies involving VR-based self-directed therapy and VR-based gaming:

1) Can a VR application that was not designed specifically for therapeutic purposes be used in a therapeutic context to aid individuals suffering from mild to moderate acrophobia symptoms?

2) Will there be any adverse behavioural consequences from playing VR games, specifically heightened cyber aggression or diminished prosocial behaviours?

Solutions to these inquiries would inform whether a self-directed VR treatment solution can be implemented in such a way that appropriates non-therapeutic, commercial VR programs (e.g. games and simulations) for therapeutic use. If the outcomes from the present thesis show promise, this type of approach towards VR-based therapy would not only be increasingly accessible to individuals who may not have ready access to proper care, but also for researchers and therapists to better integrate therapeutic protocols into existing programs without the need to create a program from the ground up. Before these questions can be answered, however, it is important to have a comprehensive understanding of the existing VR-based therapeutic literature as well as the historical and modern states of the technological medium. This can be accomplished by a combination of a systematic review and literature review, which would ultimately inform the protocols for each of the three experimental studies within this thesis. By the end of this thesis, an understanding should be established in relation to:

- The historical and modern state of VR technology
- A comprehensive overview of the existing VR-based therapy literature
- The impact of VR gaming on aggression and prosocial behaviours
1.1: An Introduction to Virtual Reality

VR refers to technology that facilitates user immersion within a digital environment, often incorporating visual and auditory stimuli displayed through a head mounted display (HMD) or immersive projection technology (IPT) displays. These VR catalysts have their own unique advantages and disadvantages regarding factors such as stimuli presentation quality and commercial availability, but with the constant cycles of technological advancement and innovation, the limitations of VR, specifically in its HMD form, are diminishing while its general applicability is broadening.

To achieve a true VR experience, researchers have commonly posited that presence, defined by the subjective feeling of being in an environment, is an essential component (Shuemie, van der Straaten, Krijn, & van der Mast, 2001; Slater & Wilbur, 1997; Steuer, 1992). While presence is a wholly subjective experience, the level of presence a user can feel from a VR system can be determined in part by the levels of immersion and interaction afforded by the VR system. Immersion refers to how well the user’s senses are being mediated by the hardware, which can be evaluated based on 4 variables: how much of the real world is being shut out (i.e. Inclusive), the range of senses being attended to (i.e. Extensive), level of omnidirectional sensory information (i.e. Surrounding), and the fidelity and seamlessness of the environment (i.e. vividness; Slater, Usoh, & Steed, 1995; Slater & Wilbur, 1997). If immersion is determined by how well the VR system presents sensory stimuli, interaction is determined by how well the virtual environment (VE) can respond to the user’s actions. This can be evaluated through three factors: how fast the VE can assimilate the user’s actions (i.e. Speed), the possible outcomes for any given action (i.e. Range), and the extent to how natural an action performed in the VE feels compared to the same action performed in a real environment (i.e. Mapping; Steuer, 1992). By defining the quality of VR through both immersion and interactive variables, VR is defined more by the possible subjective experiences that it can deliver rather than the technological components that make up the VR system.

This definition of VR leaves a lot of room for generalization, as it creates a spectrum of various technological and non-technical apparatuses that can create a sense of VR depending on the levels of
interaction and vividness that the apparatus can provide. For example, individuals who read a non-
illustrated fictional book about a wizarding world or a newspaper article detailing a crisis cannot change
the events being presented (low interaction), nor can the individual see, hear, taste, touch, or smell
anything beyond the words displayed (low vividness), but both the book and newspaper article can be
considered as a VR apparatus because the reader can imagine and become immersed into the world or
events being described. Games presented either on a dedicated gaming console (e.g. Nintendo Switch,
Playstation 4, etc.) or computer may allow for a greater VR experience compared to books and
newspapers, as games can provide various visual and auditory stimuli and a means to control the events
that occur within the VE via different controller peripherals (e.g. gamepads, body tracking cameras, etc.).
HMD and IPT systems go beyond gaming on the VR spectrum by ensuring that users can only see and hear
the stimuli being presented within the VE, therefore blocking out the visual and auditory stimuli from the
physical environment around the user. While the HMDs and IPT systems available today can provide a
high level of immersion and interactivity, the apex of the spectrum has yet to be achieved, which should
be capable of simulating all of the user’s senses within a fully interactive VE (Steuer, 1992). Although these
systems have yet to be created, fictional works provide many examples of what a fully immersive and
interactive VR experience could be like, with one such example coming from the Sword Art Online series’
NerveGear, which depicts an HMD capable of delivering stimuli directly to the user’s brain.

1.2: A Brief History of Virtual Reality

Although VR can be defined by the subjective experiences of the user, the history of VR as a
 technological system is equally important, especially as the common perception of VR is largely rooted to
technological devices. The first VR device can be attributed to Morton Heilig’s invention of the Sensorama
in 1957, an immersive but non-interactive machine designed to allow users to see, feel, and smell an
environment portrayed through a specially recorded movie. Ivan Sutherland would conceptualize the
Ultimate Display shortly afterwards, aiming to create a machine that presented visual, olfactory, auditory,
taste, and tactile senses. Based on his Ultimate Display vision, Sutherland created the Sword of Damocles, heralded as the first VR HMD. Unfortunately, the Sword of Damocles fell short of Sutherland’s goals for the Ultimate Display, but the Sword of Damocles still contributed to the development of VR through its incorporation of stereoscopic vision and head tracking capabilities to view a digitally rendered wire grid (Mandal, 2013).

Several prototypes and concepts followed after the Sword of Damocles’ inception to enhance the level of interaction and/or immersion, including GROPE, a force-feedback system conceived by the University of North Carolina, and VIDEOPLACE, a system created by Myron Krueger that allowed users to interact with a VE through the use of image processing techniques on a two-dimensional plane. These systems would later pave the way for the United States Air Force’s Visually Coupled Airborne Systems Simulator (VCASS), which utilized an HMD to help train fighter pilots with targeting and flight path information, as well as the National Aeronautics and Space Administration’s (NASA) Virtual Visual Environment Display (VIVID), which incorporated a monochromatic display into an HMD (Mandal, 2013).

In 1988, VR would finally be available commercially with the release of VPL’s Eyephone HMD, which when coupled with the 1985 release of the DataGlove, allowed consumers to experience immersive and interactive VEs. Fake Space Labs would follow up the release of the Eyephone HMD with its own take on the HMD system with BOOM, a small box that integrated two cathode ray tube (CRT) monitors to display the VE, and a mechanical arm that created precise view tracking within the VE (Mandal, 2013).

In 1993, the first VR IPT system, known as CAVE Automatic Virtual Environment (CAVE) was established. Instead of relying on HMDs, CAVE networked four projectors to display images on three interconnected walls and the floor alongside the incorporation of shutter glasses to achieve a stereoscopic effect commonly found in HMDs. Although the CAVE system boasted considerably more powerful specifications than prior HMD releases in terms of visual resolution, field of view, and the ability to expand its applicability with motion controls, it was associated with high financial costs, required a large amount
of space to set up, was not capable of projecting on all six sides of the user, and structural fragility. While these disadvantages limited where CAVE could be implemented, it still provided an alternative approach to VR and would become implemented as a tool for scientific research (Cruz-Neira, Sandin, & DeFanti, 1993; Mandal, 2013).

While VR was commercialized in the late 1980’s, it had faded into public obscurity as there was a disparity between what the technology was capable of achieving and what the general consumer idealized VR to be (Mandal, 2013). In recent years, the development of advanced graphical capabilities and processing power of modern machines have allowed VR to experience a resurgence in popularity, specifically for gaming and film purposes. There are currently three variations of VR HMD configurations that general consumers can choose from: computer-based, smartphone-based, and stand-alone. Computer-based VR systems include the HTC Vive, Oculus Rift, and Windows Mixed Reality HMDs, which features high display resolution, refresh rates at a consistent 90 frames per second, dedicated motion controllers, surround sound, and can track the user’s position within a limited space. Smartphone-based VR systems are typically shells that house a compatible smartphone, trading in computational power for inexpensiveness compared to computer-based VR configurations. Lastly, stand-alone HMDs, such as the Oculus Quest and Vive Cosmos, establishes a middle ground between computer-based and smartphone-based VR by coupling the high visual resolution of computer-based VR with the inexpensiveness of smartphone-based VR.

Perhaps the largest difference that separates modern VR over legacy VR systems is in software development and integration of social features. All of the computer-based VR HMDs have their own dedicated digital distribution platforms that allow users to both download games and play with others across the world. While smartphone-based and stand-alone VR may not provide as full of a VR experience compared to computer-based VR, it is still more than capable of presenting VR and 360-degree video recordings, with platforms such as Youtube giving filmmakers an outlet to share recorded VR content to
a wide audience. This support from software developers is a major contrast to the legacy VR systems that came before the release of the HTC Vive and Oculus Rift in 2016, which were often limited to isolated, laboratory or therapeutic environments, as well as requiring researchers and therapists who wanted to use VR technology to either write their own programmes or outsource the program to someone who was literate in a computer language supported by the VR system.

1.3: Thesis Objectives and Contribution to Knowledge
1.3.1: Thesis Objectives
The current thesis has three main objectives:

1. Evaluate the efficacy of VR-based treatment based on the established literature
2. Examine the effectiveness of a self-directed approach towards VR-based treatment for acrophobia
3. Examine the influence of repeated VR gaming sessions on player aggression and prosocialness levels

The first objective serves to create a foundation towards the formulation of a self-directed iteration of VR-based therapy. Notable interests include the types of disorders that were effectively treated with VR-based therapies, examinations of features inherent to VR (e.g. depth perception, tracking systems, etc.), and the general utility of VR within experimental and therapeutic settings, all of which aim to inform each of the three main studies conducted for the present thesis. To meet this objective, a systematic review was conducted to cover the existing VR literature published prior to the 31st of January 2017.

The second objective aims to test a practical application of self-directed VR-based therapy based on the information gained from the systematic review, and the primary focus is to treat acrophobia (e.g. fear of heights) through a VR-based iteration of exposure therapy, one of the primary treatment options for the disorder. To accomplish this objective, a case study was conducted to test two main self-directed
therapeutic approaches: pure self-help and guided self-help. The main distinction between these two approaches is the amount of contact the patients would have with the experimenter. Furthermore, acrophobia was chosen due to VR’s ability to facilitate depth perception, which highlights one of the distinguishing features that VR has over other technological mediums such as computers and televisions.

The third objective aims to evaluate potential changes in player behaviour with repeated gaming sessions. Two studies were dedicated to address this objective; one study dedicated towards evaluating aggression, and another towards prosocial behaviours. If non-therapeutic VR applications are to be considered for therapeutic use, then VR games may serve to be catalysts for therapeutic procedures due to their interactive nature, quality, and capability for modifications. Some concern has been raised, however, that the immersive and interactive nature of violent situations depicted in VR games may desensitize the player towards violence and consequentially lead to a higher tendency to commit violent acts in the real world (Mandal, 2013). This concern echoes back to the classic debate as to whether media, including radio shows, television programs, movies, and most prominently, video games, is a causal influence for increased violent behaviours. Although there has been an overwhelming amount of literature that has demonstrated that video games depicting violence did not instil violent behaviours in its players (Ferguson, Olson, Kutner, & Warner, 2014; Markey, Markey, & French, 2015), an evaluation is necessary to determine whether the same findings can hold true when the game is played with the unparalleled level of immersion and interactivity afforded by VR. This is also important as the objective of exposure therapy is to desensitize patients towards the object of their phobia, so a distinction must be made to ensure that the VR user’s social behaviour would not be negatively influenced while utilizing a VR game for therapeutic purposes. The two studies conducted to address this objective both pull from established methodologies, but also incorporates aspects such as multi-week repeated gaming sessions to address some of the limitations of past video game research.
1.3.2: Contribution to Knowledge

The main contribution to knowledge that this thesis will provide is the establishment of a foundation for a novel self-directed approach towards VR-based therapy through the use of VR programs that were not intentionally designed for therapeutic use. Although there has been extensive research across all of the therapeutic approaches that comprise the present thesis’ proposed approach, there has yet to be any documented research that combines the VR and self-directed therapeutic methods that take advantage of commercial applications to produce a far more accessible therapeutic experience compared to traditional therapist-led therapies. By utilizing features that are inherent to and enhanced by modern VR (e.g. higher resolution, tracking systems, online storefronts to purchase and distribute VR applications, etc.), all of the components needed to facilitate self-directed VR therapies to function are now in place, and this thesis serves as a first step towards introducing and exploring this concept.

To support the present thesis’ primary objective, a comprehensive overview of the existing VR literature would provide the necessary information to understand the methodologies employed by past studies, factors that would need to be considered (e.g. technological limitations), and the limitations encountered by past studies. This will be accomplished through a systematic review, which aims to encompass as many aspects of VR as possible, including the therapeutic and practical applications of VR alongside the technological capabilities of VR. While the systematic review will be primarily used to inform how experiments conducted for the present thesis will be carried out, it can also serve to provide a general understanding of the VR literature for any future study focusing on VR.

Additionally, the present thesis aims to update some methodologies to address some of the methodological criticisms of past studies. Primarily, the focus will be on addressing issues with video game studies, which will be elaborated further in Chapters 5 and 6. A couple of notable changes include a novel measure to evaluate and observe flame trolling behaviours and the classification of video games used for unique experimental groups. By implementing updated methodologies based on the criticisms of older
methodologies, the process of understanding the influence of experimentally manipulated variables can be better refined and implemented in future studies.

Beyond the establishment of the proposed intervention, the present thesis will provide a new perspective towards the use of commercial programs for therapeutic use, one that minimizes or eliminates the need for therapist involvement, maximizes the patient’s sense of autonomy throughout the treatment process, and emphasizes the versatility of commercial software that the general public has access to over the rigidity of proprietary therapeutic software that may be difficult to obtain or use without a trained therapist. Particularly, the present thesis posits that VR-based gaming will be capable of serving as a catalyst for self-directed VR therapies as the quality of the stimuli from commercial games are notably greater than games that have been developed for the sole purpose of gamifying therapeutic procedures. While VR has been prevalent throughout the last few decades, VR gaming was not possible until recently due to hardware limitations and lack of developer support, but modern VR has facilitated an environment in which VR gaming could thrive. Due to the novelty of VR gaming, a secondary contribution to knowledge that this thesis will provide is an evaluation of the influence of repeated VR gameplay sessions and whether it would influence the user’s behaviour in the same vein as repeated exposure sessions conducted for self-directed VR therapies. Under these premises, findings from the three studies that comprise the present thesis will ultimately inform the efficacy of self-directed VR therapy, identify whether repeated VR gaming sessions can significantly impact the player’s behaviour, and present a refined approach towards implementing psychotherapeutic protocols through gaming and other traditionally non-therapeutic programs that portray stimuli relevant to a given phobia or other psychological disorders.
Chapter 2: Research Methodology

The purpose of this chapter outlines the rationale behind the methodological approaches employed throughout this thesis, which incorporates elements of qualitative, quantitative, and mixed methods methodologies. The aims of this chapter are to convey:

1. The philosophies behind qualitative, quantitative, and mixed method methodologies
2. The qualitative versus quantitative argument
3. The rise of mixed methods approaches and the importance of incorporating strategies of both qualitative and quantitative research methods

2.1: An Introduction to Qualitative, Quantitative, and Mixed Research Methodologies

The social sciences typically have three main methodological approaches when it comes to designing and interpreting an experiment and its data: qualitative, quantitative, and mixed methods. Qualitative research is characterized by a subjective, flexible approach in which the researcher acts as an observer and records anything that emerges as it happens. Quantitative research, however, is characterized by a more objective, rigid approach in which the researcher plans out how to approach an issue and carries out the plan in systematic steps (Abusabha & Woelfel, 2003). While both qualitative and quantitative methodologies appear to oppose one another on a fundamental level, a growing number of studies are beginning to adopt the mixed methods approach, which incorporates elements of both (Bryman, 2006). While some researchers may pledge loyalty to a single approach in the same vein as a political party, it is important to understand that none of the research methodologies are versatile enough to uncover or examine all research questions. This notion serves as the underlying research philosophy of this thesis: by practicing and understanding each of the methodological approaches, the best approach can be chosen for the research question to create better research designs and interpretation of results.

2.1.1: Qualitative vs. Quantitative: An Argument of Subjectivity and Objectivity

One of the largest ongoing debates in science, especially social science, is the qualitative vs. quantitative debate. This debate revolves around how research should be conducted, whether
researchers should simply observe the natural order of things (qualitative approach) or observe through calculated control of variables (quantitative approach; Abusabha & Woelfel, 2003). The qualitative vs. quantitative debate can be further boiled down to a debate of subjectivity vs. objectivity, respectively; should researchers observe the world around them and use their personal experiences to make inferences as to how the objects of observation are related, or should researchers be outside observers with no room for biases that identify cause and effect relationships by isolating variables in a controlled setting? Although this is an ongoing debate, quantitative research has arguably been the more preferred methodological approach in science, ironically evident with the bias academic journals have in relation to accepting papers to publish as articles (Turner, 2016).

For some sects of science, the quantitative approach is certainly the best and most appropriate approach; this is most notable for hard sciences, which are characterized by near or complete objectivity (e.g. chemistry, physics, and geology), that examines natural objects and phenomena to strive towards understanding the rules the universe follows (i.e. scientific law). Soft sciences, which focuses primarily on theoretical constructs such as the mind or soul (e.g. psychology, sociology, and political science), come across difficulties when utilizing quantitative approaches as there may be numerous ways to measure and approach a theoretical construct (e.g. mentality, behaviour, etc.), therefore a qualitative approach may sometimes produce better interpretations. Regardless of which method produces the “better” science, both methods are necessary to fully examine objective and subjective constructs. A clock is a prime example of why both are necessary; while an individual would need an objective methodology to establish how the innerworkings of the clock can work in tandem to produce an accurate measure of time, a subjective methodology would be needed to define the concept of time.

While both methodologies are essential to science, part of the driving force behind which methodology produces “better” science is the pursuit of generalization, which is the act of forming conclusions of the whole based on an isolated instance. Generalization has been important for fields such
as therapy and medicine, as researchers strive to produce cures and treatment plans that can apply to a wide range of patients while testing on as few as possible. In terms of quantitative research, the methodology to produce generalizable results often employ random sampling, which allows for inferences that the sample is representative of the whole population. Qualitative research, however, rely on inductive reasoning, a process that builds upon specific observations to broad conclusions, to produce their generalizations. While each methodology’s path towards generalization can be effective, it often also carries unique limitations; random sampling may not necessarily be representative of the whole population, but a sub-population (e.g. college students) due to whoever is available (i.e. convenience sampling), and there may be more phenomena that exists beyond the point when the researcher stops the inductive reasoning process (i.e. premature closure). Although both methodologies’ paths towards generalization are drastically different, the solutions to address both methodologies’ issues are the same: replication of both studies and samples, and systematic integration of evidence through meta-analysis (Polit & Beck, 2010).

Another reason as to why there has been a great divide between qualitative and quantitative methodologies may also be attributed to basic human bias, specifically the thinking orientation of the researcher. Murshed and Zhang (2016) conducted a study on a group of market researchers to determine whether the researchers’ thinking orientation, categorized as either analytic (viewing an object in isolation) or holistic (viewing an object in relation to the whole context surrounding the object), with the former being more representative of the quantitative methodology while the latter represented a more qualitative methodology. Over the course of 4 experiments, Murshed and Zhang (2016) concluded that thinking orientation, both when natural and primed, had influenced the market researcher’s preference for its represented methodology. Furthermore, when the market researchers were primed towards a certain thinking orientation, their preferences for the represented methodology would become stronger if they had to provide a rationale as to why they preferred the methodology.
The consequence of this debate largely limits the type of information available to researchers, which can be likened to the file drawer problem, a type of publication bias where studies are more likely to get published if the results that are reported are positive and significant, while studies with negative or inconclusive results are rejected (Rosenthal, 1979). Instead of rejecting based on results, however, journals may reject based on the methodology employed, with the bias leaning more in favour of quantitative studies. This is particularly evident in social sciences like psychology and sociology, as editors in journals typically differentiate quantitative and qualitative researchers as either scientists or activists, respectively, and as a scientific journal, the bias naturally sides with the quantitative methodology (Turner, 2016).

Regardless of the reason behind the quantitative vs. qualitative debate, both methodologies have unique contributions towards the pursuit of science. Both methodologies are tools to establish an understanding of the unknown, and while some researchers may only specialize in a single methodology, there is a growing interest to utilize the mixed methods methodology to create a fundamentally deeper understanding of the unknown.

2.1.2: The Growth of Mixed Methods
There are many variations of the mixed methods process, each with different approaches towards integrating both qualitative and quantitative methods together. The process of integrating quantitative and qualitative data can be simultaneous or sequential (Morgan, 1998), and can take place at any point of the research process (e.g. formulation of the research question, or the collection, analysis, or interpretation of the data; Tashakkori & Teddlie, 1998). These variations can be attributed in part to the rationale behind employing a mixed methods approach, which includes triangulation, exploration, or explanation. Triangulation refers to the validation of findings that result from utilizing different methods, therefore findings that can be observed through qualitative and quantitative data together have a much stronger foundation compared to findings done exclusively through either method. The use of mixed
methods for exploration and explanation refers to the use of data prior and following the experiment, respectively; for example, qualitative methods can be used to examine how individuals react to an unforeseen situation, but quantitative analysis could be used to measure and interpret the severity of the reactions (Bryman, 2006).

Mixed methods builds upon the existing similarities between quantitative and qualitative methodologies, such as employing empirical observations, detailing data, explaining the process behind their data interpretations, and enacting safeguards to limit biases (e.g. confirmation or funding). By establishing the similarities between quantitative and qualitative approaches, the same phenomena can be studied with interchangeable approaches. In relation to a construct like culture, a qualitative approach could be used to define the characteristics of a unique culture holistically, while a quantitative approach could examine how the culture may affect an individual’s brain functions, or vice versa. While there is certainly a dichotomy of holistic and reductionist views in the qualitative and quantitative approaches, respectively, the recognition of similarities behind the foundation of each methodology allows for both triangulation and better communication between primarily quantitative or qualitative researchers (Johnson & Onwuegbuzie, 2004).

In psychology, the rise in prominence of mixed methods approaches can be seen in the subfield of psychotherapy. Classically, psychotherapy has been a subfield where qualitative methods could thrive; patients may have varied response to a form of treatment, and even the most established treatments may not be the best option for some patients. Case studies, which are small, isolated studies in which a researcher or therapist tracks the recovery process of a single patient in response to an experimental treatment plan, largely serve as the foundation for establishing better forms of treatment. These case studies are often qualitative, relying on data from patient interviews and natural observation, and while they are typically not generalizable, they can lead to larger, more controlled quantitative studies if the experimental treatment demonstrates success. Even at the case study level, quantitative methods are
slowly being integrated to provide more objective evidence, specifically in the form of biometric measures (e.g. heart rate, skin conductance, etc.). While this approach towards mixed methods may not necessarily lead to triangulation, it does demonstrate how both subjective and objective evidence can be used together to define the success of a treatment plan (Creswell & Garrett, 2008; Dattilio, Edwards, & Fishman, 2010).

2.1.3: Rationale for the Methodologies Employed for the Current Thesis

The present thesis acknowledges that exclusively limiting research practices in terms of qualitative and quantitative methodologies are insufficient for a thorough investigation of the implications and lasting behavioural impacts of VR. While the present thesis will not primarily incorporate both qualitative and quantitative data simultaneously, it will be utilizing a mixed methods approach in a way that utilizes the strengths of both qualitative and quantitative methodologies where appropriate. Furthermore, as the present thesis is attempting to explore and evaluate a novel concept, the best format for this thesis to be modelled after is an hourglass, one that begins with a broad exploration of the established literature, followed by a narrow examination of select topics, and ending with broad implications based on the conclusions made by each of the studies that comprise the present thesis.

The first stage of the present thesis’ hourglass approach begins with a systematic review, one that serves to inform the range of disorders, methodological approaches, and other documentations related to the use of VR technologies (e.g. hardware limitations) and the experiences (e.g. side effects) that it provides. The systematic review will ultimately inform the three main studies outlined in Chapters 4-6.

The second stage aims to focus specifically on the efficacy of self-directed VR therapy and the potential influence of repeated VR gameplay on the player’s aggressive and prosocial tendencies. Study 1 will be dedicated towards evaluating the efficacy of self-directed VR therapy by utilizing both quantitative and qualitative data to obtain both objective (e.g. biometric data) and subjective (e.g. patient interview responses) data types, respectively, to gain a better understanding of potential treatment success on a
physical and mental level. The use of qualitative data is particularly important for Study 1, as while quantitative measures can capture data that cannot be easily fabricated (e.g. false reporting, bias, etc.), the present thesis posits that for a treatment to be truly effective, the patient must subjectively believe that the treatment was effective; even if quantitative data would indicate that a patient has improved, it would be meaningless if the patient themselves still believed that they had not made any significant improvements. In relation to addressing the potential influence of repeated VR gameplay, Studies 2 and 3 will be conducted to address aggression and prosocial behaviours, respectively, through the primary use of quantitative measures. Unlike Study 1, it is more important for Studies 2 and 3 to be based on quantitative, rather than qualitative, measures due to the risk of participant bias, one in which the participants would tend to present themselves in the best way possible.

The third and last stage aims to take all of the conclusions made throughout each of the three main studies and dictate the collective implications of each of the studies as it relates to the use of VR in therapy and the role of commercial applications for therapeutic purposes. While this stage, outlined in Chapter 7, will reflect on the conclusions and limitations of the three main studies and how each study has contributed to the wider VR, therapeutic, and gaming literatures, it will also speculate on the future of self-directed VR therapies based on the findings presented in the three main studies. By modelling the present thesis after an hourglass, a broader examination of the existing literature allows for better refinement of the three main studies, which can then be used to open up more avenues of research that would reinforce the novel concept of a self-directed VR therapeutic procedure.

Chapter 3: A Systematic Review of VR Research
This chapter outlines the systematic review process and its findings on how VR has been used to treat and evaluate various psychological disorders as well as how the technology has been implemented in general psychological research. The contents of this chapter also serve as a foundation for subsequent chapters, as the findings from the studies examined in this review also largely inform how VR could be
implemented in the studies conducted in this thesis, most notably the experiment in Chapter 4 on the examination of a VR-based self-directed treatment option for acrophobia. The aims of the chapter are to outline:

1) The capabilities afforded by VR that are invaluable to both psychological research and therapy
2) The advantages and disadvantages of VR systems prior to commercial VR HMDs released in 2016
3) The versatility of VR as a safe and adaptable tool for both psychological research and therapy.

Databases Searched
An exhaustive search of the ProQuest Central Psychology, PsycINFO, and PsycARTICLES databases were used to obtain studies for this systematic review. Studies must have been published prior to the 31st of January 2017, follow an empirical methodology, been peer reviewed and published in a scholarly journal, written in English, and have full text availability.

Search Terms
The command line used for the search was as follows: ft("virtual reality") AND ft(therapy OR treatment OR training), with “ft” representing “document text.” Theses, dissertations, other systematic reviews, meta-analyses, book chapters, and studies involving non-human participants were excluded during the initial search parameters. Initially, 231 studies were found collectively across the 3 databases used to conduct the search.

Inclusion and Exclusion Criteria
For the initial 231 studies collected, the following inclusion and exclusion criteria were implemented. Studies must have implemented the use of a VR system in the form of an HMD or IPT displays to treat a patient for a mental disorder, train participants for a task, or examine a feature of the VR system as it relates to research or therapy. As VR is a flexible term that could incorporate numerous technological configurations, any study that used traditional desktops (with or without keyboard and/or mouse controls, and with or without stereoscopic glasses), a single projection screen setup, and gaming
consoles with or without motion control peripherals (e.g. Nintendo Wii U or Microsoft XBOX Kinect) were excluded. Furthermore, augmented reality (AR) was omitted from the systematic review, as the primary focus was on a purely digital VR experience, rather than the mixed experience of a digital overlay on the real world that AR offers. Simulators that did not incorporate an HMD or IPT system into its hardware configurations were also omitted, such as studies that used computer-based driving simulators with multiple monitors for a panoramic picture.

In total, 24 studies fulfilled the requirements set by the inclusion criteria. Additional articles were gathered by reviewing the references of the 24 studies for any title that referenced “virtual reality” and fulfilled the requirements of the inclusion criteria, and this process was repeated until no additional articles could be found. 64 additional studies were collected based on these parameters, bringing the total number of studies covered under this systematic review to 88. Figure 1 provides a visual breakdown of the article collection process.
The 88 studies collected for this systematic review typically fell within one of three major themes: 1) VR as a therapeutic option, 2) Subjective perceptions within VR, and 3) VR as a safe alternative to perform experiments that would have been dangerous otherwise. Table 1.0 lists all the VR configurations from studies that specified the brand, model, or other notable specifications (e.g. field of view, display resolution, etc.), with the majority of studies employing a HMD configuration.

Table 1.0

<table>
<thead>
<tr>
<th>Brand</th>
<th>Model</th>
<th># of Studies Used</th>
<th>Type</th>
<th>Stereoscopic</th>
<th># of Displays</th>
<th>Frame Rate (Hertz)</th>
<th>Display Resolution*</th>
</tr>
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<td>CAVE</td>
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<td>IPT(^a)</td>
<td>Yes</td>
<td>4</td>
<td>N/A</td>
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<td>Chalmers Cube</td>
<td>1</td>
<td>IPT</td>
<td>Yes</td>
<td>5</td>
<td>30</td>
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<td>Visette Pro</td>
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<td>HMD(^b)</td>
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<td>2</td>
<td>N/A</td>
<td>N/A</td>
</tr>
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<td>Company</td>
<td>Model</td>
<td>Dimensions</td>
<td>HMD</td>
<td>Yes/No</td>
<td>Resolution</td>
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<td></td>
</tr>
<tr>
<td>------------------------------</td>
<td>---------------------</td>
<td>------------</td>
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<tr>
<td>Virtual-I0</td>
<td>l-glasses</td>
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<td>N/A</td>
<td></td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Note. *It is currently unclear whether the display resolution is accounting for the total display resolution, or the per-eye display resolution.

aIPT: immersive projection technology

bHMD: head-mounted display

As a note of caution, some VR device specifications (e.g. refresh rate, resolution, etc.) varied based on the requirements of the software being used, as well as being dependent on the specifications of the outputting computer (e.g. central processing and graphics power). There were also some discrepancies as to how field of vision and refresh rates were reported, with some studies reporting the former in terms of diagonal degrees or by horizontal and vertical dimensions, while the latter could be reported in terms of hertz or frames per second (1 hertz = 1 frame per second). Lastly, the Virtual Gorilla program developed by Allison, Wills, Bowman, Wineman, and Hodges (1997) that was used in a few VR analgesia studies was omitted, as it was software-based and could be used in terms of both HMD and traditional computer formats, but the specific HMDs used for the Virtual Gorilla program were not mentioned when an HMD was used.

A total of 51 of the 88 collected studies focused on the use of VR as a therapeutic tool for treating general phobias, as an evaluative or treatment tool for paranoid ideations or anxiety-based disorders, or relieving pain (See Table 1.1.1, 1.1.2, and 1.1.3, respectively). Another 31 studies were centred around investigating different subjective perceptions, which were categorized in terms of sense of presence, distance estimation and navigation strategies, and social behaviours within a shared VE (See Table 1.2.1, 1.2.2, and 1.2.3, respectively). The remaining six studies utilized VR to simulate an environment within a VE for an experiment that would have otherwise been dangerous to perform in a real setting (See Table 1.3).

Table 1.1.1

<p>| Specific Phobias |</p>
<table>
<thead>
<tr>
<th>Author</th>
<th>Phobia</th>
<th>Experiment Type</th>
<th>VR&lt;sup&gt;a&lt;/sup&gt; Type</th>
<th>Treatment</th>
<th>Comparison</th>
<th>Follow-Up</th>
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</thead>
<tbody>
<tr>
<td>Botella et al. (1998)</td>
<td>Claustrophobia</td>
<td>Case Study</td>
<td>HMD&lt;sup&gt;b&lt;/sup&gt;</td>
<td>VRET&lt;sup&gt;c&lt;/sup&gt;</td>
<td>N/A</td>
<td>1 Month</td>
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<tr>
<td>Botella et al. (2007)</td>
<td>Agoraphobia</td>
<td>Controlled</td>
<td>HMD</td>
<td>VRET</td>
<td>In-Vivo Exposure, Waiting List</td>
<td>12 Months</td>
</tr>
<tr>
<td>Carlin et al. (1997)</td>
<td>Arachnophobia</td>
<td>Case Study</td>
<td>HMD</td>
<td>VRET</td>
<td>Non-Clinical In-Vivo Exposure</td>
<td>N/A</td>
</tr>
<tr>
<td>Emmelkamp et al. (2001)</td>
<td>Acrophobia</td>
<td>Controlled</td>
<td>HMD</td>
<td>VRET</td>
<td>In-Vivo Exposure</td>
<td>6 Months</td>
</tr>
<tr>
<td>Emmelkamp et al. (2002)</td>
<td>Acrophobia</td>
<td>Controlled</td>
<td>HMD</td>
<td>VRET</td>
<td>Waiting List</td>
<td>N/A</td>
</tr>
<tr>
<td>Garcia-Palacios et al. (2002)</td>
<td>Arachnophobia</td>
<td>Controlled</td>
<td>HMD</td>
<td>VRET</td>
<td>Non-Tactile</td>
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<td>Hoffman et al. (2003)</td>
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<td>Controlled</td>
<td>HMD</td>
<td>VRET</td>
<td>Placebo Group Therapy Relaxation Therapy</td>
<td>6 Months</td>
</tr>
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<td>Maltby et al. (2002)</td>
<td>Aviophobia</td>
<td>Controlled</td>
<td>HMD</td>
<td>VRET</td>
<td>Placebo</td>
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<td>Mülhberger et al. (2001)</td>
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<td>HMD</td>
<td>VRET</td>
<td>Relaxation Therapy</td>
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<td>Controlled</td>
<td>HMD</td>
<td>VRET</td>
<td>Placebo</td>
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<td>Ressler et al. (2004)</td>
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<td>Controlled</td>
<td>HMD</td>
<td>VRET</td>
<td>Placebo</td>
<td>3 Months</td>
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<td>Rothbaum et al. (1995a)</td>
<td>Acrophobia</td>
<td>Controlled</td>
<td>HMD</td>
<td>VRET</td>
<td>Waiting List</td>
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<td>Case Study</td>
<td>HMD</td>
<td>VRET</td>
<td>Waiting List</td>
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<td>Rothbaum et al. (1996)</td>
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<td>Case Study</td>
<td>HMD</td>
<td>VRET</td>
<td>N/A</td>
<td>N/A</td>
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<td>Rothbaum et al. (2000)</td>
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<td>Controlled</td>
<td>HMD</td>
<td>VRET</td>
<td>In-Vivo Exposure</td>
<td>6 and 12 Months</td>
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<td>Aviophobia</td>
<td>Controlled</td>
<td>HMD</td>
<td>VRET</td>
<td>In-Vivo Exposure</td>
<td>6 Months</td>
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<td>Controlled</td>
<td>HMD</td>
<td>Multiple Context Exposure VRET</td>
<td>Single Context Exposure</td>
<td>3 Weeks</td>
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<td>Aviophobia</td>
<td>Case Study</td>
<td>HMD</td>
<td>VRET</td>
<td>N/A</td>
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</table>

<sup>a</sup>VR: virtual reality

<sup>b</sup>HMD: head-mounted display

<sup>c</sup>VRET: virtual reality exposure therapy
Table 1.1.2

<table>
<thead>
<tr>
<th>Author</th>
<th>Client Type</th>
<th>VR&lt;sup&gt;a&lt;/sup&gt;</th>
<th>VRET&lt;sup&gt;b&lt;/sup&gt; Setting</th>
<th>Avatar Behaviour</th>
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<tbody>
<tr>
<td>Anderson et al. (2003)</td>
<td>Case Study</td>
<td>HMD&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Classroom</td>
<td>Friendly, Bored</td>
</tr>
<tr>
<td>Anderson et al. (2013)</td>
<td>Social Anxiety Disorder</td>
<td>HMD</td>
<td>Classroom</td>
<td>Interested, Bored, Supportive, Hostile, Distracted</td>
</tr>
<tr>
<td>Difede (2014)</td>
<td>Posttraumatic Stress Disorder</td>
<td>HMD</td>
<td>City</td>
<td>N/A</td>
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<tr>
<td>Fornells-Ambrojo et al. (2008)</td>
<td>Early Psychosis</td>
<td>IPT&lt;sup&gt;d&lt;/sup&gt;</td>
<td>Train</td>
<td>Neutral</td>
</tr>
<tr>
<td>Freeman et al. (2010)</td>
<td>Low Non-Clinical, High Non-Clinical, and Persecutory Delusions Recently Assaulted</td>
<td>HMD</td>
<td>Train</td>
<td>Randomized Breathing, Gaze, Responsive, Smiling</td>
</tr>
<tr>
<td>Freeman et al. (2013)</td>
<td>Recently Assaulted</td>
<td>HMD</td>
<td>Train</td>
<td>Neutral</td>
</tr>
<tr>
<td>Freeman et al. (2014a)</td>
<td>Recently Assaulted</td>
<td>HMD</td>
<td>Train</td>
<td>Randomized Breathing, Gaze, Responsive, Speech</td>
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<tr>
<td>Freeman et al. (2014b)</td>
<td>Paranoid Ideations Non-Clinical</td>
<td>HMD</td>
<td>Train</td>
<td>Speech</td>
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<tr>
<td>Freeman, Gittins, et al. (2008)</td>
<td>Non-Clinical</td>
<td>HMD</td>
<td>Train</td>
<td>Randomized Breathing, Gaze, Responsive, Smiling</td>
</tr>
<tr>
<td>Freeman, Pugh, et al. (2008)</td>
<td>Non-Clinical</td>
<td>HMD</td>
<td>Train</td>
<td>Randomized Breathing, Gaze, Responsive, Smiling</td>
</tr>
<tr>
<td>Gerardi et al. (2008)</td>
<td>Case Study</td>
<td>HMD</td>
<td>Middle East</td>
<td>N/A</td>
</tr>
<tr>
<td>Harris et al. (2002)</td>
<td>Students</td>
<td>HMD</td>
<td>Auditorium</td>
<td>Laughing, Conversational, Asking Questions</td>
</tr>
<tr>
<td>McLay et al. (2011)</td>
<td>Posttraumatic Stress Disorder</td>
<td>HMD</td>
<td>Middle East</td>
<td>N/A</td>
</tr>
<tr>
<td>Pertaub et al. (2002)</td>
<td>Students</td>
<td>HMD</td>
<td>Conference Room</td>
<td>Positive and Negative</td>
</tr>
<tr>
<td>Price and Anderson (2012)</td>
<td>Social Anxiety Disorder</td>
<td>HMD</td>
<td>Conference Room, Classroom, Auditorium</td>
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<tr>
<td>Reger et al. (2011)</td>
<td>Posttraumatic Stress Disorder</td>
<td>HMD</td>
<td>Middle East</td>
<td>N/A</td>
</tr>
<tr>
<td>Reger et al. (2016)</td>
<td>Posttraumatic Stress Disorder</td>
<td>HMD</td>
<td>Middle East</td>
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Table 1.1.3

<table>
<thead>
<tr>
<th>Author</th>
<th>Case Type</th>
<th>VR(^{a}) Type</th>
<th>Pain Type</th>
<th>Comparison</th>
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</thead>
<tbody>
<tr>
<td>Dahlquist et al. (2007)</td>
<td>Controlled</td>
<td>HMD(^{b})</td>
<td>Cold Pressor</td>
<td>Interactive VR, Passive VR, No VR</td>
</tr>
<tr>
<td>Gershon et al. (2003)</td>
<td>Case Study</td>
<td>HMD</td>
<td>Cancer Procedure</td>
<td>Computer</td>
</tr>
<tr>
<td>Gershon et al. (2004)</td>
<td>Controlled</td>
<td>HMD</td>
<td>Cancer Procedure</td>
<td>No VR</td>
</tr>
<tr>
<td>Hoffman et al. (2003)</td>
<td>Controlled</td>
<td>HMD</td>
<td>Ischemic</td>
<td>No VR</td>
</tr>
<tr>
<td>Hoffman, Garcia-Palacios et al. (2001)</td>
<td>Case Study</td>
<td>HMD</td>
<td>Dental</td>
<td>No VR, Movie</td>
</tr>
<tr>
<td>Hoffman, Patterson, et al. (2001)</td>
<td>Controlled</td>
<td>HMD</td>
<td>Burn</td>
<td>No VR</td>
</tr>
<tr>
<td>Patterson et al. (2006)</td>
<td>Controlled</td>
<td>HMD</td>
<td>Thermal</td>
<td>Hypnosis</td>
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<tr>
<td>Schneider and Workman (1999)</td>
<td>Controlled</td>
<td>HMD</td>
<td>Cancer Procedure</td>
<td>No VR</td>
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<tr>
<td>Steele et al. (2003)</td>
<td>Case Study</td>
<td>HMD</td>
<td>Physiotherapy</td>
<td>No VR</td>
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<tr>
<td>Wolitzky et al. (2005)</td>
<td>Controlled</td>
<td>HMD</td>
<td>Cancer Procedure</td>
<td>No VR</td>
</tr>
</tbody>
</table>

\(^{a}\)VR: virtual reality

\(^{b}\)HMD: head-mounted display
### Realism and Presence

<table>
<thead>
<tr>
<th>Author</th>
<th>VR Type</th>
<th>Comparisons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoffman et al. (1998)</td>
<td>HMD&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Tactile and Cyberheft vs. Non-Tactile Without Cyberheft, Imaginal Taste vs. Physical Taste</td>
</tr>
<tr>
<td>Hoffman et al. (2004)</td>
<td>HMD</td>
<td>High Tech vs. Low Tech</td>
</tr>
<tr>
<td>Slater et al. (1998)</td>
<td>HMD</td>
<td>High Variation vs. Low Variation Body Movements and Head Turning</td>
</tr>
</tbody>
</table>

<sup>a</sup>VR: virtual reality  
<sup>b</sup>HMD: head-mounted display

### Table 1.2.2

#### Distance Estimation and Spatial Knowledge

<table>
<thead>
<tr>
<th>Author</th>
<th>VR Type</th>
<th>Topic</th>
<th>Task</th>
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</thead>
<tbody>
<tr>
<td>Bailey and Witmer (1994)</td>
<td>HMD</td>
<td>Spatial Knowledge</td>
<td>Route Navigation</td>
</tr>
<tr>
<td>Foo et al. (2005)</td>
<td>HMD</td>
<td>Navigation</td>
<td>Triangular Route Navigation, Turn-and-Walk</td>
</tr>
<tr>
<td>Geuss et al. (2012)</td>
<td>HMD</td>
<td>Exocentric Distance Perception</td>
<td>Visually Directed Walking</td>
</tr>
<tr>
<td>Interrante et al. (2006)</td>
<td>HMD&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Distance Estimation</td>
<td>Visually Directed Walking</td>
</tr>
<tr>
<td>Lampton et al. (1995)</td>
<td>HMD</td>
<td>Distance Estimation</td>
<td>Assessment Battery</td>
</tr>
<tr>
<td>Messing and Durgin (2005)</td>
<td>HMD</td>
<td>Distance Estimation</td>
<td>Visually Directed Walking</td>
</tr>
<tr>
<td>Mohler et al. (2006)</td>
<td>HMD</td>
<td>Egocentric Distance Perception</td>
<td>Visually Directed Walking</td>
</tr>
<tr>
<td>Mou and Zhou (2013)</td>
<td>HMD</td>
<td>Goal Localization</td>
<td>Collecting and Replacing Objects</td>
</tr>
<tr>
<td>Plumert et al. (2005)</td>
<td>IPT&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Distance Estimation</td>
<td>Timie-to-Walk Estimation</td>
</tr>
<tr>
<td>Sahm et al. (2005)</td>
<td>HMD</td>
<td>Distance Estimation</td>
<td>Visually Directed Walking, Throwing</td>
</tr>
<tr>
<td>Sinai et al. (1999)</td>
<td>HMD</td>
<td>Egocentric Distance Perception</td>
<td>Perceptual Matching</td>
</tr>
<tr>
<td>Stanney et al. (2013)</td>
<td>HMD</td>
<td>Spatial Knowledge</td>
<td>Underway Replenishment, Helicopter Piloting</td>
</tr>
<tr>
<td>Waller and Richardson (2008)</td>
<td>HMD</td>
<td>Distance Estimation</td>
<td>Visually Directed Walking</td>
</tr>
<tr>
<td>Waller et al. (1998)</td>
<td>HMD</td>
<td>Spatial Knowledge</td>
<td>Maze Navigation</td>
</tr>
<tr>
<td>Willemsen and Gooch (2002)</td>
<td>HMD</td>
<td>Egocentric Distance Perception</td>
<td>Blindwalking</td>
</tr>
<tr>
<td>Willemsen et al. (2004)</td>
<td>HMD</td>
<td>Distance Estimation</td>
<td>Blindwalking</td>
</tr>
<tr>
<td>Witmer and Sadowski (1998)</td>
<td>HMD</td>
<td>Distance Estimation</td>
<td>Visually Directed Walking</td>
</tr>
</tbody>
</table>
VR: virtual reality

HMD: head-mounted display

IPT: immersive projection technology

Table 1.3

<table>
<thead>
<tr>
<th>Author</th>
<th>Topic</th>
<th>VR</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garau et al. (2005)</td>
<td>Responding to Virtual Avatars</td>
<td>IPT</td>
<td>Responding to avatars who were static, moving, or responsive</td>
</tr>
<tr>
<td>Gillath et al. (2008)</td>
<td>Prosocial Behaviour</td>
<td>HMD</td>
<td>Helping a digital avatar</td>
</tr>
<tr>
<td>Jouriles et al. (2009)</td>
<td>Sexual Violence</td>
<td>HMD</td>
<td>Role play scenarios featuring sexual aggression</td>
</tr>
<tr>
<td>Jouriles et al. (2014)</td>
<td>Sexual Violence</td>
<td>HMD</td>
<td>Role play scenarios featuring sexual aggression</td>
</tr>
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<td>Jouriles et al. (2016)</td>
<td>Sexual Violence</td>
<td>HMD</td>
<td>Role play scenarios featuring sexual aggression</td>
</tr>
<tr>
<td>Lydon et al. (2008)</td>
<td>Attractive Alternatives</td>
<td>HMD</td>
<td>Manipulating the order of pictures, carrying a balloon to a specified room</td>
</tr>
<tr>
<td>Ma-Kellams et al. (2012)</td>
<td>Visceral Perception</td>
<td>HMD</td>
<td>Crossing a rickety bridge</td>
</tr>
<tr>
<td>Navarrete et al. (2012)</td>
<td>Trolley Problem</td>
<td>HMD</td>
<td>Pulling a switch to either save or kill people on a train track</td>
</tr>
<tr>
<td>Schroeder et al. (2001)</td>
<td>Collaboration</td>
<td>IPT</td>
<td>Solving a puzzle with another individual</td>
</tr>
<tr>
<td>Slater et al. (2000)</td>
<td>Small Group Behaviour</td>
<td>HMD</td>
<td>Solving puzzles as a group</td>
</tr>
<tr>
<td>Slater et al. (2013)</td>
<td>Bystander Behaviour</td>
<td>HMD</td>
<td>Intervene or watch two avatars brawl</td>
</tr>
</tbody>
</table>

Table 1.4

<table>
<thead>
<tr>
<th>Author</th>
<th>Topic</th>
<th>VR</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chihak et al. (2010)</td>
<td>Road Crossing Behaviour</td>
<td>IPT</td>
<td>Crossing Street Intersections</td>
</tr>
<tr>
<td>Nagamatsu et al. (2011)</td>
<td>Road Crossing Behaviour</td>
<td>IPT</td>
<td>Crossing Street with or without Distraction</td>
</tr>
</tbody>
</table>
Quality Assessment Outcomes

The 88 studies included in this systematic review was appraised through the Mixed Methods Appraisal Tool (MMAT; Hong et al., 2018), which was designed to evaluate the methodological quality of studies included for systematic review. The MMAT can be used to appraise five different types of studies:

1. Qualitative Research
2. Quantitative Randomized Controlled Trials
3. Quantitative Non-Randomized Studies
4. Quantitative Descriptive Studies
5. Mixed Methods Studies

Collectively, the studies included in the systematic review received an average rating of 81.82% and a modal rating of 100% (n = 34). Of the 88 studies, 9 were classified as qualitative, 38 were quantitative randomized trials, 39 were quantitative non-randomized studies, and 2 were quantitative descriptive studies.

3.1: Summary of Papers: Implementing VR for Therapeutic Use

Phobias are typically marked by a persistent fear of an object (e.g. spiders, airplanes, or heights) or a situation (e.g. public speaking or going out in public). People who struggle with a phobia often recognize the excessive or unreasonable nature of the fear, and in some instances, the fear of an irrational

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1 For a published version of this section, please see Oing and Prescott (2018).
reaction to encountering the object or situation may serve as a major cause of their anxiety (American Psychiatric Association, 1994; Garcia-Palacios, Hoffman, Carlin, Furness, & Botella, 2002). Garcia-Palacios et al. (2002) posited that most phobias are developed through conditioning, while others acquire fears via instruction or through vicarious experience. Phobias can also be reinforced by operant conditioning; as the individual experience a fight-or-flight response when confronted by a stimulus that elicits fear or anxiety, opting to escape the situation until the fear or anxiety subsides would strengthen the individual’s phobia reaction. As the individual continues to escape the stimulus, rather than confront it, the likelihood of the individual opting to escape increases, and in turn intensifies the phobia (Hoffman, Garcia-Palacios, Carlin, Furness, & Botella-Arbona, 2003). Furthermore, phobias can become so intense that the individual’s everyday routines, activities, and interpersonal relationships may be disrupted (Carlin, Hoffman, & Weghorst, 1997).

The main method of treating most types of specific phobias is through a process known as exposure therapy. This form of therapy is an approach that stems from the broader practice of cognitive-behavioural therapy (CBT), where the main goals of the therapy are to correct the way the patient thinks and behaves towards the stimulus related to their phobia. The exposure to the stimulus during exposure therapy is typically conducted in one of two ways: in-vivo and in-vitro. With in-vivo exposure, the patient is subjected to physical exposure to the stimuli, whereas in-vitro exposure is conducted by having the patient imagine the stimuli. Regardless of the exposure method used, the core processes of exposure therapy is the same: a series of systematic steps are introduced to gradually expose the patient to the object or situation that elicits fear or anxiety until the patient’s phobia is attenuated (i.e. systematic desensitization). As the patient is continually exposed to the physical or imaginary stimulus, desensitization occurs and minimizes the patient’s intense phobic reaction, thereby correcting the patient’s behaviour towards the fear or anxiety-inducing stimulus. As exposure therapy is a form of CBT, some exposure therapies may also incorporate a cognitive component in addition to systematic
desensitization in which therapists attempt to restructure the way the patient thinks about the stimulus (Hoffman, Garcia-Palacios, Carlin, et al., 2003). Together, these methods have been found to be effective in treating a large variety of phobias, including arachnophobia (i.e. fear of spiders; Carlin et al., 1997), acrophobia (i.e. fear of heights; Rothbaum, Hodges, Kooper, Opdyke, Williford, & North, 1995a, b), aviophobia (i.e. fear of flying; Rothbaum, Hodges, Watson, Kessler, & Opdyke, 1996), and public speaking anxiety (Wallach, Safir, & Bar-Zvi, 2009).

While exposure therapy has been one of the most prominent methods of treating phobias, it does have some major limitations depending on the type of phobia being treated. In relation to in-vivo exposure, phobias such as acrophobia and aviophobia often require leaving the therapist's office to expose the patient to an elevated area or an aircraft, in contrast to arachnophobia treatments that could be conducted within the confines of the therapist's office (Emmelkamp, Krijn, Hulsbosch, de Vries, Schuemie, & van der Mast, 2002; Rothbaum et al., 1995b). This former poses a potential risk of breaching patient confidentiality, as the sessions would be conducted in a public setting (Garcia-Palacios et al., 2002; Rothbaum et al., 1996). Furthermore, in-vivo exposure therapy for aviophobia and acrophobia may be expensive to conduct due to travel costs or airline ticket prices for a single session, and repeated exposures would only increase the expenses associated with the therapy (Mühlberger et al., 2001). Uncontrollable factors during these sessions are also an issue, such as weather conditions (Mühlberger et al., 2001) or whether spiders will bite the patient (Carlin et al., 1997), which would undermine the efficacy of the therapy session and potentially cause the phobic reaction to worsen. Assuming both the expenses and uncontrollable factors can be addressed by the therapist, another obstacle would be the individual not seeking treatment at all due to the nature of their intense fears or anxieties (Emmelkamp, Bruynzeel, Drost, & van der Mast, 2001; Emmelcamp et al., 2002; Garcia-Palacios et al., 2002). While in-vitro exposure may address many of the issues found in in-vivo exposure, there are still some who may not be able to or
are unwilling to clearly imagine the fear or anxiety-inducing stimuli or may not be as engaged with the stimuli compared to those who undergo in-vivo exposure (Reger et al., 2016).

A growing alternative to in-vivo and in-vitro exposure therapy is virtual reality exposure therapy (VRET), which establishes a middle ground between in-vivo exposure’s physical stimulus and in-vitro exposure’s imaginary stimulus by presenting the stimulus with an immersive, VE. VRET has already been tested for various types of phobias, including acrophobia (Regenbrecht, Schubert, & Friedmann, 1998), aviophobia (Rothbaum et al., 1995a, b; Rothbaum, Hodges, Smith, Lee, & Price, 2000), arachnophobia (Carlin et al., 1997; Garcia-Palacios et al., 2002), claustrophobia (i.e. fear of tight spaces; Botella, Baños, Perpiña, Villa, Alcañiz, & Riva, 2007). The level of control during VRET is primarily what sets it apart from both in-vivo and in-vitro exposure therapy, as well as other alternative treatment options such as relaxation treatment, which involves instructions for deep muscle relaxation techniques to diminish feelings of anxiety or fear (Mühlberger et al., 2001; Rothbaum et al., 1995b). Due to the virtual nature of VRET, factors that could not be controlled for an in-vivo exposure session, such as weather or a living stimulus’ behaviour, can be controlled by the therapist overseeing the VE. VRET sessions can also be personalized to better suit the patient, which includes repeating exposures of sessions the patient is having difficulty in until the patient is ready to progress (e.g. takeoffs and landings in VRET sessions for aviophobia; Maltby et al., 2002), and ensuring consistent behaviour of an animate stimulus (e.g. a docile spider; Carlin et al., 1997). Under this premise, VRET has broad applications for treating multiple types of phobias and anxiety disorders, providing not only a sense of convenience and security by allowing therapists to conduct VRET sessions within a controlled, private setting, but also exemplifying the versatility of VR equipment for a wide variety of phobia types.

While VR has been a promising alternative that addresses the shortcomings of both in-vivo and in-vitro exposure therapies, the cost of the VR equipment has been expensive and underpowered. HMDs are perhaps that most simple VR configuration as it typically only requires a computer that meets the
hardware specifications required by both the HMD and VR software, while IPT projectors and simulation peripherals (e.g. airline seats, tactile feedback apparatuses, etc.) require a much more complex setup. Furthermore, the expense of using VR as a therapeutic option would also need to consider training costs for therapists to operate and sometimes create applications for the VR system (Maltby et al., 2002). Other factors outside of the expensiveness of VR are the sensations that VR cannot simulate, such as the sense of gravitational forces that an individual would feel while riding on an aircraft during the takeoff or landing phases, which ultimately detracts from the patient’s overall experience (Rothbaum et al., 2000). Regardless of these limitations, however, researchers have long pursued the implementation of VR in psychotherapy and exhibited promising results even with hardware that was barely capable of handling VR.

This section details studies that have implemented the use of VR for the treatment of multiple types of anxiety-related disorders and situations. While the primary focus of the present thesis is to establish an effective self-directed treatment for acrophobia through the use of VR technologies, findings from the studies in this section can exemplify the versatility of VR-based treatment, and if the present thesis’ self-directed treatment procedure can be shown to be effective, it may be possible that the procedure can be applied to other disorders and situations in which traditional VR-based treatment was shown to be effective.

3.1.1: Phobias
3.1.1.1: Acrophobia

A prototypical study to evaluate the efficacy of VRET for acrophobia followed an experimental methodology that compared a VRET group with a secondary treatment group and/or a waiting list group that went without any form of treatment for the same time as the treatment length of the treatment group(s). Pre-treatment assessments would be conducted to establish baseline levels of self-report measures that focused on the individual’s acrophobia, attitudes towards heights, and fear ratings. Sessions would often be held weekly for approximately an hour, with the first session being used to allow
the patient to become familiar with both the VR equipment and the VE, and subsequent sessions being allocated to guide the patient to progress through gradually intense height levels. Once the treatment concludes, a post-treatment assessment consisting of the same measures used for the pre-treatment assessment would be conducted. For Rothbaum et al. (1995a, b), who compared VRET with a waiting list group over the course of 8 weeks, found that those who underwent VRET for acrophobia exhibited significantly improved symptoms compared to those in the waiting list group. Those who were a part of the VRET group not only experienced a decrease in terms of their acrophobia and fear ratings, but also gained a positive attitude towards heights, whereas the waiting list group experienced no changes on any measure.

With Rothbaum et al. (1995a, b) successfully demonstrating the effectiveness of VRET for acrophobia, further studies were conducted to compare VRET with traditional in-vivo exposure therapy. Most notably, Emmelkamp et al. (2001) conducted a study that had patients undergo two sessions of VRET followed by two sessions of in-vivo exposure therapy, and acrophobic symptoms were measured through the use of both self-report and biometric (e.g. heart rate) measures. Ultimately, Emmelkamp et al. (2001) found significant symptom improvements based on post-treatment assessments, but perhaps more importantly, the in-vivo exposure sessions that followed the VRET sessions did not appear to significantly improve acrophobia-related avoidance behaviour as well as the patients’ attitude towards heights beyond what was achieved during the VRET sessions. These results indicate that VRET is a comparable alternative to in-vivo exposure therapy, so much so that the potential benefits of in-vivo exposure had mostly diminished following VRET. Another study by Emmelkamp et al. (2002) found similar findings when comparing VRET and in-vivo exposure therapy separately, but went on to also note that there were no significant differences between the two treatment conditions based on a 6-month follow-up assessment. Based on these studies, VRET appears to be equally as effective as in-vivo exposure therapy.
Lastly, in an attempt to enhance the treatment outcomes of VRET, a study by Ressler et al. (2004) evaluated whether the incorporation of D-Cycloserine (DCS), a glutamate receptor that had been demonstrated to improve the efficacy of exposure therapy for severe anxiety, would also work for VRET. Comparisons were made between those who took DCS, alprazolam (used primarily as a pharmacological treatment for anxiety), and a placebo, all of which were taken prior to each VRET session, and while each treatment group experienced significant improvements in their acrophobia symptoms, only those who had taken DCS experienced a decrease in behavioural avoidance that was not observed in the other two groups. This finding suggests that DCS can be an option for individuals who may need additional help for VRET to be effective, but also further highlights the general effectiveness of VRET.

3.1.1.2: Aviophobia

The benefits of VRET as a cost saving, effective alternative to in-vivo exposure therapy exemplified in the acrophobia studies extends to the treatment of aviophobia, and perhaps even more so. Whereas in-vivo exposure for acrophobia would have required the therapist and patient to travel to a location that was high off from ground level (e.g. balcony, cliff edge, etc.), in-vivo exposure sessions for aviophobia would have required both the therapist and patient to purchase expensive airline tickets and spend time in an airport.

The majority of the studies that evaluated the efficacy of VRET on aviophobia were case studies, which could be attributed to the costly nature of flying. As the VRET procedures for aviophobia treatment was largely similar to the ones used for the acrophobia studies in Section 3.1.1.1, the main difference were the use of VEIs that reflected various flight-based situations (e.g. take-offs, landings, and flights during weather fluctuations). The end goal of the treatment was for patients to be able to fly on a real aircraft, and VRET was generally found to be effective across each of the case studies (Rothbaum et al., 1996; Wiederhold, Gervirtz, & Wiederhold, 1998). The findings of the case studies would go on to be reinforced by controlled studies from Rothbaum et al. (2000) and Rothbaum, Hodges, Anderson, Price, &
Smith (2002) that compared VRET alongside in-vivo exposure, with Rothbaum et al. (2002) also providing evidence that the improvements made during VRET persisted based on a 1-year follow-up assessment with no significant differences to in-vivo exposure. VRET for aviophobia was also compared alongside group treatment (Maltby et al., 2002) and relaxation therapy (Mühlberger et al., 2001), both of which found similar findings.

3.1.1.3: Arachnophobia

One of the stark differences between VRET for arachnophobia and for acrophobia and aviophobia is the inclusion of a tactile augmentation in the form of a fuzzy toy spider in which moving the spider in the real world could translate into movements for the spider in the VE. This tactic to create a deeper sense of presence within the patients is similar to the one used by Rothbaum et al.’s (2000) use of speakers to simulate the sounds and vibrations typically felt during flight, which represents the importance of touch within the VE rather than relying solely on visual and auditory stimuli.

The seminal VRET arachnophobia study comes from Carlin et al. (1997), who reported on a case study involving a 37-year-old woman who had been suffering from arachnophobia for two decades. Unlike the VEs for the VRET in Sections 3.1.1.1 and 3.1.1.2, careful consideration into the behaviour of the virtual spider was needed as arachnophobia centres around a living organism rather than a situation or environment. In this instance, the spider depicted in the VE was programmed to jump at random intervals, with the therapist also being able to control the spider’s movements by moving a positional sensor attached to a fuzzy toy spider. By the end of a battery of twelve treatment sessions, the woman reported that she no longer felt the need to actively avoid spiders and was no longer intensely vigilant of spiders as she had been prior to VRET. A controlled study by Garcia-Palacios et al. (2002) that compared VRET to a waiting list group reinforced Carlin et al.’s (1997) findings, but found significant symptom improvements after four sessions rather than twelve. Furthermore, Hoffman, Garcia-Palacios, Carlin, et al. (2003) demonstrated the importance of a tactile component when treating arachnophobia through VRET, as
those who underwent VRET with tactile augmentations achieved better treatment gains compared to those who underwent VRET without any tactile augmentations.

Lastly, a study by Shiban, Pauli, and Mühlberger (2013) took a different approach from the other VRET arachnophobia studies and examined how multiple context exposure (MCE) could help prevent patients from relapsing after treatment completion. MCE follows the general procedures of VRET, but systematically alters the environment surrounding the stimuli in an effort to aid the extinction for the phobia within multiple settings and situations. In comparisons to a single context exposure (SCE) condition, those in the MCE condition appeared to experience treatment gains that lasted longer compared to the ones achieved by those in the SCE condition.

3.1.1.4: Claustrophobia

While there was only a single case study that examined efficacy of VRET on claustrophobia, the methodology and outcomes appear to be consistent with VRET studies for other types of specific phobias. Botella et al. (1998) treated a woman with severe claustrophobia by implementing a series of progressively tight VE spaces, including a 2x5 meter space depicting a small garden and balcony, a 4x5 meter room with interactive doors and windows, and a 3x3 meter room that had been dimmed and contained a lockable door. For the latter, once the door was locked, the walls of the virtual room would gradually move closer towards the woman until the room was only one square meter. The woman completed a total of 8 sessions over the course of three weeks, and post-treatment assessments indicated that her fear of closed spaces had lessened, her attitude towards closed and tight spaces had improved, and treatment gains persisted during the 1-month follow-up.

3.1.1.5: Agoraphobia

Agoraphobia is characterized by an intense fear of situations where escape may be difficult or impossible if a panic attack were to occur. Treatments for agoraphobia have been difficult, and although treatment options such as CBT have been demonstrated to be effective, factors such as patients refusing to seek help (i.e. non-acceptance rate) limit its effectiveness. Whereas in-vivo exposure therapy has been
shown to help mitigate the fears and anxieties associated with phobias such as arachnophobia or aviophobia, it was deemed ineffective for the treatment of agoraphobia as patients would often report that the process felt too aversive or have high non-acceptance or drop-out rates. Furthermore, in-vivo exposure sessions for agoraphobia are more likely to encounter breaches of patient confidentiality as sessions would generally have to be conducted in a public environment, and in addition to the lack of environmental control, these factors have a high likelihood of undermining any treatment benefits (Botella et al., 2007).

Botella et al. (2007) evaluated the efficacy of VRET and compared it to in-vivo exposure and waiting list conditions. Those in the VRET condition experienced six different VEs, which consisted of a training room, tunnel, buildings (e.g. house and mall), and public transportation (e.g. subway and bus). Each VE also contained several factors that the therapist could adjust to control for the intensity of the environmental stimuli, such as the number of avatars that populated the area, the length of trips on public transportation, and unforeseen difficulties (e.g. a credit card being declined at the mall). While the stimuli for the in-vivo condition were not given, it was presumed that those in the in-vivo group experienced a relatively similar experience to the VRET group. Findings for the study indicated that there were no significant differences in treatment outcomes between the VRET and in-vivo exposure groups, and both had demonstrated significant improvements in relation to catastrophic thought beliefs, severity of panic disorder, and impairment levels at post-treatment and 12-month follow-up assessments.

3.1.1.6: Section Conclusions

The studies in this section exemplify an overwhelming support for the use of VR as a psychotherapeutic tool, with VRET being demonstrated as an effective method to treat multiple varieties of phobias on par with established treatment options such as in-vivo exposure, relaxation therapy, and group therapy. By utilizing VR, each study has demonstrated its broad applicability for psychotherapy, ranging from integrating multiple VEs to serve as progressive stages or multiple contexts, allowing for
control over various factors to tailor VRET sessions based on patient needs, and as a cost saving measure in place of alternatives that would require purchasing airfare, traveling costs, or care for living organisms. While some studies, such as Maltby et al. (2002) acknowledge that the cost of the VR equipment used for the study can be daunting, the studies also anticipated VR to eventually become cheaper and more affordable—a notion that has certainly come to pass with the recent introduction computer-based VR HMDs (e.g. HTC Vive, Oculus Rift, and Windows Mixed Reality), smartphone-based HMDs (e.g. Google Daydream and Samsung Gear VR), and standalone HMDs (e.g. Oculus Quest and Vive Focus).

While there appeared to be a wide variance in terms of the time it takes to achieve significant treatment gains, which ranged from four (Rothbaum et al., 1996) to twelve (Carlin et al., 1997), studies that performed follow-up assessments appear to support the notion that any treatment gains achieved following treatment have lasting effects that persist for at least six months. This is especially notable as it is comparable to what is expected from traditional treatments such as in-vivo exposure, which positions VRET as an effective treatment option that is equally, if not better, than traditional treatment methods.

3.1.2: Anxiety
3.1.2.1: Social Anxiety Disorders
Individuals who suffer from a social anxiety disorder (i.e. social phobia) tend to overestimate criticism, scrutiny, or embarrassment as a treat, and faulty cognitions (e.g. exaggerating or inferring from a present situation or minimal cues, respectively) facilitate these symptoms (Wallach, Safir, & Bar-Zvi, 2009). Symptoms associated with social phobia include seating, gastrointestinal discomfort, confusion, and muscle tension when faced with a social situation, which may consequentially lead to poor work or school performance (Harris, Kemmerling, & North, 2002). Treatment options for this disorder are essentially identical to the options available for other forms of specific phobias, which include CBT (with in-vivo or in-vitro exposure) and cognitive-behavioural group therapy (CBGT; Anderson, Rothbaum, & Hodges, 2003; Safir, Wallach, & Bar-Zvi, 2012). The main issue, however, is that exposing patients to realistic social situations has been difficult; whether it is addressing the potential breach of confidentiality
that plague other phobia treatments like agoraphobia, or individuals not seeking treatment due to social situations with the therapist being an initial barrier, social anxiety is a tough disorder to treat in a traditional talking-based therapy paradigm. Just as VRET addressed the issues surrounding established treatment options for specific phobias, the control and safety afforded by VRET also appear to be a good fit for treating social anxiety disorders (Anderson et al., 2013).

VRET for social anxiety was largely handled in the same fashion as VRET for arachnophobia, but rather than spiders, the focus was on groups of people. Avatars in the VE either had scripted behaviours (e.g. friendly, hostile, etc.) or randomized autonomous behaviours (e.g. twitching, nodding, etc.; Pertaub, Slate, & Barker, 2002). As one of the most common social anxieties is glossophobia (i.e. fear of public speaking, general fear of speaking, or public speaking anxiety), the majority of the tasks and goals of the VRET treatments focused on the patient giving speeches to the VR avatars. Overall, each of the studies that utilized VRET for the treatment of social anxiety concluded that it was an effective treatment option (Anderson et al., 2003), especially in comparison to other treatments such as exposure group therapy (EGT; Anderson et al., 2013; Price & Anderson, 2012) and CBT (Wallach et al., 2009). Additionally, a brief VRET treatment method that incorporated four 15-minute sessions was also able to lead to significant improvements for the patient’s attitude towards public speaking (Harris et al., 2002). These findings are congruent with the studies outlined in Section 3.1.1, and further position VRET as a versatile, effective treatment option.

3.1.2.2: Posttraumatic Stress Disorder
Posttraumatic Stress Disorder (PTSD) is characterized by hyperarousal, numbness, avoidance, and a re-experiencing of a traumatic event in which the individual was the subject or witness to actual or threatened harm. Diagnosing PTSD has been difficult, however, as the diagnostic process heavily depends on the patient’s subjective reports rather than objective reports, which consequentially lead to purposeful or accidental overstatements or understatements of the symptoms being experienced (Webb, Vincent,
Jin, & Pollack, 2014). Treating PTSD has also been difficult as the available treatment options often require patients to imagine or describe their traumatic experiences, and if patients were either unable or unwilling to do so, the treatment would be ineffective. Similar to treatments for specific phobias, in-vivo exposure has been one of the most effective treatment options for PTSD, however, some stimuli from events that led to the development of PTSD symptoms, especially in relation to military combat, are either unfeasible or expensive to replicate in a therapeutic setting (Rothbaum et al., 1999). In-vitro exposure can occasionally address this issue, however, the same hurdle that applied to specific phobias also applies for PTSD: if the patient is unwilling or unable to imagine the causal situation(s) that led to their PTSD, the treatment would not be effective (Reger et al., 2016).

While there are many parallels in the advantages and disadvantages of popular treatment options between specific phobias and PTSD, the same parallels also apply to VRET. Through the use of VRET, a specific situation or stimuli can be constructed in the VE and allows the therapist to tailor situations and stimuli within the VE to suit the patient’s needs, the latter of which is particularly important since PTSD is largely a personal psychological ailment. Due to the vast amount of benefits that VRET is able to offer over traditional in-vivo and in-vitro exposure therapies, many sought to examine whether it would yield the same results as shown in the specific phobia studies (Ressler et al., 2004; Rothbaum et al., 1999).

Studies that have examined the use of VRET for the treatment of PTSD largely focused on war veterans, which ranged from those who participated in the Vietnam War (Rothbaum et al., 1999) to the ongoing Middle Eastern conflicts in Iraq and Afghanistan (Gerardi, Rothbaum, Ressler, Heekin, & Rizzo, 2008; McLay et al., 2011; Reger et al., 2016), but conclusions as to the efficacy of VRET had a few caveats. While both case and controlled studies do suggest that VRET can help to significantly reduce PTSD-related symptoms, many of the studies also noted that the patients still met the criteria for PTSD (Rothbaum et al., 1999; Gerardi et al., 2008). Additionally, when VRET was compared to in-vitro exposure therapy, the
latter appeared to be a more effective treatment option based on post-treatment, 3-month, and 6-month follow-up assessments (Reger et al., 2016).

Overall, unlike VRET for specific phobias, it appears that VRET is not nearly as effective for treating PTSD, even if it can still lead to some significant improvements. While some improvements can be made to facilitate better treatment outcomes when using VRET to treat PTSD, such as the inclusion of DCS (Difede et al., 2014; Rothbaum et al., 2014), established treatments such as in-vitro exposure and group therapy appear to be slightly more effective. Nevertheless, while VRET may not be entirely useful for the treatment of PTSD, one application that was not as emphasized in the studies, but may be invaluable, is in VR’s capability to recreate scenes and situations that trigger a PTSD reaction. This application could be used for diagnostic purposes as well as giving the therapist a better understanding of the types of stimuli that the patient is most sensitive to, and while this has not been as thoroughly examined in the PTSD literature, it has been examined in a similar disorder: paranoia.

3.1.2.3: Paranoia

Paranoia, or paranoid ideations, is defined by an unfounded fear that a person or group intends to cause harm (Freeman, Pugh, et al., 2008). These ideations exist in some form in a spectrum within the general population, but those with severe levels of paranoid ideations are seen by psychiatrists. Literature on paranoia have also determined that early detection of low-level paranoia symptoms could help determine if an individual is susceptible to developing paranoia as a classifiable clinical disorder (Freeman, Gittins, Pugh, Antley, Slater, & Dunn, 2008). These symptoms include mistrust, suspiciousness, and persecutory delusions, but determining whether an individual’s belief is founded or unfounded has been difficult to ascertain (Fornells-Ambrojo, Barker, Swapp, Slater, Antley, & Freeman, 2008; Freeman et al., 2010). Due to the difficulty to differentiate between individuals with true paranoia and individuals who are being targeted by a hostile individual or group, the utilities afforded by VR serve as an invaluable tool to help aid in the diagnostic process of paranoia.
The use of VR to investigate paranoia stemmed from the research that focused on evaluating how VR could be used to treat anxiety-based disorders such as specific phobias and PTSD, as well as evidence that users within a VE responded to computer-generated avatars as real social agents, even despite being aware that the avatar was not real (Fornells-Ambrojo et al., 2008; Pertaub et al., 2002). Under this premise, avatars could be created and programmed to perform any actions, and any paranoid ideations developed towards the avatar could be guaranteed as unfounded as the avatar is not capable of conspiring against the user by its own volition. The use of VR to diagnose, as well as to study, paranoia also ensures an environment where the user cannot harm other individuals, as well as enabling the therapist or experimenter a greater sense of control over environmental factors as seen from the VR phobia treatment studies (Valmaggia et al., 2007).

In short, all of the studies that aimed to use VR as a diagnostic tool for paranoia were able to successfully demonstrate its effectiveness, which distinguished between those with a high-risk of psychosis, early clinical psychosis, and non-clinical participants without any risk of psychosis (Fornells-Ambrojo et al., 2008; Freeman et al., 2010; Freeman, Gittins, et al., 2008; Valmaggia et al., 2007). Moreover, VR was also demonstrated to be used as a means to test various factors that may lead to higher susceptibility to paranoia, such as height perception (Freeman, Evans, Lister, Antley, Dunn, & Slater, 2014b), as well as a way to predict an individual’s susceptibility to PTSD based on their level of paranoia (Freeman et al., 2013; Freeman et al., 2014a). This application of VR as a diagnostic tool further demonstrates some of the utility for VR, especially in the case of specific phobias; while VRET has been repeatedly shown to be an effective treatment option, the use of VR can also serve as a valid option for the diagnosing of specific phobias by presenting various stimuli to the patient and evaluating their self-report or biometric measures.
3.1.2.4: Section Conclusions
The studies in this section generally reflect the same findings detailed by the studies dedicated to examining the efficacy of VRET on specific phobias. VRET for PTSD appears to demonstrate mixed results; while patients may experience mitigated PTSD symptoms, they could still hold a clinical classification for PTSD at the end of treatment (Gerardi et al., 2008; McLay et al., 2011). In-vitro exposure for PTSD was also shown to be slightly more effective than VRET, at least in terms of long-term treatment gains (Reger et al., 2016). In relation to treating social anxiety, however, VRET tends to be just as effective as established treatment options such as CBT and EGT. Furthermore, as a diagnostic tool for paranoia, VR has been shown to be a safe tool to discriminate between those with paranoid ideations and those with true threats against them.

While there were not any studies showing how VR could be used to treat paranoia on the same level as has been seen with VRET for specific phobias and PTSD, the paranoia studies demonstrate a novel use for VR that further supports its versatility within psychotherapy and psychological research (Freeman et al., 2013; Freeman, Antley et al., 2014). This is especially important for the present thesis, as the use of VR would allow for the observation of a prospective patient’s phobia-related reactions towards an object or situation presented in VR, such as heights.

3.1.3: Pain Analgesia
Opioids have long been considered the best in terms of pharmacological analgesics (i.e. painkillers or pain relievers; Hoffman, Patterson, Carrougher, & Sharar, 2001). These drugs do carry some common side effects however, including nausea, cognitive impairment, constipation, urinary retention, and hallucinations. More serious side effects have also been documented, such as respiration failure, and prolonged use may lead to patients developing a physical or psychological dependence to opioids (Hoffman, Garcia-Palacios, Kapa, & Sharar, 2003; Hoffman, Garcia-Palacios, Patterson, Jensen, Furness, & Ammons, 2001; Hoffman, Patterson et al., 2001). The pursuit of non-pharmacological analgesia has led to procedures such as hypnosis (Patterson, Hoffman, Garcia-Palacios, & Jensen, 2006; Steele, Grimmer,
Thomas, Mulley, Fulton, & Hoffman, 2003), coping strategies (e.g. imagery, relaxation, positive thinking, etc.; Gershon, Zimand, Pickering, Rothbaum, & Hodges, 2004), and distraction (e.g. watching a movie, listening to music, etc.; Dahlquist, McKenna, Jones, Dillinger, Weiss, & Ackerman, 2007). Although non-pharmacological analgesia techniques can be effective in relieving pain without carrying any of the common side effects of pharmacological analgesics, the techniques have been known to be ineffective against certain types of pain (e.g. a distracting conversation does not reduce a child’s distress during a chemotherapy session) or that no significant differences were found when compared against a placebo (Dahlquist et al., 2007). Furthermore, these methods typically involve a prerequisite for the patient to practice prior to being exposed to a painful procedure or stimuli, which is unrealistic for victims of sudden painful circumstances (e.g. car crash, burning building, etc.), and even with practice, patients may still be unable to divert their attention away from the perceptually unpleasant sensation (Schneider & Workman, 1999).

Whereas VR was sought to address the shortcomings of in-vivo and in-vitro exposure in treatments for specific phobias, PTSD, and social anxiety disorders in the form of VRET, VR was sought as a non-pharmacological analgesic in the form of virtual reality distraction (VRD). While classic distraction methods could only appeal to the patient’s visual and auditory senses (e.g. watching a movie), VRD could include tactile and kinaesthetic senses on top of enhancing visual and auditory stimuli through the immersion users feel when exposed to VR. Video games, another medium that could be used for non-pharmacological analgesia, have also operated under a similar premise, as it would often require patients to focus their attention towards the events occurring in the game via visual and auditory cues alongside tactile (e.g. rumble sensations from the controller) or kinaesthetic (e.g. motion controls) senses (Dahlquist et al., 2007). The advantage of VRD over traditional video games, however, is in VR’s immersion and interactivity; while video games played on a traditional setup can allow patients to see uncomfortable aspects of their procedure (e.g. needles, chemicals, etc.), VR blocks out external stimuli so that patients
can focus solely on what is being displayed (Wolitzky, Fivush, Zimand, Hodges, & Rothbaum, 2005). It has also been posited that since pain has a psychological component in that it requires conscious attention to process, VR would be able to pull more of the patient’s attention away by flooding more of the patient’s senses compared to other established distraction methods, therefore leaving little attention available for the patient to process pain (Patterson et al., 2006).

The general consensus from studies that have used VRD to alleviate pain suggests that VR could be used to significantly reduce pain-related physiological arousal (Gershon et al., 2004), distress (Schneider & Workman, 1999), and intensity (Patterson et al., 2006), while increasing pain tolerance (Dahlquist et al., 2007) for both short and long-term pain (Hoffman et al., 2001). In comparisons to other distraction methods, such as a computer, VR appeared to be a more effective distractor as more of the external stimuli was blocked by the headset (Gershon et al., 2003). Based on the overall evidence, VRD has been positioned to be an effective distractor for a variety of pain sources, including cancer-based procedures (e.g. port access, chemotherapy; Gershon et al., 2003; Schneider & Workman, 1999), physiotherapy (Steele et al., 2003), dental (Hoffman, Garcia-Palacios, et al., 2001), ischemic (i.e. pressure; Hoffman, Garcia-Palacios, Kapa, et al., 2003), and thermal (Dahlquist et al., 2007; Hoffman et al., 2001; Patterson et al., 2006).

In relation to the present thesis, while specific phobias do not typically involve pain, the concept of VRD may serve to reduce the patient’s anxiety while being exposed to phobia-related stimuli, especially when presenting the stimuli within the context of a game. The majority of the studies in this section often used some sort of game presented in VR to divert as much attention away from the patient’s pain as possible (Dahlquist et al., 2007; Wolitzky et al., 2005), and this mechanic can potentially be utilized when using a game that showcases the VR user’s phobia. While exposure to the phobia requires more attention to the anxiety-inducing stimuli compared to those undergoing a painful procedure, various features of a
game, such as a seemingly unrelated goal (e.g. getting a high score), may help to alleviate some of the VR user’s anxiety and allow them to confront their phobias much more easily.

3.2: Summary of Papers: Perception
Perception is an important factor when considering the quality of a VE presented through VR; if elements such as the physics or depth of the world is not consistent or on part with what the VR user would expect, there could be a loss of presence and a break in immersion. This section primarily focuses on two elements that are believed to be crucial components for the development of a self-directed VR treatment for acrophobia based on the studies from the previous section: realism and depth perception. The stimuli presented through VR is arguably the most important element to consider when formulating any VR-based therapy, and in the case of acrophobia, it is important for VR to be able to be able to create an accurate illusion of depth and for VR users to perceive that depth to be real.

3.2.1: Realism and Presence
Presence has been an important aspect of VR, briefly touched upon in relation to several of the VRET and specific phobia studies, but technological limitations have limited how much presence an individual could feel while within a VE. Hoffman, Hollander, Schroder, Rousseau, and Furness (1998) declared that objects within the VE were not realistic, as virtual objects do not have any mass (i.e. cyberheft), solid properties, and may not follow physical laws such as gravity. Furthermore, although enhancements towards visual and auditory technologies have been developed (e.g. head tracking, increasing the size of eyepieces for a broader field of view, etc.; Hoffman et al., 2004), there has been a lack of developments made towards tactile, olfactory, and taste feedback (Hoffman et al., 1998). Based on the successful VR studies that yielded significant treatment and experimental results, however, it may be possible that other senses are only minimally influential and would not significantly enhance the virtual experience. Studies that incorporated tactile augmentations for specific phobia treatments have demonstrated that the augmentations do tend to increase one’s sense of presence and treatment
outcomes more than standard VR (Hoffman, Garcia-Palacios, Carlin et al., 2003), although for some applications, such as pain reduction, adding more senses may not have much of a noticeable effect (Hoffman, Garcia-Palacios, Kapa, et al., 2003). Nevertheless, the stimuli elicited by the VR system is in constant competition with the stimuli from the real, physical environment, therefore the subject for some VR presence studies aimed to identify factors that are necessary to control to promote one environmental stimuli’s dominance over the other (Slater, Steed, McCarthy, & Maringelli, 1998).

Based on the studies that evaluated factors that impacted the VR user’s sense of presence, two main factors appear to be the most influential: technological tier (e.g. high-tech vs. low-tech), and input and feedback methods. For the former, a study by Hoffman et al. (2004) evaluated whether any difference in VRD outcomes would occur depending on the type of HMD used, with the main comparison being a “high-tech” and “low-tech” VR system. The “high-tech” VR system was characterized as one that could block out external visual and auditory stimuli, provide its own converging stimuli (e.g. a sound matching what is expected from an object, such as the clink of a coin on a table), allows for a panoramic field of view, has a high resolution screen to promote smoother textures, allows for interaction with the VE, and utilizes head tracking. The “low-tech” VR system, then, was characterized as one that did not completely block out external stimuli, only provided one sensory stimulus (e.g. visual, but not auditory), and had degraded field of view, resolution, interaction with the VE, and no head tracking capabilities. While these definitions of the technological tiers of VR systems may not necessarily apply to modern VR, the main finding from the study was that those who underwent VRD with the “high-tech” VR HMD had significantly better outcomes than those who used the “low-tech” VR HMD. This finding is especially important for both the therapeutic and gaming contexts covered by the present thesis; by using the highest quality VR HMD available, patients can potentially achieve better treatment outcomes, and games can utilize more of the computational power to provide a more fluid, immersive experience.
Additional findings further confirm the importance of utilizing as many sensory input and feedback methods as possible, which was particularly pronounced in the arachnophobia and social anxiety studies outlined in Sections 3.1.1.3 and 3.1.2.3, respectively. Specifically, tactile feedback and tasting cues were found to increase immersion in a food-related VR scenario (Hoffman et al., 1998) and the incorporation of whole-body movements (e.g. crouching, leaning, etc.) led to a greater sense of presence. For the present thesis, the programs used throughout each of the three main studies should incorporate as many applications and games that encourage whole-body movements to promote a greater sense of presence and immersion. While the present thesis unfortunately cannot incorporate feedback stimuli outside of visual, auditory, and basic tactile senses due to the lack of current hardware support, there does appear to be a market for devices that can add additional sensory feedback to the core VR experience, such as the *FeelReal* mask that can deliver a variety of scents.

3.2.2: Distance Estimation and Spatial Knowledge Acquisition

3.2.2.1: Distance Estimation

Judging distances accurately is an essential aspect for performing a variety of tasks ranging from navigation to targeting (Witmer & Sadowski, 1998). In relation to perceived distances, there are two types to note: egocentric distance, which is the absolute distance from oneself to an object, and exocentric distance, which is the relative distance between objects. A popular method to measure perceived distances is through the visually guided judgment task (i.e. blind walking; Willemsen, Colton, Creem-Regehr, & Thompson, 2004). Blind walking is a task in which participants view a target, close their eyes (or have their view obstructed by an object such as a blindfold), and move towards the target until they feel that they have reached it. Studies utilizing this task have often found that the further a target is away egocentrically, the more likely that individuals will underestimate the actual distance (Plumert, Kearney, Cremer, & Recker, 2005). Another variation of blind walking is the triangulated walking task, which requires individuals to walk along two points of a triangle and make their way back to the initial point without any visual cues. The triangulated walking task, just like blind walking, also tends to reveal that
individuals often underestimate actual distances (Sahm, Creem-Regehr, Thompson, & Willemsen, 2005). As VR is a medium that facilitates depth perception, the studies within this section have aimed to investigate how perceptual distance within the virtual world may vary from the real world, as well as how VR technology could be used to enhance spatial knowledge acquisition.

3.2.2.2: Distance Perception

One of the most common observations when examining distance perception within an environment presented in VR is that VR users tend to underestimate distance in the VE more than they would in a real environment. This was tested in a variety of ways, such as comparing low-tech HMDs and traditional computers (Lampton et al., 1995) and randomizing and rating both virtual and real environments to test for order effects (Witmer & Sadowski, 1998), but the reason as to why distance estimation suffers in VR is less apparent. Factors that were considered include whether donning an HMD was an influential factor in worsening the VR user’s distance perception (Messing & Durgin, 2005; Plumert et al., 2005; Willemsen et al., 2004), distance types (e.g. egocentric vs. exocentric; Geuss, Stefanucci, Creem-Regehr, & Thompson, 2012), and the type of task used to measure distance perception (e.g. blind walking vs. blind throwing; Sahm et al., 2005; Sinai, Krebs, Darken, Rowland, & McCarley, 1999). The most reasonable conclusion, however, may be due to the methods used to measure distance estimation. In Sinai et al.’s (1999) study, participants were found to have overestimated, rather than underestimated distances in VR when tasked with a perceptual matching task that required participants to move a flag from one leg of an L-shaped room to another leg at the same distance. This finding goes contrary to the ones observed through tasks such as blind walking and blind throwing, and suggests that while some distance estimation tasks are reliable for real world testing, the same task may produce different results in VR. This is further supported by Willemsen et al. (2004), who posited that while the physical properties of VR HMDs can contribute to worsened distance estimations, other factors may potentially have a greater influence.
Regardless of the reason as to why users are underestimating, or perhaps overestimating, distances in VR, it still stands that there is some inaccuracies. Luckily, it seems like estimations are only slightly off from real world estimations, therefore it should still be plausible for a VR application that showcases depth to elicit a phobia-related response from a VR user with acrophobia for the present thesis. Of course, while this means that exact measures of the height achieved in a VE may be unobtainable due to discrepancies in distance, having the VR user progressively move vertically should still translate to the VR user perceiving that they are gaining altitude.

3.2.2.3: Spatial Knowledge and Training

Although distance estimations have generally been demonstrated to be inaccurate in VR, especially in comparison to estimations made in a real-world environment, a few studies have shown that VR could be an effective tool to train for spatial knowledge, specifically related to navigation strategies. Most notably, a study by Stanney, Cohn, Milham, Hale, Darken, and Sullivan (2013) tested various methods of acquiring spatial knowledge in relation to an underway replenishment (UNREP) task, which requires multiple precise actions such as manoeuvring a ship to a predetermined location and maintaining close proximity with another ship while supplies are being transferred between the ships (i.e. Seaman’s Eye). By using VR as a training tool, Stanney et al. (2013) concluded that the efficacy of VR training programs is largely determined by the quality of the VE and the sensory stimuli that can be incorporated to replicate as many experiences from a real environment as possible. Studies that utilized VR as a training tool for navigating unfamiliar areas also found similar findings, although participants were shown to generally learn navigation routes slightly faster in a real environment than a VE (Bailey & Witmer, 1994; Waller, Hunt, & Knapp, 1998).

The spatial knowledge and training studies generally provide more context behind the studies outlined in Section 3.2.2.2; while distance estimations can differ in a VE presented in VR compared to estimations made in a real environment, the difference may be unnoticeable as tasks that require precise
movements, such as UNREP, can still be done in VR and have the skills obtained in VR transfer to real-world use. Another point to highlight is the importance of VR quality; for any VR training to be useful, the quality of the VR experience must be as high as possible to present stimuli that reflects what would be expected from a real environment where skills acquired in VR training would transfer to. Under this notion, if the VR-based therapeutic process for treating specific phobias is likened to training, then it is further evident that for VR users to have the best chance of transferring their VR-based treatment gains to the real world, the highest quality VR hardware and software should be utilized.

3.2.2.4: Section Conclusions
The studies in this section outline two major points. The first is that while distance estimation, and by extension, depth perception, is less accurate in VR compared to estimations made in a real environment, the difference does not seem to be significant enough that it would be subjectively noticeable by the VR user. This finding supports the present thesis’ choice to utilize VR experiences as a way to treat acrophobia, as the stimuli presented in VR can reflect similar expectations of the depth perceived in a real environment. The second point posits that training achieved in a VE can transfer over to the real environment, which further supports the notion that treatment gains made through VR-based therapies should be retained outside of VR. While there may be some limitations of using VR for training purposes, such as the extra time needed when compared to training done in a real environment (Waller et al., 1998), the benefits of VR-based therapies, such as convenience and affordability, outweigh the minor differences in distance estimation and time.

3.3: Summary of Papers: Applications of VR in Social and Cross-Cultural Studies
One of the common trends that can be seen with the studies in Section 1.1 and 1.2 is that VR has largely been used as an isolated experience. While the VR-based therapies detailed in Section 1.1 were therapist-led, the VR user was largely alone in the VE without any meaningful interactions with other VR users or sophisticated, interactable avatars. While this was generally due to the inaccessibility of VR,
modern VR has made strides to facilitating shared VR environments that may be beneficial towards the treatment of some disorders such as social anxiety disorder, or allow therapists and patients to interact in novel ways. Furthermore, if VR games and other non-therapeutic applications are to be used for therapeutic purposes as the present thesis intends, it is important to evaluate how past studies have approached shared VR experiences as well as how it may compare to shared real-world experiences. This section details a few studies that demonstrate some of the uses of VR within experimental settings to better inform how the present thesis’ gaming studies should be approaches.

3.3.1: Social Psychology
The rise in popularity for virtual online worlds such as massively multiplayer online games (MMO; e.g. World of Warcraft, Final Fantasy XIV, etc.) and online communities (e.g. social networks, imageboards, and social aggregation sites) have sparked research into utilizing VR as a medium for collaboration (Slater, Sadagic, Usoh, & Schroeder, 2000). Presence in general has been viewed as the level in which a user feels as if they were in the VE rather than the physical environment surrounding them, evaluated in relation to both the level of immersion and interaction afforded by the hardware and software, but co-presence (i.e. social presence) was rarely accounted for. As VR research began to extend to social psychological concepts, a distinction for different kinds of presence could be made: environmental presence, which is the level of immersion and interactivity a user has within a VE, and co-presence, which is the level of immersion and interactivity a user has with others in a shared VE (Garau, Slater, Pertaub, & Razzaque, 2005). Although there have been studies that examined the use of VR to study social behaviours and interactions, such as the social anxiety study by Pertaub et al. (2002), the general trend of both therapeutic and experimental VR studies examined so far have used isolated, single-user VR systems rather than a networked interface that pairs VR users with other human agents in a shared VE. Of course, this is most likely due to technological limitations of the time; studies around the 1990’s and early 2000’s were still in a period where the Internet and wireless communication technologies
were in its infancy, therefore shared VEs that are common today in games such as *Minecraft*, *Pokémon GO* or *Fallout 76*, where the action of one player could be seen and interacted with by other players, would have been difficult to conceptualize, operate, and maintain.

### 3.3.1.1: Cooperation within a Shared VE

While early VR systems were largely isolated, there were still attempts to establish shared experiences within a VE presented by VR. For example, Slater et al. (2000) linked identical VEs presented in both VR and a traditional computer to evaluate whether social relationships established through a task done in the VE would transfer to the real world. While the findings for this study are questionable, as the VR experience was explicitly poor due to instances of navigation difficulties, poor audio, and reports of simulator sickness, Slater et al.’s (2000) study represents one of the earliest attempts at establishing shared VR experiences.

Another attempt by Schroeder et al. (2001) utilized networked IPT systems instead of HMDs, with main comparisons including IPT-to-IPT (ItI), IPT-to-Desktop (ItD), and Face-to-Face (FtF). Participants from this study were tasked with solving a Rubik’s cube puzzle, and notable findings include the notion that those who used the IPT system in the ItD condition felt a greater sense of presence and rated their contribution to the task as higher compared to their partner using a traditional computer. Furthermore, there were no significant differences found between the ItI and FtF conditions, and co-presence appeared to be stronger for the ItI participants than the ItD participants. Ultimately, these findings suggest that social experiences in VEs presented in VR are identical to social experiences in real environments, which is particularly important when considering the potential for VR-based therapies for social anxiety disorders.

The findings from Schroeder et al. (2001) are further emphasized by Garau et al. (2005), who evaluated the degree in which virtual humans (e.g. artificially intelligent avatars) can influence the VR user’s sense of environmental presence, co-presence, and physiological responses (e.g. heart rate and
electrodermal activity). Through various combinations of avatar behaviours (static, moving, responsive, and talking) and interpersonal distances between the VR user and the avatars (public/outermost zone, social-consultative, personal, and intimate/innermost zone), findings from this study suggests that VR users tend to respond more to avatars that are verbally responsive. Additionally, a significant positive correlation was found between the extent in which participants tried to avoid disturbing the avatars and the participant’s scores for social avoidance and distress, which indicates that the VR users’ behaviour towards the avatars can be predicted by their social anxiety scores. This is further supported by an observation that, even though the participants were aware that the avatars were programmed and not represented by another VR user sharing the VE, the participants appeared to follow their usual social norms.

3.3.1.2: Attraction

In a study on attraction, Lydon, Menzies-Toman, Burton, and Bell (2008) used VR as a supplemental apparatus to study the influence of attractive alternatives on relationship maintenance. Although the study utilized a variety of non-VR tasks, an HMD was used to perform a distancing task. In this task, participants were sent to an empty space and shown four photographs, three of which served as a neutral control and the other being an attractive person based on the participant’s preferred sex. Participants were instructed to push or pull the photographs to a preferred distance relative to themselves, and once the participant was satisfied with the distance of each picture, the distance in virtual units were recorded. The use of VR here exemplifies how VR technology could be used as an apparatus within a social psychology study. Although the task could have been performed via a traditional computer or in a real setting, the use of an HMD allowed for a sense of depth that a monitor could not replicate, as well as providing a precise measure that may not have been as accurate if measured in a real-world setting.
3.3.1.3: Sexual and Physical Violence

Whereas the studies in Sections 3.3.1.1 and 3.3.1.2 detailed attempts at establishing shared VR-based VE experiences and VR features that can enhance the experimental process, respectively, studies that have used VR to study sexual and physical violence combined both attempts and produced a practical application to educate, replicate, and examine these types of violence. For example, Jouriles, McDonald, Kollowatz, Rosenfield, Gomez, and Cuevas (2009) tasked female participants with role playing scenarios in which they would be sexually coerced by a male confederate. This was done to educate women about sexual coercion tactics and rape-resistance skills, and was ultimately successful in eliciting significant more negative affect and sense of realism compared to those who underwent the same role play outside of VR. This finding was further reinforced by Jouriles, Rowe, McDonald, and Kleinsasser (2014) and Jouriles, Kleinsasser, Rosenfield, and McDonald (2016), but Jouriles et al. (2016) noted that the participant’s sense of realism during VR-based role playing may depend on their prior life experiences. A study by Slater et al. (2013) also found similar findings when examining bystander behaviour in the context of a physical confrontation between two individuals in a pub, but emphasized that while participant who intervened in the scenario felt immersed, those that did not intervene potentially found the scenario to be silly. While the studies outlined in Section 3.1.2.1 had a mixed reception to VR-based PTSD therapy, the studies in this section demonstrate VR’s ability to replicate traumatic events, especially when the scenario presented in VR is congruent with the user’s own prior life experiences.

3.3.1.4: Prosocial Behaviour

In a study on prosocial behaviour, Gillath, McCall, Shaver, and Blascovich (2008) examined whether behaviours such as empathy or compassion could be observed when participants are confronted with a digital avatar within a VE. This study was done in two phases: 1) An evaluation was conducted to see whether participants would be affected by a digital avatar, and 2) Whether the participant would help the digital avatar. For the first phase, the participant would be approached by a blind man who would fall to the ground and lose his walking cane. After 20 seconds, the scenario ended and the participant’s
reactions to the event were recorded. During the second phase, participants would be approached by two types of people: a beggar and a businessman, both of whom would ask the participant for help. Findings for this study found that nearly half (46%) of the participants responded to the virtual avatar, while only a little more than a third (36.2%) showed explicit concern or compassion towards the avatar. The latter finding was reportedly consistent from other studies who observed that only a third of individuals would help a person in need within a real-world scenario.

3.3.1.5: Moral Dilemma: The Trolley Problem

Moral dilemmas have long been difficult to test due to the potential ethics violations, but VR presents an opportunity to test these dilemmas within a safe, controlled environment. One such dilemma is the Trolley Problem, a classic thought experiment in which an individual explicitly knows that a runaway trolley is about to hit and kill a group of people, but the individual can switch the tracks so that the trolley only hits one person. Although this dilemma has been examined across various studies, the actual dilemma could not be tested for obvious ethical reasons. By using VR, however, Navarrete, McDonald, Mott, and Asher (2012) aimed to provide evidence of how people would react within a virtual replication of the scenario. Of the 147 participants, 90.5% (133) chose a utilitarian outcome in which they actively pulled the switch and diverted the trolley to kill one person in order to save the group. Although it could be argued that there were no real consequences as everything was conducted in the VE, findings could be disputed to not be a reliable way to predict real-world behaviours for the same scenario, the study does further demonstrate how VR could be a useful tool to study previously unexplored concepts. Furthermore, as VR technology comes closer to mirroring real-world environments to a point where both may be indistinguishable from one another, this may not be an issue.

3.3.2: Cross-Cultural Psychology

In a cross-cultural study, MaKellams et al. (2012) focused on the difference of visceral perception across Eastern and Western populations, namely Asians and European Americans, respectively. VR was
used to replicate a classic rickety bridge scenario in which an attractive individual of the participant’s preferred sex stood at the opposite end of a seemingly unstable bridge over an abyss that would in turn elicit higher physiological arousal (e.g. faster heartbeat, sweaty hands, etc.). This scenario was used to test the misattribution of arousal, which posits that inferential errors are due to the individual’s visceral states. In the case of the rickety bridge scenario, misattribution would occur if the participant had poor visceral perception, meaning that the participant perceives the confederate as more attractive after crossing the bridge due to the participant’s higher physiological arousal, rather than attributing the arousal to the act of crossing the seemingly dangerous bridge. While the focus of the study was not solely on the experience of VR, it does demonstrate another method on how VR could be implemented in an experimental setting congruent to how VR has been used for recreating environments not readily available in PTSD and spatial knowledge and training studies.

3.3.3: Section Conclusions

While this section was considerably smaller than previous sections, the studies outlined here reflect some of the early attempts at establishing shared VR experiences and some practical applications that can inform future research related to the treatment of social disorders. These studies are also indicative of how far technology has progressed, as many of the attempts at providing shared VR experiences outlined in this section can be easily achieved and supported with modern VR HMDs. Furthermore, while the studies in Section 3.1.2.1 had a mixed reception in relation to using VRET for PTSD, the studies in Section 3.3.1.3 may suggest that it may not be the fault of the stimuli, but some other factor that would influence the efficacy of VR-based treatment for PTSD as VR users were generally found to respond more towards scenarios that they could personally identify with (Jouriles et al., 2016). Other notable contributions from the study in this section include the studies by MaKellams et al. (2012) and Navarrete et al. (2012), both of which demonstrated different utilities of VR to test relatively dangerous scenarios; in the context of the current thesis, this would suggest that more extreme situations (e.g. falling
from a point several hundred metres above ground) could be incorporated during the VR-based self-directed treatment for acrophobia where it would be near impossible for traditional in-vivo exposure treatment to address.

3.4: Summary of Papers: Utilization of VR as a Protective Measure for Dangerous Situations

The studies that examined the safety concerns of VR for paranoid ideations have provided evidence that VR carries many safety benefits, such as preventing the user from harming actual individuals if he/she should retaliate against supposed conspirators (Freeman et al., 2010; Valmaggia et al., 2007). Although there are some potential side effects, such as simulator sickness, most of the studies examined in the previous sections rarely contained participants who experienced simulator sickness, with those that did were most likely using low quality VR systems such as the ones in Slater et al.’s (2000) study. Nevertheless, the safety afforded by VR has made for an attractive option for studies whose experimental procedures may pose physical harm to the participants or experimenters.

A study by Readinger, Chatziastros, Cunningham, Bülthoff, and Cutting (2002) utilized an IPT-based driving simulator that projected three screens on a cylinder wall around a steering wheel controller. The goal of the study was to examine whether participants could orient their virtual car along the centre of the road in the absence of any markers to indicate where the centre was. To ensure that the participant was fixated on a certain area of the display, a Landolt-C figure (i.e. Japanese Vision Test) occasionally appeared at random intervals at a random location from the centre of the display. As driving experiments may be perilous for both the participant and experimenter, this experiment demonstrates how VR equipment can provide a safe environment to carry out the experiment, as well as giving experimenters additional levels of control over the VE that are not necessarily possible in real-world conditions.

The rest of the studies in this section had examined road crossing behaviour, and although there was a distinction between cycling and pedestrian crossings, each study was conducted relatively the same. For Plumert, Kearney, and Cremer (2004) and Chihak et al. (2010), a bicycling simulation within an IPT
system had participants identify gaps in continuous cross traffic that were large enough to cross. Pedestrian crossing studies all studied the effects of distractions on road crossing behaviours, and rather than using a bicycle, a treadmill was used in conjunction with an IPT system (Neider, McCarley, Crowell, Kaczmarski, & Kramer, 2010, 2011; Nagamatsu et al., 2011).

Just as Foo et al. (2005) and Lydon et al. (2008) have demonstrated, these studies provide more supporting evidence towards VR’s capability of being used for a variety of research topics, as well as being invaluable for certain experimental methodologies that have elements that could potentially pose a risk towards the participant or experimenter. The benefits of environmental control consistently exemplified in the VRET studies also apply in this context, as the VE for the driving task in Readinger et al.’s (2002) study could have a variety of weather patterns to control, as well as set traffic patterns for the study concerning pedestrian and road cycling behaviour. By utilizing VR, the experimenters also guaranteed that each participant experienced the exact same scenario, therefore eliminating potentially confounding variables that would have plagued a real-world setting.

3.5: General Conclusions
The main objective of this systematic thesis was to establish a fundamental understanding of the existing VR literature in relation to the methodologies used for VR-based therapy, implementations of VR technology for therapeutic and experimental settings, and the advantages and disadvantages of using VR technologies for therapeutic and experimental purposes. Together, the findings derived from this systematic review can help aid in the establishing of the present thesis’ self-directed iteration of VRET as well as the VR gaming studies.

3.5.1: Moving Towards a Self-Directed Approach towards VRET
VRET has largely been demonstrated to be just as effective as traditional therapies (e.g. exposure therapy, relaxation training, hypnosis, etc.) for various disorders such as aviophobia (Rothbaum et al., 2000, 2002) and arachnophobia (Garcia-Palacios et al., 2002; Hoffman et al., 2003). For some specific
phobias, such as aviophobia and acrophobia where travel expenses may be an issue, the use of VR serves as a cost-saving alternative to traditional in-vivo exposure therapy while also facilitating an environment of confidentiality as the patient could be kept secure within the therapist’s private operating area. VR also gives therapists unprecedented levels of control over the VE, which allows them to both standardize the stimuli as well as tailoring it to match the patient’s needs. Considering the numerous extraneous variables that could surface with traditional in-vivo exposure therapy, such as weather conditions and bystander behaviour, VR-based therapy addresses many of the shortcomings of traditional therapeutic procedures.

While there are certainly many advantages of using VR technologies for therapeutic purposes, a few studies did mention a few negative side effects, most notably in the form of simulator sickness. Aside from the study by Slater et al. (2000), studies that explicitly anticipated for simulator sickness did not find any indication that participants were negatively affected by VR exposure, at least in the long term. This trend may be due to the overall immersive factor of the VR equipment used, as some studies have suggested that increasing the user’s sense of presence by integrating additional sensory stimuli (e.g. Garcia-Palacios et al., 2002; Hoffman et al., 2003), control schemes (Slater et al., 1998), and overall hardware power (Hoffman et al., 2004) could mitigate the likelihood of simulator sickness from occurring. Furthermore, Slater et al. (2000) also reported that patients’ VR presence scores did not differ significantly from traditional computer experiences, which run contrary to other studies that claimed that those who used VR had higher levels of presence than their traditional computer counterparts. This could, however, be due in part to early VR technology’s insufficient computational and graphical power. Regardless, these findings further reinforce the notion that there is a relationship between sense of presence and the possibility of simulator sickness; by increasing the user’s sense of presence, the user’s susceptibility to simulator sickness should decrease accordingly.

Despite these limitations of using VR, the general process of VRET still appears to be an effective approach towards treating and identifying a wide variety of anxiety-based disorders. While all of the
studies focused on therapist-led VRET, some of the methodologies employed in these studies can be employed for self-directed VRET, most notably from Rothbaum et al. (1995a, b) and Emmelkamp et al. (2001). Aspects such as the measures used, the amount of time allotted for treatment, and the use of follow-up assessments are all important aspects to determine whether self-directed VRET can achieve long-term effectiveness, with the measures being used to gauge the patient’s level of acrophobia, the time being used as a reference for when treatment gains should be expected to be observable, and the follow-up assessments to verify any persisting treatment gains. As a trained therapist would be absent from the self-directed VRET, the focus should be placed more on the stimuli and the patient’s understanding of the basic protocols behind exposure therapy. In relation to acrophobia, while documented evidence from the distance estimation and spatial knowledge studies seem to imply that there is a slight disparity in depth perception between the VE and the real world, this disparity does not appear to be significant (Messing & Durgin, 2005), especially as VR has been demonstrated to be useful for training in tasks that require a high degree of spatial knowledge and awareness (Stanney et al., 2013).

As the core procedures behind VRET have largely been similar across each study regardless of the specific phobia or anxiety-related disorder being treated, if the self-directed iteration of VRET should be shown to be effective, it would be safe to assume that the same procedure could be applied to treat other types of specific phobias and anxiety-related disorders provided that the stimuli is respective of the disorder being treated. While not immediately applicable towards the present thesis’ focus on acrophobia, other types of phobias and anxiety-related disorders could take advantage of features that have been demonstrated in some of the studies in this review. Most notably, social anxiety disorders could benefit from VR-based therapeutic role playing through the use of multiple, interconnected VR systems (Jouriles et al., 2009; 2014; 2016), or with pre-programmed avatar behaviours (Gillath et al., 2008). Additionally, VR has also been notable for replicating particularly dangerous situations, therefore more
extreme situations could be included during the later stages of the treatment process, such as walking across a rickety bridge (MaKellams et al., 2012) for patients with acrophobia.

3.5.2: Evaluation of VR Systems

The two main VR systems used throughout each study in this systematic review were HMDs and IPT systems, and each version of VR had clear advantages and disadvantages associated with them. HMDs were the clear VR system of choice used by the majority of the studies included in this review, while IPT systems tended to appear more powerful in terms of pure computational and graphical specifications. Although both VR systems do rely in part on the main computer’s specifications, HMDs appeared to have a much more limited field of view, required users to put on the heavy and uncomfortable headset, and generally displayed the VE in an inferior graphical resolution compared to IPT systems. Likewise, while IPT systems are generally more powerful than HMDs, a significant investment in both space and money would have to be reserved to set up and maintain the IPT system, which presents a physical barrier that is virtually non-existent for HMDs. Furthermore, evidence from studies such as Plumert et al. (2005) suggests that IPT systems may not necessarily include stereoscopic capabilities that are standard in HMDs, which takes away an integral factor of depth that some topics, such as road crossing behaviour and height-based stimuli for acrophobia treatment, may find essential.

Multiple studies, but most notably Hoffman et al. (2004), emphasized the importance of using the best VR systems possible, as VR users have notable differences in how they perceive and interact within the VE based on how powerful the VR system was. Under this premise, researchers and therapists who would like to carry out experiments and treatments using VR should consider whether the capabilities afforded by the VR system can fit the needs of the study, and how the quality of the VR and its associated experiences may affect the study’s outcomes.

With this in consideration, the present thesis has opted to use the best available computer-based VR HMD to carry out each of the three main experimental studies in an effort to reduce the possibility of
simulator sickness and maximize sense of presence and immersion. The use of a high-quality VR HMD is also important for gaming purposes, as any loss in stimuli fidelity (e.g. graphical and auditory) and tracking latency could detract from the overall enjoyment and immersion afforded by the game.

Chapter 4: Automating VRET: A Case for Self-Directed or Minimally Guided VR Therapy (Study 1)

As evident in the systematic review, there have been substantial evidence supporting the use of VRET to treat specific phobias, general and specific anxiety, and PTSD with similar or sometimes greater efficacy compared to traditional exposure therapy methods. The evidence towards VR-based treatment is significant in part that patients were able to achieve the reported treatment gains despite issues that were prevalent with older VR HMD systems, such as simulator sickness and potential fatigue associated with the HMD’s low display resolution and heavy weight (Rebenitsch & Owen, 2016). Furthermore, while HMD systems were generally more affordable and accessible than other forms of VR (e.g. IPT systems), HMDs were still expensive and VR programs were not as readily accessible, sometimes forcing researchers and therapists to develop their own VR programs that met their needs (Lindner et al., 2017). Fortunately, modern VR has embraced many technological trends and advancements to address many of the older VR systems’ shortcomings. Digital storefronts such as Steam allow for a wider distribution of VR programs and content for all major VR headsets while allowing for potential shared VE experiences on a local or global scale. VR headsets can also be tethered to a wide range of devices ranging from smartphones to computers or work as a standalone system, further increasing its accessibility through adjusting the quality of VR based on the hardware’s capabilities. While the majority of the VR content found and promoted on VR-focused digital storefronts are for entertainment, therapeutic applications can also take advantage of the accessibility afforded by modern VR to establish new ways to administer treatment options, such as self-directed or minimally guided VRET.

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2 For the poster version of this study, please see Oing and Prescott (2019)
Self-directed intervention (i.e. self-help intervention) is a form of therapy in which the patient progresses through a standardized psychological treatment protocol independently (i.e. pure self-help) or with minimal guidance from a trained therapist (i.e. guided self-help; Cuijpers & Shuurmans, 2007; Gellatly, Bower, Hennessy, Richards, Gilbody, & Lovell, 2007). Treatment protocols are typically presented via systematic step-by-step instructions, and the only difference between pure self-help and guided self-help methodologies is the level of therapist contact involved (Cuijpers, Donker, van Straten, Li, & Andersson, 2010), although it is possible that some therapists may opt to use either method in conjunction with individual or group therapy (Gregory, Canning, Lee, & Wise, 2004). These protocols can be delivered in a variety of mediums, such as books (i.e. bibliotherapy), audio or video recordings, computer software, or the Internet. Although self-directed interventions will not work for every psychological disorder, some disorders that it can address include addiction, social and sexual dysfunctions, and anxiety (Cuijpers & Schuurmans, 2007).

Practical benefits for using self-directed interventions include allowing therapists to have more time to spend with more patients, giving individuals who live in areas with limited to no access to trained therapists an easily accessible treatment option, and providing individuals with treatment when their disorder or mindset may make them reluctant to initially seek traditional therapist-led treatment (e.g. social anxiety disorders, stigmatized view of mental health care, or bad prior experiences with seeking help; Cuijpers & Schuurmans, 2007). Self-directed interventions may also be more affordable than traditional therapy as it is administered independently and can be performed at the patient’s leisure without interfering with the patient’s work and personal obligations (Cuijpers, 1997; Newman, Szkodny, Illera, & Przeworski, 2011).

While there are certainly many positive aspects with self-directed interventions, there are also some negative aspects, mainly due to the limited types of individuals who may benefit from it, the potential for ethical concerns when commercializing self-help materials not backed by scientific evidence,
and a risk of the problematic symptoms to worsen (Menchola, Arkowitz, & Burke, 2007; Newman, Erickson, Przeworski, & Dzus, 2003; Rosen, 1987). Furthermore, if the individual does not perceive any benefits, or does not finish the therapy in its entirety, the individual may drop out of the intervention or may result in an increased sense of helplessness (Cuijpers & Schuurmans, 2007). A meta-analysis by Mechola et al. (2007) posited that self-directed interventions were most likely to be effective for patients whose symptoms were mild to moderate, while those with more serious disorders that had severe symptoms, such as major depression, needed a therapist. This finding was echoed by Newman et al. (2003) and Gregory et al. (2004), who suggested that some individuals do need or would prefer a therapist to help treat their symptoms. In relation to the commercialization of self-help materials, the industry had become a multi-billion-dollar venture in the United States since 2004 alone, therefore it was an inevitability that some organizations would publish and promote scientifically unsupported treatment methodologies that would do more harm than good (Menchola et al., 2007; Salerno, 2005).

Despite the negative aspects, research-supported self-directed materials have been shown to be effective for individuals with mild to moderate symptoms. As VR has become increasingly accessible for the general population, programs have already been created and published that claim to be based on exposure therapy techniques and to help aid the user to overcome their fears, such as the Oculus-exclusive Fearless developed by Fearless. As these programs propagate, it is of increasing importance to evaluate the efficacy of a self-directed approach to VRET to understand its potential and efficacy for treatment, especially as it has been difficult for the general population to distinguish between research-supported and uninformed self-help materials due to its mass commercialization. A self-directed variation of VRET would mitigate some of this by focusing primarily on the stimuli and reducing therapeutic instructions to a singular objective of progressing through increasingly difficult stimuli. Additionally, while the aim of self-directed VRET is to lessen the need for therapist involvement, therapists can still benefit
from this variation of VRET as there is less of an emphasis on proprietary software. The aims of this chapter are to outline:

1. The advantages and disadvantages of self-directed interventions
2. Outcomes and future directions for VR-based self-directed interventions

4.1: An Evaluation of Self-Directed Interventions
4.1.1: Evidence from Meta-Analyses

Several meta-analyses have been conducted to test for the efficacy of certain self-directed interventions (e.g. bibliotherapy; Cuijpers, 1997; Gregory et al., 2004), comparative outcomes to traditional treatment (Cuijpers et al., 2010), and for the effective components that comprise self-directed interventions (e.g. guided vs. self-help approach, diagnosis, acceptance, etc.; Gellatly et al., 2007; Hirai & Clum, 2006; Menchola et al., 2007). Although these meta analyses cannot concretely establish whether self-directed interventions are truly effective, each one does shed some light on the type of person and disorder that this form of intervention can help.

Both Cuijpers (1997) and Gregory et al. (2004) conducted meta-analyses on the efficacy of bibliotherapy on depression, ultimately forming a uniform conclusion that bibliotherapy was an effective alternative treatment option. Although both meta-analyses did yield promising evidence towards bibliotherapy, Cuijpers (1997) cautioned that his study only examined a small number of studies, which in turn also had small sample sizes. Despite these limitations, Gregory et al. (2004) did a more extensive search and still confirmed the findings found in Cuijper’s (1997) meta-analysis but was also able to extend his findings by identifying the populations that tend to benefit the most from bibliotherapy. Those with mild to moderate depression, as well as those whose depression is not a result of other psychological disorders, were ones who would experience the most out of bibliotherapy. Gregory et al. (2004) also posits that it is important for clinicians to be able to structure how self-directed interventions should be conducted in the form of selecting, recommending, and determining the kinds of materials that would be
conducive to a clinically significant outcome, as well as evaluating how much therapeutic contact, if any, is necessary for the patient. Furthermore, Menchola et al. (2007) reinforced these findings, but noted that while self-directed interventions can be better than no treatment at all, the outcomes might be less significant compared to traditional therapist-directed treatments.

To clarify how effective self-directed interventions are compared to traditional therapist-directed treatments, Cuijpers et al. (2010) evaluated whether the guided self-help approach would be as effective as face-to-face therapy. Although the guided self-help approach can indeed contain a face-to-face component sporadically throughout the patient’s treatment period, patients are also given opportunities to communicate with their therapist via other modes of communication (e.g. telephone or e-mail), whereas face-to-face therapy is typically conducted exclusively in person. Cuijpers et al.’s (2010) findings indicated that no major significant difference between guided self-help and face-to-face treatment for both depression and anxiety-based disorders (e.g. general and specific phobias) were observed, which deviates from Menchola et al.’s (2007) finding that self-directed interventions tended to be less effective than traditional therapy. Furthermore, self-directed intervention treatment outcomes were found to have persisted during 1-year follow-ups, and there was no significant difference in drop-out rates compared to face-to-face therapy methods. Cuijpers et al. (2010) further reiterated a notion that Gregory et al. (2004) made in that self-directed interventions are not an effective treatment option for everyone, specifically those who are not willing to undergo the self-directed therapeutic process.

A meta-analysis from Gellatly et al. (2007) also cites similar findings, but to a lesser degree. Self-directed interventions were thought to be useful as a treatment measure, but not as a preventative tool. The authors also go on to posit that self-directed interventions should focus more on the core fundamentals of cognitive-behavioural therapy rather than psychoeducation, which Gellatly et al. (2007) suggests would extend the usability of these interventions for those who are illiterate in health terminology. The guided self-help approach was also believed to be superior to the pure self-help
approach, although each approach varied in the number of sessions that were conducted as well as how a successful treatment completion could be defined.

A more exhaustive search of the literature for the efficacy of self-directed interventions on anxiety-based disorders by Hirai and Clum (2006) confirmed most of the findings from other meta-analyses. Drop-out rates were reportedly low across most studies and was comparable to traditional therapies for anxiety-based disorders, but those with more severe anxiety disorders were just as likely as those with milder anxiety disorders to perceive self-directed interventions as a viable treatment option. Furthermore, self-directed interventions were found to be moderately effective for both individuals with diagnosed and non-diagnosed anxiety disorders, and treatment gains persisted for at least 6 months. Despite these findings, however, Hirai and Clum (2006) did note that while self-directed interventions are comparable to traditional treatment methods, it appears to vary depending on the disorder. While treatment outcomes for panic disorders and agoraphobia were relatively consistent between both treatment approaches, outcomes for self-directed interventions appeared to be weaker than outcomes for traditional treatments for specific phobias and social anxiety disorders.

While the meta-analyses detailed in this section do demonstrate some variance in terms of how effective self-directed interventions can be, a recurring theme is that these interventions can be effective under certain conditions. Despite some conflicting reports, self-directed interventions appear to be more of a promising treatment option when conducted properly and towards populations that are more likely to benefit from it, although more research would be needed to determine the finer conditions that could determine how an individual may make the most of these types of interventions to maximize treatment outcomes.

4.1.2: Evidence from Controlled Studies for Specific Phobias

While the meta-analyses in Section 4.1.1 have exemplified the efficacy of self-directed interventions as well as outlining the conditions in which it would be the most optimal treatment option,
it is also important to examine some of the individual studies to better inform the general methodology of the present study. While the present study is focused on treating acrophobia, an examination of the approaches used by studies that have utilized self-directed interventions for anxiety-related disorders would both help to inform how the methodological protocol of the present study should be built as well as the potential versatility of the procedure to treat disorders beyond acrophobia.

VR-based therapies and self-directed interventions share a unique versatility in being able to be utilized to treat various types of specific phobias. In addition to common phobias such as acrophobia (Baker, Cohen, & Saunders, 1973) and arachnophobia (Öst, Stridh, & Wolf, 1998), there have been documented evidence supporting the use of self-directed interventions for other types of phobias not yet tested with VRET, such as fear of using public toilets, needle phobia (i.e. fear of injections), dental phobia (i.e. fear of dentists), and ophidiophobia (i.e. fear of snakes; Kahn & Baker, 1968; Rosen, Glasgow, & Barrera, 1976). While the materials used to deliver self-directed interventions varied between studies, which ranged from using a manual (Öst et al., 1998; Rosen et al., 1976) to phonograph records (Baker et al., 1973; Kahn & Baker, 1968), the general consensus among these studies is that self-directed intervention, both in its form of pure self-help and guided self-help, can significantly improve the patient’s phobic symptoms. Furthermore, it is further evident that the patient’s perception of the self-help materials and their motivations are important factors to determining the treatment outcomes of the self-directed intervention. Based on this notion, the present study should aim to recruit patients who have the motivation to confront their phobia as well as ensuring that the stimuli presented in VR can elicit phobic responses.

Studies that focused on using self-directed interventions for disorders outside of specific phobias have also found similar treatment outcomes, ranging from panic disorder (Carlbring et al., 2005; Carlbring, Westling, Ljungstrand, Ekselius, & Andersson, 2001; Klein & Richards, 2001), OCD (Clark, Kirkby, Daniels, & Marks, 1998), and depression (Andersson, Bergström, Holländare, Carlbring, Kaldo, & Ekselius, 2005;
Marks, Metaix-Cols, Kenwright, Cameron, Hirsch, & Gega, 2003). Of particular note is Klein and Richards’ (2001) study on panic disorder in which a brief, one-week self-directed intervention was conducted; while the majority of the other studies allotted weeks for treatment, Klein and Richards (2001) demonstrated that it is possible for patients to be able to quickly achieve some immediate effects. Their study goes on to posit that demand effects may have influenced the results, but this would further reinforce Öst et al.’s (1998) conclusion that a crucial factor for the success of self-directed interventions lies in the patient’s perception and motivation. Overall, while the materials used for each of these studies varied, ranging from paper manuals (Rosen et al., 1976) to computer-based stimuli (Clark et al., 1998), the general treatment procedures tended to be similar, which would suggest that if a VR-based version of self-directed therapy should be demonstrated to be successful, there is a high likelihood that the findings can be extended to other types of anxiety-based disorders.

4.2: Study Overview

The studies outlined throughout this chapter all point to a general theme: self-directed interventions can be effective, but under certain conditions. This, of course, is generally true for any kind of established therapeutic procedure such as CBT, and while a particular treatment option can work for some individuals, it may not necessarily work for everyone. To benefit the most from a self-directed intervention, individuals must be motivated to complete and follow through the procedures outlined in the materials, the materials must be perceived to be credible, and symptoms should be mild enough to warrant treatment, but not severe enough to require the support of a therapist (Öst et al., 1998). While most of the studies did find that self-directed interventions yielded equal effectiveness when compared to traditional treatment options, there were some studies that found it to be less effective than traditional therapy (Öst et al., 1998), or may require more sessions for greater effectiveness (Clark et al., 1998). Self-directed interventions have the potential to, however, allow patients to experience continual improvements in treatment gains, which does not seem present for traditional therapist-led therapies.
(Baker et al., 1973). Furthermore, there are many associated benefits with implementing more self-directed interventions for individuals who are most likely to be able to benefit from it, such as shorter waiting times at clinics, affordability, and the ability to conduct treatment at the patient’s convenience (Cuijpers, 1997; Newman, Szkodny, Ilera, & Przeworski, 2011).

The method of delivering self-directed interventions also appears to change as time progresses. Kahn and Baker (1968) used both a manual and a phonograph record to deliver their self-directed intervention, which was followed by Baker et al.’s (1973) use of a cassette tape, and then leading u to the use of computers and the Internet for more recent studies (Andersson et al., 2005; Clark et al., 1998; Carlbring et al., 2001). While older self-directed intervention materials can still be used today, a noticeable trend for more progressively recent studies is to embrace newer forms of technology. By utilizing more advanced technologies, the therapeutic process will not only be easier to conduct and innovate upon, evident with easier methods of parsing through text (e.g. using a computer’s word search function to find specific passages) and gamifying treatment processes (Clark et al., 1998), but also allow for more accessibility to people on a global scale (e.g. Internet-delivered self-directed interventions vs. physical books or recordings of self-directed interventions). VR stands as modern time’s newest established technology, which benefits from many technological advancements such as Internet connectivity and hardware improvements while also providing a unique capability to providing an immersive experience that cannot be replicated by any other current technological medium.

The current study operates under these notions, positing that recent advancements in VR can be used to further innovate how self-help interventions can be administered and conducted, specifically for the treatment of acrophobia. VR has already been demonstrated as an effective tool to treat various psychological disorders, but whereas early VR systems were expensive, largely limited to institutions that could afford and operate the equipment, and often required proprietary programs to implement treatment plans, modern VR systems have addressed all of these issues by having cheaper entry points,
the capability of connecting VR users together across the world, and makes obtaining VR programs more accessible through the use of digital storefronts. While the latter may raise concerns about the growth of untested materials not backed by science and research, the nature of a digital storefront can mitigate this issue as users and prospective patients can easily post and read reviews about a particular program to determine for themselves whether the program can be effective.

While the VRET literature has provided an overwhelming amount of supportive evidence towards the use of VR systems to treat psychological disorders such as acrophobia, the current study will follow a case study approach due to the novelty of the proposed protocol, as it deviates from the established VRET protocols by focusing more on the pure experience of an immersive virtual stimuli rather than a rigid, systematic process seen in past studies.

4.2.1: Methodology
4.2.1.1: Design
The current study has opted to utilize a randomized, mixed methods case study approach. As this approach is relatively novel, this study serves as an initial test as to whether a VR-based version of self-directed interventions can be feasible; if outcomes are in favour of the proposed treatment plan, further research can be done to replicate the protocols outlined in the present study with a larger clinical sample. Furthermore, the randomized aspect allows the present study to test different types of conditions, mainly Pure Self-Help, Guided Self-Help, and Waiting List, without any risk of bias. Furthermore, by utilizing both quantitative self-report measures and qualitative interview responses, the present study would be able to obtain a better sense of each patient’s level of acrophobia during pre-, post-, and follow-up assessments.

4.2.1.2: Participants
A total of three patients were recruited via fliers posted throughout the University of Bolton. Potential patients must have completed the Acrophobia Questionnaire as a screening measure and
achieve a score that fell within the clinical average as outlined by Cohen (1977). The names of each patient were changed for the present study’s report to ensure their anonymity.

4.2.1.3: Instruments/Apparatus

- **HTC Vive**: A VR HMD designed specifically for games and programs that can be obtained from the Steam digital storefront client. Minimum systems requirements for the Vive include a NVIDIA GeForce GTX 970 or AMD Radeon R9 290 graphics processing unit (GPU), an Intel i5-4590 or AMD FX8350 central processing unit (CPU), at least 4 gigabytes of random-access memory (RAM), a DisplayPort 1.2 or HDMI 1.4 port for video output, and a Windows 7 SP operating system. Room scale VR was chosen as the primary VR option as it allowed for greater movement throughout the VR program, which required at least 2 x 1.5 metres of physical space but could be scaled to incorporate up to 3.5 x 3.5 metres. 360-degree head tracking is achieved via external base stations that communicate with sensors found on both the HMD and controllers, the latter of which also includes a multifunction trackpad and basic buttons to interact with the VE. The headset has a 110-degree field of view with a 2160 x 1200 screen resolution (1080 x 1200 per eye), and allows most prescription eyeglasses to be used with the headset.

- **Richie’s Plank Experience**: Developed by Toast, *Richie’s Plank Experience* is a height simulator VR experience. The main feature of this program is to ride an elevator to a simulated height of 160 metres and to walk a think plank situated outside of the elevator (See Figure 2), but additional modes include *Fire Deck*, a superhero flying simulator in which users fly around the cityscape with a fire hose to extinguish randomly generated fires (See Figure 3), and *Sky Brush*, a sky writing simulator in which players leave coloured smoke trails behind as they fly (See Figure 4). The plank from the main feature can be customized via different plank dimensions, but the default one was used for the purpose of this study as it fit perfectly within the physical space available. It should be noted that the program was not designed specifically for therapeutic purposes but was used...
based on positive reviews on how well the program simulated heights, while also containing
features that could be appropriated for therapeutic purposes.

Figure 2: Plank Mode

Figure 3: Fire Deck Mode
• **Acrophobia Questionnaire (AQ; See Appendix A):** Developed by Cohen (1977), the AQ contains 2 subscales that evaluates the patient’s level of anxiety and avoidance related to acrophobia. Each subscale has its own individual Likert scale to rate each of the 20 items within the subscale (40 items total), with anxiety being rated from 0 to 6, and avoidance being rated from 0 to 3. Participants can obtain a total score ranging from 0, representing no acrophobia, to 180, which represents a debilitating level of acrophobia. Scores for the anxiety subscale can range in between 0 to 120, while scores for the avoidance subscale can range from 0 to 60, with lower scores on both subscales representing lower levels. The AQ was administered during screening, pre-treatment, post-treatment, and 6-month follow-up measure. For the screening measure, participants must have obtained scores that fell within 1 standard deviation of the clinical average from Cohen’s (1977) study, who observed a mean anxiety score of 61.30 (SD = 15.85) and a mean avoidance score of 14.37 (SD = 5.70).
- **Attitudes Towards Heights Inventory (ATHI; See Appendix B):** Adapted from the work of Abelson and Curtis (1989), the ATHI was developed to assess the individual’s attitudes towards heights along six dimensions on an 11-point Likert scale. The dimensions examined with the ATHI include good vs. bad, pleasant vs. unpleasant, awful vs. nice, safe vs. dangerous, harmful vs. harmless, and threatening vs. unthreatening. Each dimension refers to how the patient would describe their attitude towards heights, with higher scores on the ATHI representing a subjectively negative attitude towards heights, while lower scores represent subjectively positive attitudes.

- **Subjective Units of Discomfort (SUDS):** Participants are asked to verbally rate their level of discomfort from a scale of 0 to 100, with 0 representing “completely comfortable” and 100 indicating “completely uncomfortable.”

- **Behavioural Assessment Test (BAT):** Participants are tasked to climb a 4-floor spiral staircase located outdoors as high as they are willing to while peering over the staircase’s handrail to the ground below. If the patient stops, a 1-minute pause would begin before the patient is asked if they can climb any further, and this is repeated until either the patient reaches the top or refuses to continue. The number of steps that the patient ascended, SUDS, and heart rate recorded at the base and stopping point serve as the BAT’s main measures, and would be conducted at pre-treatment, post-treatment, and 6-month follow-up assessments.

- **Wahoo TICKR Heart Rate Monitor:** The Wahoo TICKR heart rate monitor is a chest strap that links to a Bluetooth-enabled device (e.g. smartphone, tablet, etc.) that was used to monitor the patient’s heart rate throughout each session and during the BAT. Patient heart rate was recorded every 5 minutes during VR sessions, with the averages and peak heart rate measures being recorded from the Wahoo companion app following each VR session.

- **Presence Questionnaire (PQ; See Appendix C):** The PQ, originally developed by Witmer and Singer (1998) was used to evaluate the participant’s sense of presence. A revised version by Witmer,
Jerome, and Singer (2005) was used for the present study and included subcategories for Realism, Possibility to Act, Quality of Interface, Possibility to Examine, Self-Evaluation of Performance, Sounds, and Haptic. A total of 24 items ($\alpha = 0.84$) were included with the scale and could be answered through a 7-point Likert scale. Higher scores indicate higher values of the subcategories, with maximum scores as follows: Realism = 49, Possibility to Act = 28, Quality of Interface = 21, Possibility to Examine = 21, Self-Evaluation of Performance = 14, Sounds = 21, and Haptic = 14.

- **Simulator Sickness Questionnaire (SSQ; See Appendix D):** The SSQ, originally developed by Kennedy, Lane, Berbaum, & Lilienthal (1993) was used to gauge whether participants experienced any symptoms of simulator sickness after each experimental session. A revised version by Bouchard, Robillard, Renaud, & Bernier (2011) was used for the present study, and includes 16 items ($\alpha = 0.86$), 9 of which are dedicated to evaluating nausea-related symptoms, and the remaining 7 dedicated to oculo-motor symptoms. Higher scores indicate higher severity of the associated symptom category, and maximum scores are as follows: Nausea = 36, Oculo-Motor = 28.

4.2.1.4: Procedure

The pure self-help and guided self-help patients were allotted up to 12 1-hour treatment sessions held weekly, while the waiting list patient was instructed to come only at the beginning and end of the 12-week period. During the first session, all patients were given a battery of pre-treatment assessments consisting of the AQ, ATHI, and BAT. Once the measures were recorded, the pure self-help and guided self-help patients (i.e. treatment patients) were given a pamphlet describing the treatment process, a summary of the past VRET studies that served as a foundation for the present study, and an explanation of how to use the VR equipment during *Richie’s Plank Experience*. Treatment patients were also made aware of their role and responsibilities for each subsequent treatment session, with the pure self-help participant being responsible for setting their own goals to achieve throughout each session and
introspectively review treatment session activities, while the guided self-help participant would be able to briefly discuss and set treatment goals with the experimenter at the beginning of each session and review treatment session activities at the end of the session. At the end of the first session, treatment patients were given the chance to become familiar with the VR equipment and standard controls using the home hub as the VE, which depicted an open studio room overlooking a mountain range.

Beginning in session 2, both treatment patients were allotted 45 minutes of VRET, with 15 minutes set aside for setting up (calibrating the participant to the VE and heart rate monitor), setting session goals, and reviewing prior sessions. At the beginning of session 2, both treatment patients were given a second BAT, but rather than being tasked with climbing the physical staircase, they were tasked with walking the plank in the VE, as being able to fully walk the plank was set as the primary goal for the treatment. Upon seeing the plank, none of the treatment patients were able to step out of the elevator and were promptly returned to the ground floor. Throughout each VRET session, the patient’s base heart rate was recorded at ground level while wearing the VR equipment and then recorded every 5 minutes until either the 45 minute time limit had elapsed. Once the patient believed that they were ready to walk the plank, or when 12 treatment sessions had been completed, a battery of post-treatment assessments consisting of the AQ, ATHI, BAT, and a post-treatment interview would be administered. A follow-up assessment would also be conducted 6 months following the post-treatment assessments, which consisted of the AQ, ATHI, BAT, and follow-up interview. The waiting list patient was given the opportunity to take part in his choice of the pure self-help or guided self-help approach following his post-treatment assessments, and while he initially chose to begin with the guided self-help approach, scheduling conflicts prevented him from being able to complete more than 2 sessions.

4.2.2: Case Summaries
4.2.2.1: The Case of Christina
Christina was a 24-year-old Caucasian female who attributed her development of acrophobia to turbulence felt while riding on a plane a little over 6 months prior to the beginning of her treatment. Her
AQ screening assessment fell within the clinical average for acrophobia (AQ\textsubscript{Anxiety} = 48, AQ\textsubscript{Avoidance} = 13), and in response to situations involving heights, she reported symptoms of increased heart rate, sweating, and trembling, as well as believing that her fear of heights was unreasonable, excessive, and disproportionate to the perceived threat. Although she felt that she had missed out on opportunities due to her fear of heights, she had not sought for any form of treatment prior to registering for the present study.

There was a 3-month waiting period between the acceptance into the present study and the start of treatment sessions due to scheduling conflicts, but pre-treatment assessments revealed that her AQ scores had increased slightly from her screening scores (AQ\textsubscript{Anxiety} = 56, AQ\textsubscript{Avoidance} = 19). Furthermore, she scored a 34 on the ATHI, indicating that she felt heights were more dangerous, harmful, and threatening than good, pleasant, and nice, respectively. For her physical BAT, she successfully climbed up the entirety of the staircase, with her baseline heart rate set at 80, peaking to 123 during her climb, and averaging at 98. When asked to rate her discomfort using SUDS, she rated her discomfort as 50 at both the base and apex of the staircase. Her VR BAT yielded similar results, with her heart rate set at 80, peaking to 99, and averaging at 84. Although her SUDS at the base of the VE was 20, she reported a SUDS of 50 as she saw the plank and refused to step out of the elevator.

In total, Christina would complete 10 sessions of VRET under the pure self-help approach. Her first VRET session had a few complications, mainly due to feelings of simulator sickness that ultimately ended the session after 17 minutes and 41 seconds. To mitigate this, a solution was developed at the beginning of the second session where she would take a 30 second break every 5 minutes, which was done by having her close her eyes after her heart rate was recorded. This method allowed her to complete all 45 minutes of the VRET sessions and was subsequently implemented for the rest of her sessions. Furthermore, the primary feature that she chose to use within the VE was \textit{Sky Brush}, which allowed for slower movements around the VE that would give her the opportunity to gradually ascend to greater heights when she felt...
ready. The *Fire Deck* mode was avoided because it was faster pace and included gravity simulations that tended to worsen her simulator sickness symptoms.

After she had completed the 10 sessions of VRET, her post-treatment assessments revealed that while her AQ and ATHI scores had decreased (AQ$_{Anxiety} = 48$, AQ$_{Avoidance} = 10$, ATHI = 29) compared to her pre-treatment scores, her AQ scores were still within the clinical average for acrophobia and resembled her scores during the screening assessment. She was able to climb the entirety of the staircase for her physical BAT, with her heart rate baseline set at 68, peaking to 104, and averaging at 95. Her SUDS at the base of the staircase was 0, and she rated her discomfort at 40 at the apex. Her VR BAT yielded similar results to her pre-treatment VR BAT, with her baseline heart rate set at 80, peaking to 98, and averaging at 84. Her SUDS at the base of the VE was 0 while her discomfort at the plank was 40, but she was able to walk to the edge of the plank. Throughout the 10 VRET sessions, her heart rate did not appear to indicate any changes (See Figure 3.1), as well as her sense of presence within the VE (See Figure 3.2). Aside from her first VRET session where she suffered from severe simulator sickness, her symptoms for subsequent sessions were low (See Figure 3.3).

![Figure 3.1: VR Exposure Heart Rate Graph (bpm = beats per minute)
Based on her post-treatment interview, she reported that she still felt increased heart rate when confronted with situations involving heights, but no longer felt the sweating and trembling from before. In response to an inquiry on which aspects of the treatment had resonated with her the most, she answered with the following:

“I used to get really dizzy and anxious before especially on a plane or while climbing stairs like those fire escape ones. I think right now I feel a lot better while doing these activities.”
I also see the difference in using VR because in the beginning I felt very dizzy and even sick whereas now I can use it for more than 30 minutes without any discomfort.”

Additionally, when asked to describe her experience with using the VR system, she responded with:

“I really enjoyed this experiment because I had the opportunity to use VR and learn more about technology. I am very interested in that part of psychology because it’s very different than what I do now and I would love to learn more. It’s a great way to test your abilities and see how you react to certain situations. I think it can be used as a form of therapy because it reminds me of a game.”

Christina’s 6-month follow-up assessments generally show that any treatment gains she made had been lost, with her AQ scores showing increases in both anxiety and avoidance (AQ\textsubscript{Anxiety} = 64, AQ\textsubscript{Avoidance} = 20). Both of her physical and VR BAT scores were similar to her pre-treatment BAT scores, with her physical heart rate baseline set at 85, peaking to 105, and averaging at 94, and her VR heart rate baseline set at 80, peaking to 96, and averaging at 89. SUDS for her physical BAT was 30 at the base of the staircase and 50 at the apex, while her SUDS for the VR BAT was the same as her post-treatment scores.

While her objective measures appear to show that she had made little to no improvement, especially when comparing her pre-treatment and 6-month follow-up assessments, her responses to the follow-up interview questions indicate that her subjective views towards her personal treatment gains as well as the self-directed process was positive overall.

4.2.2.2: The Case of Freddy

Freddy was a 39-year-old Caucasian male who attributed his acrophobia to a traumatic childhood event. Despite having been enlisted in the military where skydiving was an assigned task multiple times, he reports that he feels increased heart rate, sweating, trembling, upset stomach, and breathlessness when he is confronted with a situation involving heights in which he perceives that he has no control of
his descent (e.g. free falling without a parachute). He reports that he has been aware of his acrophobia for over 5 years, and while he enjoys some height-based activities, such as skydiving, he believes that his fear of heights is disproportionate to any perceived threat or danger, especially as he reports feelings of unease when standing over a ledge 4-6 feet (1.219-1.829 metres) above ground. Just like Christina, he has felt that he has missed out on opportunities in the past due to his acrophobia and had never sought treatment for it prior to registering for the present study. During the screening process, his AQ scores were within the clinical average (AQ\textsubscript{Anxiety} = 77, AQ\textsubscript{Avoidance} = 21), and there was a 3-month wait due to the same scheduling circumstances that Christina faced.

Freddy’s pre-treatment scores were slightly lower compared to his screening scores (AQ\textsubscript{Anxiety} = 64, AQ\textsubscript{Avoidance} = 13), but he scored a 48 on the ATHI, indicating that his attitudes towards heights were high degrees of bad, unpleasant, awful, dangerous, harmful, and threatening. For the physical BAT, Freddy was able to climb the entirety of the staircase, with his baseline set at 87, peaking to 115, and averaging to 107. His SUDS was rated at 40 at the base of the staircase and 70 at the apex. During the VR BAT, his baseline heart rate was set at 95, peaking to 108, and averaging at 102, with his SUDS being rated at 35 at the base of the VE and 80 at the plank. Just like Christina, he refused to step out onto the plank.

In total, Freddy would go on to complete 4 sessions of VRE \textsubscript{T} under the guided self-help approach, and there were no complications due to simulator sickness. As Freddy’s acrophobia was peculiar in that he was okay with certain height-based situations but not with others, a plan was set at the start of the first VRE \textsubscript{T} session to investigate what actions within the VE would cause him the most distress. For 5 minutes each, Freddy was tasked with gradually ascending while looking downwards using the Sky Brush mode, peering down the plank towards the ground while still in the elevator, and falling from gradually greater heights by making leaps from one platform to another with the Fire Deck mode. Towards the end of Session 1, it was discovered that the latter distressed him the most.
The goal set for Session 2 was for Freddy to be comfortable with finding a platform near the ground and leap off of it, gradually finding platforms located in taller areas as he felt more comfortable. This would be done in the Fire Deck mode, with leaps being performed by using rockets to boost himself off of the platform, and immediately toggling the rockets off so falling could occur within the VE. This would continue for each subsequent session, with each session’s goals being set for him to be able to leap from greater heights and freefalling to the ground. During his last session, he felt that he had made significant improvements and decided he was ready for the post-treatment assessments.

Post-treatment assessments revealed a dramatic drop for his AQ and ATHI scores ($AQ_{Anxiety} = 6$, $AQ_{Avoidance} = 0$, $ATHI = 12$) compared to his pre-treatment scores, and he was no longer within the clinical average for acrophobia. He was able to climb up the entirety of the staircase for his physical BAT, with his baseline heart rate set at 95, peaking to 120, and averaging at 107, and he rated his SUDS at the base of the staircase as 13, and 20 at the apex. For his VR BAT, his baseline heart rate was set at 88, peaking at 105, and averaging at 98, with his SUDS rating being 8 at the base of the VE, and 12 at the plank where he was able to successfully walk to the edge of the plank. Throughout his 4 sessions of VRET, his heart rate remained relatively similar (See Figure 3.4), as well as his sense of presence (See Figure 3.5), and simulator sickness symptoms (See Figure 3.6).
It should be noted, however, that prior to beginning the VRET sessions, Freddy reported that he has had a history of heart-related health issues, therefore it is unclear whether his heart rate is a reflection of his experiences during VRET or due to his overall health. During his post-treatment interview, while he reported that he still feels increased heart rate, sweating, trembling, and breathlessness when confronting situations involving heights, he attributes these feelings as a physiological response to exhilaration rather
than fear, likening it to the sensations he felt when skydiving. When asked to describe his experience with using the VR system, he believed that the VR system was a “fantastic piece of equipment to use,” while also believing that the VR system allowed him to “feel relaxed about the height and evaluate the actual treat rather than the visual one.”

Freddy’s 6-month follow-up assessment generally showed that he was able to maintain his treatment gains ($AQ_{Anxiety} = 0$, $AQ_{Avoidance} = 0$, $ATHI = 15$). For his physical BAT, he was able to climb the entirety of the staircase with a baseline heart rate set at 103, peaking at 119, and averaging at 114 while rating his SUDS as 0 at both the base and apex of the staircase. His VR BAT was also consistent with his physical BAT, with his baseline heart rate set at 102, peaking at 108, and averaging at 103, and his SUDS ratings were also 0 at both the base of the VE and the plank where he successfully walked towards the edge without hesitation. Aside from his heart rate data, both objective and subjective measures demonstrated that the guided self-help VRET approach was effective in treating Freddy’s acrophobia symptoms.

4.2.2.3: The Case of Marshall

Marshall was a 36-year-old Caucasian male who was unable to attribute any situation in his life to his development of acrophobia but has avoided activities such as skydiving and bungee jumping as well as fairgrounds due to his fear of heights. He has been aware of his fear of heights for over 5 years, reporting symptoms such as increased heart rate, dizziness, nausea, sweating, upset stomach, and breathlessness when confronted with situations involving heights. He believes that his fear of heights is disproportionate to the perceived threat or danger, never sought treatment prior to registering for the present study, and believes he has missed out on opportunities in the past due to his acrophobia.

As Marshall was a part of the waiting list condition, his screening process was integrated with the pre-experimental phase as the 3-month waiting period that occurred for both Christina and Freddy would have been approximately the same amount of time that would have elapsed between the pre- and post-
treatment assessments. This was done by first administering the AQ to check for eligibility, followed by the ATHI and physical BAT within a week after eligibility had been confirmed. Marshall’s screening/pre-treatment AQ scores were within the clinical average (AQ\textsubscript{Anxiety} = 76, AQ\textsubscript{Avoidance} = 17) and had a score of 28 on the ATHI, with the latter representing a more negative view of heights. For his physical BAT, he was able to climb the entirety of the staircase, with his baseline heart rate set at 92, peaking to 127, and averaging at 117 with a SUDS of 70 at the base and 80 at the apex. His post-treatment scores at the end of the 12-week period were generally higher compared to his screening/pre-treatment scores (AQ\textsubscript{Anxiety} = 93, AQ\textsubscript{Avoidance} = 26, ATHI = 48). He was able to climb the entirety of the staircase again for the physical BAT, with his baseline heart rate set at 105, peaking to 131, and averaging at 120 with a SUDS of 60 at the base and 80 at the apex. Marshall was given the opportunity to take part in either the pure self-help or guided self-help VRE sessions of his choice following post-treatment assessments. While he initially chose the guided self-help approach, he was unable to complete more than a couple of sessions due to scheduling conflicts.

4.3: Discussion

The primary goal of the present study was to examine whether general VR experiences that, while not specifically designed for, could be used for therapeutic purposes with the specific aim of addressing symptoms of acrophobia. VR’s capability of displaying depth, which has rarely been capable on a singular screen (e.g. Nintendo 3DS) makes the medium perfect for displaying height-related stimuli, and as VR HMDs like the HTC Vive and Oculus Rift are becoming more affordable and accessible, users may inevitably come across objects and stimuli that they are afraid of within the VE. This study demonstrated one such situation in which participants were tasked with freely interacting with a popular, affordable, and accessible program that featured height-related stimuli demonstrated to elicit fearful and anxious reactions from all of the patients in the present study. While the findings from this study are not generalizable due to the nature of its case study approach, the findings do demonstrate some of the
variability and obstacles that may occur from VR-based self-directed therapeutic approaches that are concurrent with findings from the VR therapeutic and self-directed intervention literature. In short, findings from this study reflect the first step towards establishing and refining self-directed VRET.

Overall, results from both Christina and Freddy’s treatments are positive in favour of the use of VR as a therapeutic tool. Both experienced some level of improvement from pre- to post-treatment assessments based on established measures such as the AQ and ATHI, as well as reporting that they both subjectively believed that the treatment had worked to alleviate their acrophobia symptoms. Although this improvement was not reflected in Christina’s objective measures, both her interview responses and her ability to walk on the virtual plank during the post- and 6-month follow-up assessments demonstrated some notable progress. Meanwhile, Marshall’s acrophobia symptoms appeared to have worsened over the course of the 3-month waiting period, whereas Christina’s symptoms appeared to have objectively worsened only after post-treatment. This would indicate that, at some level, the self-directed VRET was effective.

One of the major limitations of this study is that, as the experimenter was not a trained and licensed therapist, measures commonly used in other studies such as the Clinical Global Improvement (CGI) scale, which is a subjective rating of treatment progress and response administered by a clinician (Busner & Targum, 2007), could not be used as the experience needed to effectively implement the CGI, or a qualified clinician, was not available for the study. Furthermore, while biometric measures such as heart rate have been used in numerous studies to gain an insight on any biological changes that may occur throughout the treatment process, heart rate did not reveal anything in particular for the present study. In the physical BAT, heart rate could be naturally assumed to rise as the patient is climbing the stairs, therefore it is not entirely certain if the peak heart rate exhibited by each patient was either due to their acrophobia or physical exertion. For Freddy, heart rate was also not an indicative measure due to heart issues he had been diagnosed with long before he had registered for the study. Despite these limitations,
the present study posits that the subjective belief of the patient is more important than objective measures; even if quantified self-report and biometric measures indicate clinically significant change, treatment is not successful until the individual feels significant improvements compared to their state prior to beginning treatment.

Due to the nature of the case study methodology, another limitation of the present study is that the findings are not generalizable for a larger population. Initially, there were plans to recruit more patients to be a part of the study, but only a few had either registered or expressed interest. Part of the struggle of recruiting individuals for the present study could be attributed to the nature of self-directed interventions; the therapeutic approach is not for everyone, especially for individuals that may not have a high self-motivation to begin and complete the treatment (Öst et al., 1998). Low patient registration was partially anticipated due to this notion and its strict qualification prerequisites, and while a case study methodology was the best fit for the present study due to this and the novelty of the approach, future research should consider examining a larger clinical population to better evaluate the efficacy of self-directed VRET.

Despite these limitations, the findings from this study open the possibility for the use of VR games to carry out self-directed interventions for specific phobias. Gaming and exposure therapy already share many of the same processes, such as difficulty progression (i.e. gradually increasing the intensity of the challenge or obstacle), interactivity, and goal setting (Lohse et al., 2013), but by using a VR game rather than a program specifically designed for systematic desensitization of the specific phobia, VR users would be able to encounter their phobic objects and situations naturally within the VE. For example, both The Lab: Longbow and Arizona Sunshine have scenarios that position players atop certain heights, albeit less than what Richie’s Plank Experience depicted; The Lab: Longbow had the player shoot enemies from a small tower, while Arizona Sunshine has a scenario early in the story campaign where the player would need to cross a bridge while shooting zombies. If continual and repeated exposure to one’s object of
phobia will eventually attenuate it, perhaps it is possible that the inviting and appealing nature of video gameplay can subtly implement this process. While this represents a less systematic approach compared to traditional VRET, in-vivo, and in-vitro exposure approaches, the findings from the present study suggests that it is possible for individuals to experience some level of improvement from VR exposure alone.

Chapter 5: Examination of the Effects of Violent VR Gaming on Cyber Aggression (Study 2)

In Study 1, the stimuli used for the self-directed VRET procedure stemmed from a commercial VR application that was not designed for therapeutic used, and by combining the VR stimuli with a basic understanding of the rationale behind exposure therapy, both treatment patients were able to achieve some level of improvement in relation to their acrophobia symptoms, albeit more subjectively than objectively. As the stimuli from Richie’s Plank Experience was sufficient to elicit phobic responses from each of the three patients, Study 1 went on to posit that VR games may serve to better introduce therapeutic elements and allow VR users to come across the object of their phobia via gamified scenarios. As VRET often relies on systematic desensitization, however, it is important to investigate whether other aspects of the VR user’s behaviour would also be desensitized alongside the targeted phobia-related symptoms. Specifically of interest is aggression, as there has long been an argument as to whether video games can significantly lead to increased aggressive behaviours; if VR games are to be used for therapeutic purposes in the same vein as Study 1, a proper risk assessment of potential consequences of using commercial VR games is needed.

The purpose of this chapter is to examine the effects of violent VR games on cyber aggression, defined as offensive, derogatory, harmful, or unwanted acts delivered through social networks, Internet forums, or any technology-based communication device (Grigg, 2010). Prior to this examination, this chapter will outline the general argument of whether video games can contribute to the development
and facilitation of violent and aggressive behaviours. Specifically of interest are the major underlying theories behind the two main sides of the argument (those who believe that video games is a causal influence to heightened violent and aggressive behaviours, and those who do not), as well as the methods used to measure an individual’s level of violence or aggression. The present study seeks to address some of the long-standing issues prevalent in the established violent video game literature, exemplified through the formulation of an explicit measure of cyber aggression and the use of a multi-week semi-longitudinal controlled experimental design. The aims of this chapter are to outline:

1. The general violent video game argument and the two competing theories
2. The variations of trolling
3. The effects of VR gaming on cyber aggression

5.1: Introduction
Over the course of nearly three decades, there has been a fierce debate as to whether violent content in video games are a causal source of aggressive behaviours in its players, or if video games are a harmless form of entertainment regardless of its content (Elson & Ferguson, 2014). In academia, the term aggression is used to refer to behaviour with the intent to harm someone physically, psychologically, or socially (i.e. relational). The term violence, however, contrasts itself from aggression by referring to an explicit act of physically harming someone to inflict a major injury or death, therefore it does not typically cover psychological or relational harm. These definitions for aggression and violence establish the foundation in which the violent video game literature revolves around; while all violence is aggressive, not all aggressions are violent (Anderson & Bushman, 2001; Bushman, Gollwitzer, & Cruz, 2015).

Early research into the causal influence of violent video games on player aggression largely focused on children and adolescents, and researchers typically concluded that video games caused an increase in aggressive behaviours while diminishing prosocial behaviours (Anderson, 2004). In a meta-analysis on 44 studies, Anderson (2004) went as far as to claim that violent video games were a public
health risk, equating the effect of violent video games on player aggression being greater than the use of condoms to diminish the risk of contracting human immunodeficiency virus (HIV), the link between being exposed to passive tobacco smoke and lung cancer, and the relationship between calcium intake and bone mass. Recent studies, however, have posited a contrary claim that violent video games have no such influence on aggressive behaviours, citing a plethora of methodological issues that impairs the quality of the findings established by studies that advocated towards the causal nature of video games. These issues include a failure to conduct pre-test or baseline assessments, comparing games without accounting for mismatched features (e.g. difficulty, engagement/enjoyment, narrative context of the violence, etc.), lack of clinical validity, and selective interpretation (Ferguson, 2015). Perhaps the most detrimental factor that invalidates the findings set by the studies advocating towards the causal side is the lack of using baseline measurements to compare with post-test measurements; the causal nature of an object cannot be observed if an initial baseline measure is not present to be compared to a post-test measure, and to infer a causal relationship without doing so is bad science. Nevertheless, this debate has led to an increasingly clear divide within the academic community: those who view video games as a public safety threat (i.e. causationalists or advocates of the harm view), and those who do not (i.e. sceptics or advocates of the harmless view; Elson & Ferguson, 2014; Ferguson et al., 2015).

This debate has a few major implications outside of the academic community, as video games are a multi-billion-dollar industry worldwide with consumers spanning nearly all ages (Markey, Markey, & French, 2015). Concern over the violent content in video games have already led to the creation of rating boards for different territories across the world, such as North America’s Entertainment Software Ratings Board (ESRB; Funk, Flores, Buchman, & Germann, 1999; Markey et al., 2015), the European Union’s Pan European Game Information (PEGI; Van Rooij, Meerkerk, Schoenmakers, Griffiths, & Van der Mheen, 2010), Japan’s Computer Entertainment Rating Organization (CERO; Jeong, Biocca, & Bohil, 2012), and the Australian’s Office of Film and Literature Classification (OFLC; King, Delfabbro, Derevensky, & Griffiths, 2015).
The purpose of these organizations is to evaluate the content within a game and to assign an appropriate age rating to inform potential buyers and players, which can be used to restrict sales to individuals who fall below a certain age. This is exemplified by the ESRB’s M-rated games that indicate mature content (graphic violence, gore, sexual content, etc.) that cannot be sold to individuals under the age of 17 without someone 18 or older present. In certain regions, most notably Australia, if a game is deemed too violent or vulgar (e.g. explicit sexual content or derogatory depictions), the ratings board can refuse to classify the game, or the game developer can choose not to get the game classified—both options would inevitably block the game from being legally sold in the region and would effectively be a banned game (King et al., 2012). The ratings boards exemplify a vested political interest by both politicians and political organizations (e.g. National Rifle Association; i.e. NRA) alike, both of whom may seek to establish more regulations on the video game industry (e.g. completely prohibiting minors under the age of 18 from playing games with mature content), or use strawman tactics to infer that violent video games serve as a causal antecedent to a violent action to deviate from a more sensitive issue (e.g. gun control measures), the latter of which has become an increasingly common occurrence after a tragic event unfolds (e.g. Sandy Hook Elementary School shooting; Ferguson, 2015).

In a broader context, the study of violent video games is a part of a larger study on the effects of violent media, which includes music, television, film, and Internet activities. The concept of a ratings board was an inevitability for video games, as there was a precedent for television shows and movies to have an extensive rating system based on age. In 1968, the United States formed the Classification and Ratings Administration (CARA), and ratings from the ESRB bear a striking resemblance to the ratings from CARA. For example, an ESRB rating of “E for Everyone” and “AO18+ for Adults Only” had similar specifications to CARA’s rating of “G for General Audience” and “NC-17 for No Children 17 and Under,” respectively; although there are some slight variations, lower tier ratings representing content that was perceptually appropriate for all ages allowed the same level of violent content, profanities, and sexual depictions, while
extreme depictions of violence and sex were reserved for the strictest ratings (Funk et al., 1999). Furthermore, prior to the violent video game debate, there was already literature examining whether violent media could influence aggressive behaviours within children, and the consensus of the literature largely attributed greater exposures to violent media to an increase in aggressive behaviours (Bartholow & Anderson, 2002).

Although the violent video game literature does stem from the general violent media literature, video games are different from other forms of media, mainly due to the interactive elements of video games and the incentives the game places on performing or achieving certain actions (e.g. reaching a certain combo of hits in a fighting game to deal more damage to the opponent; Funk & Buchman, 1996). In relation to violent content, whereas television shows and movies are passively consumed, meaning that no matter what the viewer does, the events in the shows and movies do not change, video game players are active participants and can perform violent actions (e.g. killing an enemy combatant) while being rewarded in some way for doing so (e.g. gaining a higher score for the leader board or obtaining in-game loot). Under this notion, the violent video game literature has often looked at this active participation and reward structure as incrementally facilitating aggressive behaviours outside of video game play (Funk et al., 1999).

5.2: General Aggression Model vs. Catalyst Model: A Nature vs. Nurture Debate

The violent video game argument shares many similarities with the classic nature vs. nurture debate, with the debate revolving around whether predispositions (i.e. nature) or experiences (i.e. nurture) have the most influence on an individual’s growth throughout life. This is exemplified by the 2 main theories of aggression used in the violent video game literature, with the General Aggression Model (GAM; Bushman & Anderson, 2002) used by advocates of the harm view and reflecting the nurture side, and the Catalyst Model (CM; Ferguson, Rueda, Cruz, Ferguson, Fritz, & Smith, 2008) used by advocates of the harmless view and reflecting the nature side. While both models of aggression do account for some
aspect of both the nature and nurture side of aggressive behaviour, each model places more weight on one side of the argument to interpret whether video games may contribute to influencing one’s aggressive tendencies.

5.2.1: General Aggression Model

The GAM is a proponent of Bandura’s (1978) social learning theory (SLT), which posits that aggression is due to vicarious or indirect learning (i.e. modelling), therefore aggression is learned through imitation and not innate. The SLT, in conjunction with other socio-cognitive theories that focuses on evaluating the causes of aggression (e.g. frustration-aggression theory, cognitive neoassociation theory, script theory, etc.) form the basic principles of the GAM. The GAM takes and compiles components of these socio-cognitive theories and forms a feedback loop that consists of 3 stages: inputs from personal (e.g. sex, personality traits, beliefs, etc.) and situational (e.g. aggressive cues, incentives, etc.) variables, which leads to changes in present internal states (i.e. affect, cognition, and arousal), resulting in outcomes due to the appraisal and decision-making processes based on the present internal states, which then leads into the input variable stage for the process to repeat again (DeWall, Anderson, & Bushman, 2011). In relation to the influence of violent video games on aggression, violent video games serve as a situational input variable, which incrementally reinforces aggressive cognitions, affect, and arousal, which ultimately lead to an outcome of aggressive behaviours after repeated exposures (Bushman & Anderson, 2002). Although personal variables are accounted for within the GAM, the variables have a much lesser emphasis compared to situational variables (Ferguson & Dyck, 2012).

DeWall et al. (2011) advocated for the GAM as a means to explain the development of aggressive behaviours outside of both violent video game and controlled laboratory settings, which included topics such as intimate partner violence, intergroup violence, the link between global warming (i.e. climate change) and violence, and suicide. Under the premises posited by the GAM, the development of intimate partner violence considers both personal (e.g. attachment style, substance abuse, trait anger, etc.) and
situational (e.g. alcohol, provocation, insults, etc.) factors that may lead to hostile cognitions and affect, which may ultimately lead to violence against one’s significant other. The development of intergroup violence can be explained in the same way as intimate partner violence, but group input variables (e.g. collective motivations, beliefs, etc.) would be substituted for the personal input variables. Global warming, however, primarily focuses on the situational input variables (e.g. rise in temperatures), as heat may make individuals more susceptible to behaving more aggressively. Lastly, suicide can be considered as a form of self-violence, therefore the individual’s present internal states of affect (e.g. internalized anger, depression, etc.), cognition (e.g. suicidal ideations), and decreased arousal to pain or distress may lead the individual to attempt or successfully commit suicide.

While DeWall et al. (2011) presented a qualitative evidence to support the GAM, there have been some studies that demonstrated more quantitative evidence to demonstrate the versatility and applicability of the GAM. Specifically, the model has been useful for evaluating the relationship between aggression and economic distress (Barlett & Anderson, 2014), personality disorders (Gilbert & Dafern, 2011), and peer rejection (Plaisier & Konijn, 2013). Combined with the examples provided by DeWall et al. (2011), these studies collectively demonstrate the notion that the GAM has a strong external validity in terms of evaluating the development of aggressive tendencies outside of the context of violent video games.

5.2.2: Catalyst Model and the Catharsis Hypothesis

Whereas the GAM promotes the notion that aggression is learned and reinforced over time, the CM posits that aggressive behaviour is based on innate predispositions, therefore exposure to violent content is correlational to aggressive behaviour, not causal. CM operates under the diathesis-stress approach, which posits that individuals who are vulnerable to certain behaviours (e.g. hostility; Raghavan, Le, & Berenbaum, 2002) or disorders (e.g. schizophrenia; Walker & Diforio, 1997) may exhibit those behaviours or disorders when exposed to certain situations or environments (e.g. stress; Raghavan et al.,
In the context of general aggression, the diathesis-stress approach is supported by past studies that have linked genetic factors to antisocial personalities and violent criminal behaviour (Ferguson et al., 2008).

Within the CM, violent video games are considered as a stylistic catalyst, one in which an individual prone to aggression or violent behaviours may model their own behaviours to match what they have seen within the game. As a stylistic catalyst, violent video games serve as an example of how aggressive and violent acts can be performed (e.g. shooting others with a projectile-based weapon, using a chainsaw to cut down targets, or repeatedly bashing someone’s face into concrete), but cannot induce the desire to perform the actions observed or performed within the game as that desire already exists innately. Under this premise, if violent video games were not present around those that are predisposed towards aggression, the individual may still act in an aggressive or violent matter, but the actions would take on another form based on other observed acts of aggression or violence (Ferguson et al., 2008). Furthermore, it should be noted that the CM frames criminal behaviour as a behavioural disorder rather than an outcome, which further differentiates the theory from the GAM (Ferguson, Ivory, & Beaver, 2013).

Like the studies advocating the nature side of the nature vs. nurture debate, evidence that supports the CM stem from twin studies and studies on genetic predisposition. For instance, suicide is in part modulated by genetic factors, which has been confirmed by both twin and adoption studies (Turecki, 2001). Mice studies have also shown that lower density of serotonin receptor gene expressions, specifically 5-HT\textsubscript{1A}, led to an increase in aggressive behaviours, while higher densities of this expression were more prevalent in non-aggressive mice (Popova, 2008). Furthermore, it was also found that dopamine D2 receptors (DRD2) that code for lower dopaminergic functioning resulted in heightened sensation seeking, which was found to be predictive of higher levels of aggression (Chester et al., 2015). Ilchibaeva, Tsybko, Kozhemyakina, Konoshenko, Popova, and Naumenko (2017) also found that different forms of aggressive behaviours (e.g. defensive, predatory, and asocial) have similar innate, underlying
mechanisms. Together, these studies suggest that aggressive behaviours can be attributed to genetic influences.

An alternate view of the CM is the Catharsis Hypothesis, but while the Catharsis Hypothesis is not as developed as both the GAM or the CM, the Catharsis Hypothesis posits that individuals seek out violent media to displace their aggressive urges in a more socially acceptable way. In relation to violent video games, individuals may use these types of games to release their aggressions by performing violent acts within the game rather than to express their aggressions against other people or objects. This is supported by evidence that boys feel less aggressive, less angry, and generally calmer after playing a violent video game (Olson, Kutner, & Warner, 2008). Unfortunately, there has not been as much research in terms of the relationship between playing video games and catharsis, therefore the two main competing theories within the violent video game literature presently are the GAM and CM (Ferguson & Rueda, 2010).

5.2.3: Criticism of the General Aggression Model and the Catalyst Model

The CM was generally developed as a response to address some of the perceived shortcomings of the GAM. Although the GAM includes a component that considers personal input variables, the use of the GAM in relation to violent video game research has largely ignored these variables in favour of the situational input variables brought upon by the violent content within these games (Ferguson & Dyck, 2012). This alone does not discount the GAM as a bad or inaccurate model of aggression, but rather, an incorrect use of the model by researchers who derive findings without accounting for other personal and situational variables, such as gender or game mechanics, respectively. Furthermore, there lies a potential bias when using the GAM to explain potential developments in aggressive behaviours due to video games, as the creators of the GAM, Bushman & Anderson (2002), are also the leading advocates of the harm view.

Advocates of the harmless view often criticize the GAM’s inability to explain aggressive behaviours, as the advocates of the harm view often infer aggressive behaviours from experimental measures rather than directly observing the behaviours; to attempt the latter is an ethically sensitive
minefield after all. At its core, the GAM is a cognitive model that explains how aggressive cognitions, affect, and arousal can develop over time via learning processes and repeated exposures to violent content. This model ultimately infers—not explains—that as a person develops an internal state more facilitative of aggression, their behaviours and actions will follow suit (Liu, Lan, Teng, Guo, & Yao, 2017). Although there is indeed a likelihood that internal states of aggression can lead to aggressive behaviours, other factors would have to be examined alongside the individual’s internal state, such as competing reinforced cognitions (e.g. seeing aggression being rewarded in one context but punished in another context).

The CM, while much newer than the GAM, has its own limitations. As it is based on the notion that aggression stems from genetic predispositions, it is a difficult model to test in a general experimental setting (Breuer, Vogelgesang, Quandt, & Festl, 2015). As the GAM is a compilation of several established theories of aggression, the CM also appears to pale in comparison in terms of its theoretical foundation. This can be rectified in part by assessing more accessible aspects of supposed predisposition, such as personality traits, rather than attempting to assess more difficult factors, such as genetic predisposition. Nevertheless, more research would be needed to validate the CM to the same degree as the GAM.

5.2.4: Methods and Issues of Evaluating Aggression
Discounting the limitations of the overarching theoretical foundations of the violent video game literature, there are still issues when taking the experimental measures of aggression into consideration. The main concern revolves around the direct measure or observation of physical aggression; to potentially goad someone into performing acts of physical aggression carries many potential ethical and safety concerns. To work around this obstacle, researchers have utilized a few different methods to evaluate aggressive behaviours, such as the Retaliation Reaction Time Task (RRTT; i.e. Taylor Competitive Reaction Time Test; Adachi & Willoughby, 2011; Taylor, 1967), hot sauce paradigm (HSP; Lieberman, Solomon, Greenberg, & McGregor, 1999; Yang, Gibson, Lueke, Huesmann, & Bushman, 2014), or self-report and
physiological measures that are believed to be related to aggression to infer future aggressive behaviours (e.g. anger, heart rate, etc.; Ballard, Visser, & Jocoy, 2012; Lull & Bushman, 2016). Although there are a few other methods to measure aggression within the general study of aggression (e.g. bungled procedure paradigm, experimental graffiti, and teacher/learning paradigm; Ritter & Eslea, 2005), the RRTT, HSP, and self-report and physiological measures are the most commonly used methods in the violent video game literature.

5.2.4.1: Methodological Issues of Measuring Aggression

The RRTT is performed in two phases, and participants are led to believe that they are playing a competitive game based around reaction time against another player. The goal of the task is to click a button as fast as possible in response to an audio cue, and if the winner was in control of a punishment apparatus (the winner can set the intensity of a sound blast or electrical shocks before administering the punishment to the user. For the punishment apparatus, the opponent was given control during the first phase, while the participant was given control of the apparatus during the second phase (Bartholow & Anderson, 2002; Gabbiadini et al., 2014; Ritter & Eslea, 2005). All trials during this task were predetermined in terms of wins and losses, set in a randomized order, and the intensity and duration of the punishment made by the participant towards their opponent served as an indication of the participant’s level of aggression.

For the HSP, although there are a few variations on how the task is presented to the participants, the general premise mirrors the RRTT. In the HSP, a confederate would explicitly inform the participant of their dislike of spicy foods, which can be conveyed verbally (Ritter & Eslea, 2005) or via a survey on food preferences that is exchanged between the participant and confederate (Yang et al., 2014). In a standard HSP to study general aggression in which video games were not involved, the confederate would have provoked the participant prior to the task, but studies investigating the effects of violent video games utilized the task by framing it as a separate study on food preferences following exposure to the violent
content. Participants were able to choose how much hot sauce to give to the confederate while knowing that the confederate had to consume all of it, and the amount of hot sauce given served as an indication of the participant’s aggressive behaviour (Ritter & Eslea, 2005; Yang et al., 2014).

Although these measures have been used throughout many studies in both the general aggression and violent media literature, some researchers have voiced concerns over the validity of these measures in terms of measuring aggression. Adachi and Willoughby (2011) questioned the participant’s motivations during an RRTT task, as their actions could be construed as a product of competition rather than aggression; by inflicting a highly intense punishment for losing, the participant may believe that he or she can gain an advantage for subsequent trials. Ritter and Eslea (2005) also supported this notion, but added that it can be possible that participants may also be acting on reciprocity in addition to deterring their opponent as a source of motivation for delivering higher punishments. Furthermore, competition was shown to have influenced outcomes from the HSP, therefore findings using these methods may not necessarily be attributable towards aggression, but to extraneous variables (Adachi & Willoughby, 2011). It is also important to note that these measures of aggression are typically dedicated to observing or inferring physical aggression rather than relational aggression, the latter of which is more prevalent in women while the former is exhibited more by men (Crick & Grotpeter, 1995). Self-report and physiological measures can potentially account for more relational aggression and physical aggression, but changes in the participant’s affect, cognitions, and arousal may not necessarily infer aggressive behaviours or the intent to carry out aggressive actions (Elson & Ferguson, 2014).

5.2.4.2: Evaluation Issues for Violent Content in Video Games

Issues concerning measures of aggression also extend to the aggressive and violent acts found in video games. Classification of a media form as violent is indiscriminate in terms of how the aggression or violence is portrayed, whether depicted with realism (e.g. gore and blood splatter after being shot) or cartoonish textures (e.g. jumping on the head of a walking mushroom). Certainly, this definition of
violence would classify most video games as violent, but this definition would equate a game’s violent content rated appropriate for kids by a regional games rating board (e.g. *Super Mario, Pokémon*, etc.) with games geared more towards a mature audience (e.g. *Assassin’s Creed, Mortal Kombat, Call of Duty*, etc.; Markey et al., 2015). Additionally, the violent video game literature has largely ignored the complex nature of games as a form of entertainment that incorporates various elements together for a cohesive, interactive experience (e.g. narrative, competition/cooperation, and context for any action performed in the game). Failing to take this notion into account when designing a study poses a risk for confounding variables, especially when the sole purpose of a study is to classify games as a causal source of violence and aggression (Elson & Ferguson, 2014).

Games are indeed becoming increasingly sophisticated in terms of gameplay mechanics and storytelling, and some of the most popular games today exemplify the complexity of it all when attempting to classify games and differentiating between various forms of violence. For example, the first-person shooter (FPS) *Overwatch* is a 6 vs. 6 game in which players compete to capture a point, move a payload to a designated point, or complete both objectives sequentially. This game incorporates both cooperative (e.g. coordinating with teammates) and competitive (e.g. taking an objective from the enemy team) components, which can be further broken down when considering the player’s role in a team (e.g. damage dealer, tank, or support). Damage dealers are perhaps the most violent role to play, as their goal is to deal as much damage and kill as many players from the enemy team as possible. Tanks, however, carry a balance between shielding and absorbing enemy damage to protect their team and occasionally deal minor damage, therefore while tanks can be violent, their role is not as violent as the main damage dealers. Supports, on the other hand, are primarily non-combatants, as their goal is to heal their team or provide crowd control effects (e.g. slowing or stunning an enemy) rather than to confront the enemy. Even with these defined roles, players can approach each role as they see fit; a damage dealer can simply run into the enemy team and die without firing a shot, a tank can opt to not deal any damage at all and
instead choose to primarily shield against enemy attacks, and a healer can use their limited combat capabilities (e.g. punching or low-damage weapons) rather than healing their teammates or activating crowd control abilities.

This sort of gaming structure can also be observed in massive online battle arenas (MOBAs) such as League of Legends and Defense of the Ancients 2 (DotA 2). Although this is certainly not a feature in all games, even the gameplay in the most notoriously violent games, such as the Grand Theft Auto series, incorporates non-violent content that the player can opt to play through rather than performing violent actions (Lull & Bushman, 2016). These examples illustrate the need for context behind the aggressive actions performed within a game, whether it is a justified form of violence (e.g. self-defence or killing to save someone) or unjustified (e.g. indiscriminately shooting civilians or non-combatants). By ignoring the different gameplay mechanics and moment-to-moment situations behind each game (e.g. eliminating enemies for a high score, or eliminating enemies to complete an assigned mission objective) as well as the motivations behind the player’s approaches towards the game, and instead focusing solely on the aggressive actions performed and depicted within the game, video game research findings may be invalidated based on the many potentially unaccounted confounding variables.

5.2.5: Evaluation of the Violent Video Game Literature

As scepticism began to contest the positions laid out by those that advocated the harm view, researchers have sought to re-evaluate the relationship between aggressive behaviours and violent video games. Some of the outcomes that were researchers sought to investigate included physiological (e.g. voice stress; Hasan, 2017), perceptual (e.g. judgments of offensiveness; Coyne, Callister, Gentile, & Howard, 2016), cognitive and behavioural (e.g. emotional memory, self-control, and cheating; Bowen & Spaniol, 2011; Gabbiadini et al., 2014), and neurological outcomes (Gentile, Swing, Anderson, Rinker, & Thomas, 2016) alongside crime data on violence (Markey et al., 2015; Surette & Maze, 2015). These outcome measures were done as an alternative to the RRTT and HSP, but other researchers also evaluated
potential mediators and external variables such as motion controls (Charles, Baker, Hartman, Easton, & Breuzberger, 2013), sensory realism (Jeong et al., 2012), competitiveness (Anderson & Carnagey, 2009), sex differences (Bartholow & Anderson, 2002), and narrative context (Mahood & Hanu, 2017; Sauer, Drummond, & Nova, 2015). There were also some studies that opted to use more traditional comparisons for variables such as affect (e.g., anger and hostile feelings; Kneer, Elson, & Knapp, 2016; Lull & Bushman, 2016; Valadez & Ferguson, 2012), emotional desensitization (Arriaga, Monteiro, & Esteves, 2011), and prosocial adjustment (Przybylski & Mishkin, 2016). As there have been numerous studies dedicated towards researching the potential influence of violent video games on violence and aggression, several meta-analyses have also been conducted, with some finding evidence that supported the harm view (Anderson, 2004; Anderson et al., 2010; Greitemeyer & Mügge, 2014), others that found evidence supporting the harmless view (Breuer et al., 2015; Elson & Ferguson, 2014; Ferguson, 2015), and some finding evidence that supports both views to an extent (Sherry, 2001). Although there was a large overlap in terms of the studies included in each of the meta-analyses, the interpretations of the meta-analytic results differed despite observing similar findings.

Although meta-analyses cannot imply causation, the research methodology can provide a thorough, comprehensive overview of the literature and the findings from each individual study included in the analysis, but there are some differences between and within each side of the violent video game argument in relation to the focus of the contents within the meta-analyses. One of the main points of contention to exemplify this is the interpretation of effect sizes. Anderson (2004) observed a mean effect size ($r+$) of 0.26 for the exposure to violent video games on aggressive behaviours, which indicates a statistically small, but near medium, effect size ($r_{\text{small}} = 0.10$, $r_{\text{medium}} = 0.30$, $r_{\text{large}} = 0.50$). This is slightly larger than the other meta-analyses that interpreted their findings in favour of the harm view, as Greitemeyer and Mügge (2014) found an effect size of 0.18, while Sherry (2001) had calculated an effect size of 0.15. This is further undercut by the meta-analyses that interpreted their findings in favour of the
harmless view, with Ferguson (2015) outputting 2 r+ values, one for studies that had controlled effect sizes \((r+ = 0.06)\) and one for studies that used bivariate effect sizes \((r+ = 0.14)\) when evaluating the effect of violent video games on aggressive behaviours. While those that advocate for the harm view may interpret these effect sizes as significant, even the largest effect size calculated by Anderson (2004) did not meet the threshold to pass as a medium effect size.

Despite these small effect sizes, the interpretations of their significance were still polarized by the competing sides. Sherry (2001) converted his effect size calculation to a Cohen’s \(d\) value to compare it with other studies that used the same metric, which resulted in a small effect size of \(d = 0.30\) \((d_{\text{small}} = 0.20, d_{\text{medium}} = 0.50, d_{\text{large}} = 0.80)\), an effect size that was much smaller than the effect size of televised violence on aggression \((d = 0.65;\) Paik & Comstock, 1994). Anderson (2004) posited that while the observed effect sizes were relatively small, under the premises established by the GAM, the small effects of the violent content in video games would accumulate to greater effects with repeated exposure over time. Ferguson (2015) argued, however, that when considering multivariate effects rather than bivariate effects, any effects from playing video games may be due to other factors rather than the exposure to the violent content. These disagreements hold true without regard to the study types analysed within the meta-analysis (e.g. experimental, cross-sectional, and longitudinal), and is further evident when comparing the meta-analyses from harm view advocates Anderson et al. (2010), and harmless view advocates Elson and Ferguson (2014).

As a method to understand a more general impact of violent video games and criminal aggression, Markey et al. (2015) ran four correlational analyses:

1. Video game sales and violent crime from 1978 to 2011
2. Violent game sales and violent crime by month from 2007 to 2011
3. The sales of extremely violent and realistic video games to violent from 2004 to 2011
4. The sale of 3 popular violent video games (Grand Theft Auto: San Andreas, Grand Theft Auto IV, and Call of Duty: Black Ops) to violent crime

If violent video games were a causal source for an increase in aggressive and violent behaviours, Markey et al. (2015) contended that there should be a rise in reported violent crimes following the sales of violent video games. Findings from all 4 analyses generally concluded that the sales of violent video games were not correlated with violent crime, nor did it contribute to violence within the United States. Additionally, the trends from each of their analyses suggested that there were decreases in aggravated assaults and homicides as sales of video games increased, which may serve as evidence supporting the Catharsis Hypothesis. Markey et al. (2015) did acknowledge, however, that their study was correlational, and just like meta-analyses, their study was incapable of implying or identifying causation; the data examined in the study could neither disprove that violent video games causes an increase in criminally aggressive behaviours, nor can it demonstrate that violent video games are a completely harmless form of entertainment. It can, however, indicate that violent video games may not have as much of an impact on criminally aggressive behaviours over time as the studies advocating the harm view have been led to believe. Additionally, the modern political climate has highlighted the potential possibility that aggressive behaviours, especially sexually motivated aggression (e.g. rape, sexual assault, etc.), have gone unreported, therefore the data that was examined may not have a complete view of how aggressive individuals may be.

It should be noted that while there has been an extensive amount of criticism of the studies that advocated towards the harm view and the GAM, the criticisms have not been completely ignored, and sometimes have been acknowledged and addressed in studies that followed the published criticisms. In Anderson’s (2004) meta-analysis, a criterion for “best practices” was established, which included 9 items to evaluate the soundness of a methodology that evaluated studies based on the game comparisons, pre-post experimental design, aggression measures, and whether the findings of each study included in the
analysis were tied to the violent content within the game or another variable (e.g. time spent playing the game. Under these guidelines, Anderson (2004) discovered that studies that did not meet the requirements set by the “best practices” criterion generally found smaller effect sizes compared to studies that did meet the requirements. Furthermore, some of the advocates towards the harm view have investigated whether other factors may have contributed to the link between violent video games and aggression, such as competition (Anderson & Carnagey, 2009), sex differences (Bartholow & Anderson, 2002), presence (Lull & Bushman, 2016), and racial attitudes (Yang et al., 2014). Although these studies did attempt to examine some factors outside of violent content, these studies still held some elements that were criticized by those that remained sceptical, such as mismatched games (Bartholow & Anderson, 2002) and varying levels of enjoyment between groups while playing the same game (Lull & Bushman, 2016).

Under these premises, the main components keeping the violent video game debate alive are arguments on the significance and interpretation of small effect sizes, potentially false associations between violent video games and aggression due to extraneous variables (e.g. competition, sex differences, difficulty level, etc.), and whether aggression measures are valid in terms of being able to infer present or future aggressive behaviours. While some researchers have opted to look at real world data to examine whether the impact of video gaming on aggression can be observed through crime data (Bushman et al., 2015; Markey et al., 2015), the conclusions made in these types of studies can only illustrate a rationally expected outcome, but cannot infer or determine causation.

5.3: Trolling
A common theme throughout the violent video game literature was in its focus on the violent game’s influence on physical aggression rather than relational aggression. Although there are some studies that did incorporate a measure for relational aggression, specifically those that utilized a self-report questionnaire or vignette (Möller, Krahé, Busching, & Krause, 2012), these studies represent a
minority within the literature and often do not include an experimental measure to observe direct or 
indirect acts of relational aggression. One point of interest to fill in the gap between the video game and 
relational aggression literature is the concept of cyber trolling, defined in a modern, general context in 
which a person purposefully posts or acts on an online community with the intention to enrage, humiliate, 
abuse, annoy, disrupt, or offend an individual or group for the provocateur’s own enjoyment.

This definition is the compilation of several academic definitions of trolling (Bishop, 2014a, b; 
Buckels, Trapnell, & Paulhus, 2014; Coles & West, 2016) as well as a gaming term that is referred in 
academia as ‘griefing’ (Slonje, Smith, & Frisén, 2012), the latter of which is used synonymously with 
trolling within the gaming community. The origination of the term ‘trolling’ comes from fishing, referring 
to reeling in a fish, rather than referring to the mystical monster (Binns, 2012; Bishop, 2014b), therefore 
the former conceptualizes the actions of those who perform acts of trolling (i.e. trolls): the troll baits a 
specific target with a provocative message, and the troll ‘reels in’ his or her target if a reaction is elicited. 
This conceptualization applies to both the classical and modern version of trolling; while the motivation 
of classic trolls was to generally spur discussion, the motivation of the modern troll is to demean. The 
current study is primarily interested in the modern type of trolls, therefore any reference to trolls 
hereafter will refer to those that operate under the modern definition of trolling rather than the classic 
definition.

Whereas the academic definition of trolling largely refers to posts on an Internet forum or 
comment section, trolling as a gaming term includes both offensive posts via group chats and action-based 
gestures that could be construed as disrespectful or bad manners. Action-based gestures could include 
‘teabagging,’ an action in which the victor of a duel stands over an opponent’s dead avatar’s head and 
repeatedly stands up and crouches down (simulating an act of putting the victor’s scrotum over the 
deceased as if the scrotum was a teabag), and ‘feeding,’ which is accomplished by purposely dying to 
position teammates at a disadvantage against the opposing team by granting extra in-game currency (e.g.
gold) for each kill (Salter, 2011). Gaming trolls seem to share many similarities with modern trolls in terms of their core motivations, but the context of their actions (performing an action in the game versus posting a comment in an online forum, respectively) are different and the former is not well documented in the general video game literature, even under its academic term of ‘griefing.’

Unfortunately, just as there is not a lot of research into the relationship between violent video games and relational aggression, the dearth of research also extends to trolling behaviours despite a growing awareness of the disruptive and sometimes offensive and humiliating behaviours. The study of trolling behaviours and its effects on players is especially important due to the rise in popularity of multiplayer games such as *Overwatch, Fortnite*, and *League of Legends*, which encounters with gaming trolls is near inevitable. The issue of trolling has become so problematic that the existing literature has extended into both politics and law enforcement, and as the Internet and its communities are becoming increasingly more accessible globally, this issue will only get worse unless countermeasures are enacted (Bishop, 2014a, Synnott, Coulias, & Ioannou, 2017).

### 5.3.1: Variations of a Troll

Bishop (2014a, b) outlines four broad categories of trolls, which includes Haters, Lolcows, Bzzzers, and Eyeballs, and each category consists of three subgroups that comprise and define each category. Haters are classified as those who seek to enrage others in a way that only benefits the Hater (e.g. personal entertainment value), and is comprised of E-Vengers that post to unveil the true nature of a person or group in an act of vengeance (e.g. leaking a sex tape), Iconoclasts that post to unveil the true nature of an idea by posting content that is contrary to the views of the target (e.g. posting an article about vaccines causing autism in a forum dedicated to producing accurate, scientifically-based evidence about vaccines), and Snerts that harm others just purely for personal entertainment (e.g. slut shaming a woman dealing with low self-esteem issues). Lolcows aim to become the centre of attention within the community or discussion, and consists of Big Men who post support to please others (e.g. posting an article about the
benefits of practicing scientology in a forum for scientologists), Rippers that post about real or false self-deprecations to gain empathy from others (e.g. posting about a false instance of a depressive episode to gain sympathy), and Chatroom Bobs that post to gain trust from online community members to exploit later (e.g. posing as a female on a support group to gain donation money for a non-existent disease).

Bzztters are characterized by incessant posts that may not necessarily be related to the topic being discussed, which include MHBFY Jennies who post comments aimed to help people be more optimistic and come to terms with any current issues (e.g. continually posting the same supportive messages for individuals who experienced the loss of a family member), Wizards who make and share false content to support others (e.g. referencing a massacre that has never happened as evidence of a president’s failure), and Flirts that post to encourage others to socialize more (e.g. dragging non-vocal online community members into the conversation by referencing them for their opinions). The last category, Eyeballs, are characterized by those who scout out opportune moments to act, which are comprised of Lurkers that convey their message via ‘likes’ or reporting posts (e.g. “Liking’ a Facebook post), Trolls that seek to entertain mischief (e.g. posting humorous Internet memes), and Elders that haze new members of an online community without being reprimanded or confronted by other members of the community (e.g. posting harsh rulesets for community participation that do not exist for other members; Bishop, 2014a, b).

These categories exemplify the different motivations behind trolling, while also demonstrating that not all trolls have malicious intents. MHBFY Jennies, Flirts, and Trolls are generally well-intentioned, as these subtypes aim to encourage or entertain rather than to deprecate, and although the content posted by these subtypes may be irrelevant to a given topic, the content is relatively harmless. E-Vengers, Iconoclasts, Big Men, Wizards, and Lurkers can be both productive or counterproductive depending on the context, as these subtypes potentially give rise to an important issue (e.g. posting about oil spills and the corruption existent in major oil companies during a session to determine whether a new oil pipeline
should be built), but also demean important issues (e.g. posting about the ‘dangers’ of vaccinating children based on poorly constructed studies refuted by the majority of the scientific community). Other forms of trolling, such as Snerts, Chatroom Bobs, and Elders, can be completely harmful without regard to the context, as the goals of these subtypes are often to exploit others for their own personal gains (Bishop, 2014a, b).

Although trolls can be classified based on the content being posted and the underlying intentions of the trolls, identifying whether an individual is a troll has been a herculean task. This is in part due to an attempt to boil down a troll’s actions as offensive and disruptive, therefore suggesting that trolling is always bad for an online community, but the presence of trolls such as MHBFY Jennies, Flirts, and Trolls demonstrate that some subgroups have a well-intentioned, supportive, and positive approach to trolling that is largely accepted by online communities. E-Vengers and Iconoclasts also serve as prime examples that there may be good motivations behind a perceptually offensive act of trolling, however, the method in which these kinds of trolls operate may be considered less than ideal, which is consequentially perceived as a nuisance by the community being disrupted (Bishop, 2014b). Furthermore, in countries that facilitate the concept of free speech, reprimanding malicious trolls has become difficult as debates would ensue concerning the extents to which free speech would protect the malicious trolls. Based on these distinctions, some researchers have opted to distinguish trolling behaviours into 2 groups: kudos trolling, which refers to the positive and sometimes unintentional forms of trolling, and flame trolling (i.e. flaming), which is characterized by the negative and malicious forms of trolling (Bishop, 2013, 2014a, b; Coles & West, 2016).

There are, however, some contentions in terms of how to objectively classify whether the motivations behind an act of trolling is good, bad, or unintentional (Hardaker, 2010). Specifically, kudos trolling carries slight variations in terms of its definition across studies, with some positioning it as a positive and productive form of trolling (Bishop, 2013), a form of trolling meant to entertain others
(Bishop, 2014b), or an act of posting irrelevant or misconstrued information that leads to an unintended consequence of disrupting the ongoing conversation (Coles & West, 2016). The academic definitions for flame trolling are much less varied compared to kudos trolling, with studies typically defining it as offensive (Bishop, 2013, 2014b). Nevertheless, while kudos trolling is framed as a less obnoxious and sometimes welcome form of trolling compared to flaming, an act of trolling can take on both the kudos and flame trolling forms due to differing subjective perceptions; one person’s perceptually harmless entertainment may make another person feel offended (e.g. memes that trivialize a serious issue).

5.3.2: Characteristics of a Flame Troll

In a study to examine the personality characteristics of a flame troll (i.e. flamers), Buckels et al. (2014) compared common flaming behaviours (e.g. griefing in multiplayer games, corrupting a beautiful and pure object, etc.) with the Dark Tetrad of personality, which consists of narcissism, Machiavellianism, psychopathy, and sadism. Although this study primarily used self-report questionnaires rather than directly observing and measuring flaming behaviours, Buckels et al. (2014) found that participants who took part in flaming activities were associated with high levels of Dark Tetrad personality traits, particularly in sadism and Machiavellianism, while narcissism was negatively associated, and psychopathy was overall unrelated. Furthermore, although sadism and Machiavellianism were both strong predictors of flaming, sadism was reported to be the best predictor. This finding suggests that flamers may be prototypical of everyday sadists that derive enjoyment from griefing other people, at least in an online community.

Bishop (2013) also proposes that trolls may have some form of social disorder, although the authors refer to antisocial personality disorder rather than the Dark Tetrad of personality used by Buckels et al. (2014). In the Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-V; American Psychiatric Association, 2013), flamers typically exhibit several of the common symptoms of antisocial personality disorder, including egocentrism, lack of empathy, utilizing dominance or intimidation to
control others, disregard for obligations and commitments, and lack of concern for others. In contrast with the methodology that Buckels et al. (2014) used to study characteristics of flamers, Bishop (2013) only postured the potential of flamers being diagnosable with antisocial personality disorder, relying on the exemplary behaviour enacted by flamers rather than actively measuring both the flamer’s level of antisocial personality and flaming behaviours.

Flaming can also be considered a form of cyberbullying, which is defined as an act of aggression carried out via an electronic medium (e.g. Internet, text messaging, etc.) against a vulnerable target individual or group. General forms of cyberbullies also share a lot of similarities with those who take part in flaming, as both can express aggression on a target indirectly and anonymously, both of their victims’ reactions cannot be immediately observed (contrasted with immediate reactions such as submissiveness, crying, or helplessness when the victim is being physically bullied), and as long as the target is a part of a social network or other online communities, both cyberbullies and flamers can always have an outlet to stalk and harass their victim(s). Furthermore, some cyberbullies and trolls may share similar targets to harass, such as those who are mildly or morbidly obese (Binns, 2012; Slonje et al., 2012).

The existing trolling literature has largely attributed anonymity as one of the main driving forces that facilitate trolling behaviours, which is thought to consequentially lead to deindividuation and depersonalization within online communities. Deindividuation refers to a state when individuals lose their individual identity, due in part of being in a group or being anonymous, the latter of which may be the most relevant in the case of flamers as the anonymity protects them from any physical retaliation. Depersonalization, however, refers to a loss of self-identity, self-awareness, and associated with lower levels of self-control (Bishop, 2013). Under this premise, a combination of higher susceptibility to deindividuation, depersonalization, and a lack of preventative measures for potential abuse against online community members have made online communities as a perfect breeding ground that fosters and enables flamers to anonymously victimize an individual or group without any personal consequences.
Flamers are also not solely limited to an individual or small group, as large organizations and institutions can be labelled as flamers and carry a much more detrimental effect towards modern politics and businesses. These organizational flamers (i.e. institutional trolls) are institutions or organizations that utilize classic and modern trolling methods that can follow any of the 4 broad categories of trolls outlined by Bishop (2014a, b). A prime example of political flaming is the far-right news blog Breitbart News Network (BNN), or the Daily Kos, the far-left counterpart. Both BNN and the Daily Kos tend to produce stories that support a politically conservative or liberal view, respectively, which can frame an event to either enhance or diminish the importance of a story (Budak, Goel, & Rao, 2016). As openly biased outlets (i.e. echo chambers), these news organizations can utilize Big Man or Wizard trolling tactics to produce stories, headlines, and propaganda that fit alongside their dedicated reader base’s political views, the latter of which contributes to an ongoing issue of ‘fake news.’ The influences of institutional trolls are not limited to the site where an article originates, however, as the ideas spurred by these institutions can often be repeated and shared throughout popular social media sites like Facebook and Twitter (Pickard, 2016). Although the United States’ 2016 presidential election and the United Kingdom’s vote to leave the European Union (i.e. Brexit) are recent events, scholars have begun to speculate whether the influence from these institutional trolls and their flaming behaviours had any significant impact on the political outcomes (Kucharski, 2016). In relation to businesses, patent assertion entities (i.e. PAE or patent trolls), who develop or obtain ambiguous patents and then sue successful companies under the pretext that the company infringed on a patented design, bare some resemblance to the Snert troll subtype. Rather than trolling to entertain themselves, however, PAEs troll for revenue (Haber & Werfel, 2016). These examples demonstrate that flaming behaviours are not based exclusively on an individual or small group level, but can extend to large, influential organizations and institutions that arguably have a much larger online presence.
5.3.3: Addressing Aversive Flame Trolling Behaviours

Preventative measures for flaming behaviours often point to three different solutions: eliminate anonymity or establish moderators in the online space (Binns, 2012), hold flamers accountable for their statements (e.g. criminal sentences or fines; Bishop, 2013; Synnott et al., 2017), or train individuals to better differentiate between flaming and genuine behaviour (Hardaker, 2010). Although these ideas have been explored in the literature, the efficacy of these solutions have only been evaluated through qualitative means rather than quantitative evidence. Nevertheless, studies that advocated for any of these solutions have provided some evidence and insight into potentially invaluable solutions to combat flaming behaviours.

To reduce anonymity, and subsequently the deindividuation and depersonalization that may stem from it, some sites like Quora and Techcrunch have opted to require users to sign in before commenting, either via the site’s internal login system or through a third-party system (e.g. Facebook, Twitter, Google, etc.). Although this idea may be appealing, it runs the risk of expression through anonymity, which prevents people who may want to voice their potentially productive opinions but would not do so under the fear of scrutiny or the potential for their credibility to be ruined (Binns, 2012). Furthermore, it can be easy enough to create a fake account, as e-mail, social media, and other Internet accounts are easy to create and often do not require any forms of identification (e.g. government issued identification information), which undermines any effort to identify users (Shachaf & Hara, 2010).

The use of moderators to monitor forums can also help to mitigate the propagation of flamers, although the task may be overwhelming for a few select moderators to do depending on the popularity and traffic of the site. This method can consist of having community members report abuse or violations of the community rules, or by designating active individuals to judge whether a member was acting against the community. Popular sites such as Facebook and Reddit already incorporate these functions, as both have ways for normal members of the community to report abuse so that a site administrator can review the content, or for group administrators to specify which posts can be viewed automatically or after a
time delay, and whether users would need to pass a certain threshold before obtaining certain revocable privileges within the forums (Binns, 2012). Using these systems may be effective, however, there still stands the possibility that flamers can post their content at least for a short period of time, especially if the site is popular, does not moderate posts on an individual basis before being publicly available, or the site does not have sufficient tools to allow for the moderation of posts.

There have been some documented cases in which flamers have been prosecuted by the law and given brief jail sentences, with perhaps the most infamous case being the conviction of Sean Duffy in 2011. Duffy was convicted of posting offensive messages and videos on sites dedicated towards the deceased and was sentenced to a prison term of 18 weeks (Bishop, 2013; Synnott et al., 2017). Recently, however, flaming can only be convicted if the action can be demonstrated as grossly or extremely offensive. In the United Kingdom alone, the Crown Prosecution Service raised the threshold for considering aversive trolling behaviours as a criminal offense in response to a rise in trolling reports between 2003 and 2011 (Synnott et al., 2017). Although the cases in which trolls are legally prosecuted for a short jail sentence may be conserved extreme by some, the act of flaming can lead to serious consequences worldwide. This is evident in the case of Megan Meier and Amanda Todd, both of whom committed suicide in 2006 and 2012, respectively, after being abused and harassed by flamers on the social video site YouTube (Bishop, 2014b).

Some of the issues with convicting trolls due to gross misconduct may be due in part to the evaluation itself, but there have been attempts to evaluate content to determine if the content is either minorly offensive or grossly offensive, evident in Bishop’s (2013) Trolling Magnitude (TM) Scale. The TM Scale categorizes trolling statements under four tiers: TM1 refers to playful cyber-bantering, TM2 refers to cyber-trickery, TM3 indicates strategic cyberbullying, and TM4 represents the most serious form of trolling, cyberhickery. Trolls who post statements on a TM1 level may not necessarily intend for their post to be offensive and will apologize if being called out for being offensive, which symbolizes characteristics
of kudos trolls or trolls whose intent is to entertain others within the community. TM2 shares similarities with TM1, but the troll is generally unremorseful and will continue posting the same content even while knowing that the content is inherently offensive. TM3 is a pre-mediated version of TM1 and TM2 but is not sustained over a long period of time. Lastly, TM4 is also pre-mediated, but the flamer sustains the behaviour over a long period of time, which is exemplified by Duffy’s pre-determined targets (e.g. community members on forums dedicated to honouring and remembering the deceased) and sustained efforts. Furthermore, if flamers are subject to the Dark Tetrad of personality or empathic spectrum disorders as Buckels et al. (2014) and Bishop (2013) proposed, respectively, a question on how flamers should be treated, whether as criminals or as individuals with impaired social or cognitive functions that need professional help, could be raised.

The last solution lies with resisting to respond towards a flamer, which may be the easiest solution to implement. Binns (2012) and Hardaker (2010) both advocate for the notion of not feeding trolls, meaning that those targeted by flamers should not respond in a way sought after by the flamer. For example, if a flamer’s underlying intent is to entertain themselves by causing discourse within the online community, ignoring the troll will eventually cause him or her to look for another community that might elicit the wanted response. Community members who regularly visit a site may also be able to differentiate between a malicious troll from a serious member and address the flaming behaviours (e.g. identifying whether a person is a flamer and informing the community). This solution, however, is hindered by the obstacle that plagues the other potential solutions: identifying a true flamer. Online community members must be able to identify the true intent behind each post (e.g. to express a held belief or to cause a disruption) and what constitutes kudos trolling or flaming behaviours, which may not be a skill that new users or those unfamiliar with an online community may have.
5.3.4: Summary of the Trolling Literature

Although the topic of trolling has not been as extensively studied, there are a few key things to note. Not all trolling behaviours are malicious or disruptive, therefore there are some trolling behaviours that are deemed as acceptable and welcome depending on the context and the community. This is evident with the MHBFY Jenny, Flirt, and Troll subtype classifications, trolls who have an underlying intent to either help bolster an individual or group, or to entertain members of the community. The most serious cases, however, stem from flamers that seek to manipulate or abuse an individual or group, evident with Snerts, Chatroom Bobs, and Elders. These types of trolls are particularly harmful, which may damage the reputation of a group or lead to serious consequences such as suicide (Bishop, 2014a). The current study is particularly interested in flaming behaviours, as it is representative of relational aggression and the form that can manifest during video gaming sessions.

There has also been a small movement among researchers in terms of determining whether flamers are a by-product of personality or social disorders. Buckels et al. (2014) provided the best evidence towards the notion that flamers exhibit similar tendencies as sadists, but without a clinical diagnosis and proper evaluation outside of self-report measures, this connection cannot be firmly established yet. Still, it seems as if the literature is largely attributing flaming behaviours towards innate, pre-existing conditions rather than the influence of the media, although there have been some studies outside of the trolling literature that posits that Internet usage may make users develop more antisocial personality traits (Suler, 2004).

In its basic modern form, flamers are cyberbullies. Unfortunately, while some acts of trolling may be easier to identify (e.g. commenting repeatedly about how fat a person is on a post from an individual expressing confidence in their own body), other acts of trolling may be near impossible to detect until the intentions of the flamer are made clear (e.g. a male Chatroom Bob posing as a female in a discussion reserved solely for women, aimed to use the site to meet women). So long as individuals participate in Internet activities, which is becoming increasingly difficult to avoid as the influence and necessity of the
Internet is steadily increasing worldwide for multiple social, practical, and work-related purposes, the threat posed by flamers are becoming even more unavoidable (Slonje et al., 2012).

5.4: Study Overview
The goals of the current study are twofold: 1) Evaluate whether playing video games in VR can elicit aggressive behaviours in the form of flaming, and 2) Establish an effective laboratory manipulation to evaluate direct and explicit relational aggression, specifically in the form of flaming behaviours. Both of these goals represent a novel approach towards video game research as a means to address both the limitations and lack of research from the existing video game literature. While there have been some VR games prior to the introduction of modern VR, there has not been any documented studies to investigate the influence of repeated VR gameplay sessions on aggression.

Although there have been some variations in terms of trolling, the current study has chosen to utilize the flaming aspect of trolling akin to the common trolling experiences within the video game community: any message conveyed by a user to specifically attack the main topical content, character, or online community members where the intent of the message is to disrupt, humiliate, or invalidate an individual, group, or idea. This definition provides a foundation in which an experimental manipulation can be formed to both observe and measure malicious trolling behaviours, as well as filtering out positive or kudos forms of trolling alongside statements that were made with motivations representative of classic trolling in which the goal was to spur a healthy, productive debate.

One of the major facets that led researchers into exhaustingly studying the effects of violent video games on aggressive behaviours was in the games’ feature of allowing players to interactively participate with the content. In contrast, films, television shows, and music are considered passive entertainment mediums, as individuals could divert their attention away for brief moments and still enjoy the content, and the stimuli itself cannot be changed by the user as there are no interactive elements outside of pausing, fast forwarding, and rewinding. Video games, however, require players to focus and invest most,
if not all, their attention on the game, as well as to manipulate a character or situation to progress through
the game (Sherry, 2001). The current study posits that integrating VR technology into gaming takes the
interactivity of video games a step further; rather than using traditional methods of controls (e.g.
gamepad or a keyboard and mouse combination), players can now use motion controllers and head
tracking capabilities to facilitate a more involved, body-based control scheme that translates physical
movements into in-game actions. For example, within a FPS VR game, shooting another character is no
longer a matter of aiming via an joystick and pressing down a button (representative of a traditional
gamepad), but now requires the player to simulate actual gun shooting mechanics in the form of moving
their arm to aim and squeezing the controller’s trigger. If the interactivity due to violent video games
strengthens the player’s susceptibility to aggressive behaviours, then these aggressive behaviours should
be more apparent when incorporating a more interactive control scheme coupled with greater visual and
auditory immersion.

As there are ethical and safety issues with directly observing physical aggression, and seeing as
there are very few studies that have investigated the effect of violent video games on relational
aggression, the current study aim to investigate the link between violent video games and flaming
behaviours. Although a trolling measure has yet to be established for experimental use, the current study
has opted to develop an experimental measure based on evaluating the content of comments for videos
on the Internet where flamers can typically manifest. By evaluating the contents of a comment, the types
of videos a participant actively seeks out to comment on, and the intentions and rationale of the
participant regarding the comments made, relational aggression can be directly measured and observed
in terms of the degree in which the comment was harmful, and whether the participant intended to harm
a specific individual or group. By utilizing this method, the current study addresses some of the common
criticisms of the violent video game and aggression literature by evaluating and observing relational
aggression in the form of flaming behaviours.
As relational aggression has been found to be relatively different from physical or overt aggression (Crick & Grotberg, 1995), it can be considered a stretch to link acts of physical aggression performed within a game to relational aggression, but the key to linking these factors together lies in sadism. Some video game studies have posited that sadism can serve as a significant and sometimes integral part of a video game, as the main draw for a violent game is to harm or kill other characters or player avatars (Wonderly, 2008). As a component of the Dark Tetrad of personality, sadism is a strong predictor of flaming behaviours, there is a possibility that if violent video games can lead to an increase in the player’s sadistic tendencies, it can potentially increase one’s tendency to develop and exhibit flaming behaviours within an online community or through physical means. This rationale follows a different approach towards the GAM, as the current study assumes that the pleasure derived from repeatedly harming in-game characters can translate to acts of flaming behaviours over time.

Based on these notions, the present study hypothesizes that repeated video gameplay sessions will not significantly influence the player’s aggressive tendencies in online commenting sections regardless of the type of content presented within the game. The present study postures that, based on evidence that video games have been repeatedly found to have no significant influence on the player’s aggression, there are other factors unrelated to video gameplay that may have more of an influence on the individual’s aggressive tendencies, especially in relation to online behaviour. While these extraneous factors, such as genetics or parenting styles, will not be examined in the present study, the present study aims to contribute evidence to the violent video game literature by examining a different aspect of aggression that is observable.

5.4.1: Methodology
5.4.1.1: Design

A randomized controlled experimental design was used for the present study and primarily used quantitative self-report measures to access each participant’s level of aggression alongside video comments to observe potential acts of flaming behaviour. Participants can be randomly assigned to one
of three groups, with randomization based on the random number generator from researchrandomizer.org: Violent VR, Non-Violent VR, and No Game. Each participant underwent six one-hour experimental sessions that was held weekly. Participants who completed all six sessions were also entered to win £50 at the end of the school semester, but no other financial compensation was offered.

5.4.1.1: Participants
A total of 21 (11 male, 10 female) participants were recruited via online tools and posters posted around the University of Bolton campus. Participant age ranged from 20 to 58 (\(M = 27.71, SD = 9.34\)), with the majority being Caucasian (\(n = 15\)), and the rest being Middle Eastern (\(n = 3\)), Asian (\(n = 2\)), or mixed (\(n = 1\)).

5.4.1.3: Evaluation Criteria
The current study aimed to match games in terms of enjoyment, game pace, interactivity, context, and graphics style. Rather than attempting to match a single game in terms of these factors and controlling only for violent content, a set of 3 games that touches upon a combination of these factors will be used. Game pace, interactivity, and graphics style all have multiple sublevels, and each combination of games must touch upon all sublevels. Context, however, was only important for the violent video game combinations, as the purpose and extent of the violence was necessary to differentiate between low to mild violence that has been deemed suitable for children (e.g. shooting enemies depicted as stick figures in a cartoonish game world) and extreme violence that has been deemed suitable only for adults (e.g. shooting characters with explosive bullets that result in a bloody and gory splatter). Furthermore, only single player games were considered, but games could have indirect multiplayer competitive elements in the form of leader boards that indicate high scores.

Enjoyment (i.e. recommended vs. not recommended) is determined via reviews on the Steam client, and games considered for the present study must have been recommended by at least 70% of the players who have bought the game. A game carrying at least a 70% recommendation score indicates that players had a Mostly Positive, Very Positive, or Overwhelmingly Positive experience as detailed by Steam.
This measure of enjoyment stems from hundreds to thousands of reviews from casual to hardcore players to better understand not only if the game is enjoyable in terms of gameplay content, but also enjoyable in the sense that the game works and if the gameplay mechanics are engaging.

Game pace (i.e. fast vs. slow gameplay experience) is determined by how fast the action is in the game, which also indicates how much attentional focus the player must invest within the game to successfully complete its objectives. A fast-paced game will require nearly all of the player’s attention to progress through the game and may incorporate several on screen elements to interact with at once (e.g. a swarm of enemies that appear in waves for the player to shoot down). A slow-paced game, however, will allow the player to progress at their own pace and does not punish the player for taking his or her time to make in-game decisions (e.g. evaluating the trajectory of a golf swing in a game of minigolf). A game with an average pace exhibits a mix of both fast-paced and slow-paced elements (e.g. a wave of enemies that are defeated, yet also contains moments in which the player can relax before tackling the next wave of enemies).

Interactivity (i.e. high vs. low) is defined by the level in which player actions can influence the game environment. A highly interactive game should incorporate elements such as motion controls (e.g. swinging the controller like a golf club to hit a ball, or moving the controller to aim a virtual gun), player actions that are immediately incorporated into the game world (e.g. shooting glass should shatter the glass, or touching a visual cue should make the cue disappear), and involves body movements (e.g. ducking in order to avoid getting shot). A less interactive game may not necessarily incorporate motion controls and can be played while standing in a stationary position or sitting (e.g. sitting in a cockpit and shooting enemies with a traditional game console controller).

Graphics style (i.e. realistic vs. cartoonish) refers to the art style that the game utilizes. Games that are deemed towards realism should have similar structures reminiscent of objects in physical reality that are proportionally accurate. Cartoonish games, however, can be more outlandish in terms of object
and character proportions, and the colour scheme may be more representative of those used in cartoons and anime.

Context (i.e. purpose vs. no purpose) is the reasoning behind performing certain aggressive actions. This is evaluated in two ways: classification rating and in-game narrative context. Classification rating is particularly important to consider when evaluating the level of violent content within the game, and ratings from the Australian OFLC were used. As the OFLC requires games to be classified to be sold in Australia, it was often the case that a game may not have undergone the rating process for other territories such as the United States or European Union, therefore the OFLC served as a mostly consistent reference for the violent video games used in the present study. Narrative context refers to the motivations behind the player to perform aggressive in-game actions, and could include defending oneself, indiscriminately eliminating the enemy, or having no narrative context at all.

In relation to determining violent and non-violent games, any game in which there is a depiction of harm by the player (e.g. shooting a target) or by the game environment (e.g. an avatar shooting another avatar) towards another character has been categorized as a violent game. A game that depicts objects (e.g. visual cues, balls, etc.) that may pop or explode when the player successfully interacts with the object was not considered as a violent game unless a 'living' avatar could be harmed. A game can also be considered as violent if the game’s primary focus is not on harming others but can carry the potential for harmful actions against another character (e.g. a game about doing mundane tasks in an office environment, but the player can throw a mug at another character). Figure 5 outlines the full diagram to differentiate each game used in the present study as it relates to all of the aforementioned game categories.
5.4.1.4: Instruments/Apparatus

- **HTC Vive**: The same HMD used in Study 1 was used to display VR content for the present study.

- **Arizona Sunshine**: Developed by Vertigo Games and Jaywalkers Interactive, *Arizona Sunshine* is a FPS zombie survival game in which the player fights off hordes of zombies in the Grand Canyon (See Figure 6). Players can freely explore the environment and utilize several motion controls to shoot and reload their weapons. Participants playing this game will be playing its single player
campaign, which entails fighting for survival (i.e. defensive aggression) to find other survivors. Graphics in this game are a mix between realistic and cartoonish elements, incorporating highly detailed weapons and environments, but also slightly cartoonish zombies. This game can be rather difficult, as the player must keep track of multiple elements such as zombie positions and ammo count. The OFLC granted this game a rating of R18+ for high impact violence and was recommended by 88% of players (1,349) who had bought, played, and reviewed the game (1,530) as of the 29th of March, 2017.

![Arizona Sunshine](image)

**Figure 6: Arizona Sunshine**

- **Gunjack**: Developed by CCP, *Gunjack* is a FPS game set in outer space in which the player is tasked with protecting a mining vessel by fending off oncoming enemies (See Figure 7). The game is played while sitting down and actions are carried out through an XBOX One controller, but the player’s view of the environment and the weapon’s aim is all done through the HTC Vive’s head tracking capabilities. While there are some slight narrative elements in the game, *Gunjack* is an
arcade-styled shooter in which waves of enemies are presented in bursts, which increases in difficulty as the player defeats more waves. Graphics in the game are more realistic than cartoonish, featuring highly detailed spacecrafts with an occasional cartoonish crate that indicates a usable power-up. The game is moderately easy as there are less gameplay elements to keep track of in comparison to Arizona Sunshine, but game difficulty scales with each subsequent game level. The OFLC granted this game a rating of PG for mild course language and mild violence and was recommended by 81% of players (104) who had bought, played, and reviewed the game (127) as of the 29th of March, 2017.

Figure 7: Gunjack

- The Lab: Longbow: Developed by Valve, The Lab is a collection of games and experiences meant to demonstrate the capabilities and possibilities of computer-based VR headsets, specifically the HTC Vive. Of the games included in The Lab, the Longbow game was the one primarily used for the present study. Longbow is a FPS archery-based tower defence game in which the player...
defends a castle’s gate from intruders (See Figure 8). Intruders are portrayed as black, humanoid-shaped stick figures occasionally donning garb representative of Vikings (e.g. horned helmets) that adds an extra layer of defence against the player’s arrows. When the intruders are successfully shot, they explode into a cloud of smoke and red balloons emerge, which allows players to shoot them to either restore health to their castle’s defences or gain extra points if their tower’s health pool is full. The game is played while standing in a stationary position but allows for some limited movement. An indirect competitive element is present through a leader board that can be viewed at any time behind the player, which outlines the highest level and score achieved by the player. Graphics in the game are more cartoonish than realistic, featuring colourful, low polygonal environments and effects. Like Gunjack, the game begins relatively easy, but the difficulty scales as the player progresses through subsequent levels, however, the game is slightly more difficult on account that players will need to predict the enemy’s position as the player must account for arrow travel time. While The Lab was not rated by the OFLC, possibly due to being a game that was completely free to play, it was recommended by 98% of players (1,646) who played and reviewed the game (1,676) as of the 29th of March, 2017.
Project CARS: Developed by Slightly Mad Studios, *Project CARS* is a racing simulation in which participants can ride in digital renditions of actual cars across various real-world environments (See Figure 9). The game is played while sitting down and controlled via a XBOX One controller, but the player can move their head to move the in-game camera. While the game is a racing simulation, it has an average game pace as there are moments in between the races in which the player can relax before moving on to the next race, and some modes (e.g. practice) allow for more leisurely driving experiences. The game difficulty is hard, as the player needs to understand how to handle the driving mechanisms of the car through the use of a traditional gamepad controller, and as there are multiple cars available with different handling methods, players will have to adapt to each cars’ handling method if they were to switch in between races. Participants are given free choice on which types of single-player modes they would like to play, and any competitive elements would be against computer-controlled opponents. Graphics in the game are realistic, featuring highly detailed environments, cars, and weather effects. The OFLC granted
this game a G rating, which indicates that the game can be played by a general audience. 76% (6,960) of players who bought, played, and reviewed the game (9,073) recommended it as of the 29th of March, 2017, although it should be noted that the game had been released prior to the release of the HTC Vive, therefore VR functions were added as a post-launch update.

![Figure 9: Project CARS](image)

- **Cloudlands: VR Minigolf**: Developed by Futuretown, *Cloudlands: VR Minigolf* is a minigolf game in which players attempt to guide a golf ball into a hole through a series of obstacles (See Figure 10). The game is played primarily by standing in a stationary position, but players swing the controller as if it were a golf club to control the power and direction of each golf swing. The pace of this game is slow, as players can take their time to determine how they want to hit the golf ball, and there are no real narrative elements to the game. As the gameplay is slow and modelled after a real-life activity, the game is easy and accessible to play. The graphics in this game are more cartoonish than realistic, featuring softly detailed environments and gameplay elements (e.g. a
cannon to shoot a golf ball from a lower level to a higher level within the golf course). Unfortunately, the OFLC had not rated this game, but the ESRB granted the game an E rating, which indicates that the game can be played by a general audience. 81% of players who bought, played, and reviewed the game (211) recommended the game as of the 29th of March, 2017.

Figure 10: Cloudlands: VR Minigolf

- **Holodance**: Developed by Narayana Games UG, *Holodance* is a rhythm-based game in which players must connect with different visual cues that correspond to beats within a song (See Figure 11). The pace of the game is relatively fast, although it depends on the type of music being played (e.g. a highly arousing electronic song may have a barrage of stimuli to attend to, whereas a slower song may have players attend to stimuli that are spaced farther apart). While the difficulty also depends on the song and instrumental being played, the game is generally only moderately difficult as players would only need to touch the cue in rhythm with the music. Graphics for this game contain a series of realistic and cartoonish elements, as the backdrops feature rich, highly
detailed scenic views while the visual cues and dragon avatars are more colourfully rendered with a low polygon count. As the game is still in early access, which refers to a game that is incomplete but still playable, the game had not received a rating yet. The game itself has no vocal tracks nor does it have any traces of elements, and the dragons that can be encountered are depicted as friendly. 90% (70) of players who bought, played, and reviewed the game (77) recommended this game as of the 29th of March, 2017.

Figure 11: Holodance

- *Tilt Brush*: Developed by Google, *Tilt Brush* is an experience that allows users to draw in an empty VR environment. Participants can also view the work done by professional artists, as well as the steps the artists had done. This program was used for those in the No Game group, and features no gameplay elements.
• **Trolling Magnitude Evaluation (TME; See Appendix E):** Participants were given access to an anonymous Google account to browse and comment on 3 YouTube videos of their choice, with the only parameters being that the videos should generally be less than or approximately 5 minutes in length. After each video, the participant was instructed to fill out a TME questionnaire, which contains 14 items based on trolling characteristics detailed in Bishop’s (2014a, b) studies. The 14 items in the TME questionnaire were primarily used as a reference for comment evaluators in the event that the nature of the comment was ambiguous.

• **Short Dark Triad (SD3; See Appendix F):** The SD3, developed by Jones and Paulhus (2014), was used to evaluate the participant’s level of Machiavellianism, narcissism, and psychopathy. There are 27 items, each of which can be answered on a 5-point Likert scale, and have been equally split into 3 subscales.

• **Comprehensive Assessment of Sadistic Tendencies (CAST; See Appendix G):** The CAST, developed by Buckels and Paulhus (2014) was used to evaluate the participant’s sadistic tendencies. A total
of 18 items pertaining to direct verbal, direct physical, and vicarious sadism were included with the scale. 11 questions could have also been included to offset the negativity of the main sadism items, but were not used for the present study. Each question could be answered on a 7-point Likert scale, with 6 items dedicated to measuring verbal sadism, 5 items for physical sadism, and 7 items for vicarious sadism.

- **Presence Questionnaire**: The same PQ used in Study 1 was used to evaluate the participant’s sense of presence for the present study.

- **Simulator Sickness Questionnaire**: The same SSQ used in Study 1 was used to determine whether participants felt any symptoms of simulator sickness during VR gameplay.

- **Game Enjoyment Questionnaire (GEQ; See Appendix H)**: A short 6-item questionnaire was used to evaluate the participant’s thoughts towards the games in relation to fun and enjoyment, difficulty (easy vs. hard), graphics style (cartoonish vs. realistic), game pace (slow vs. fast), interactivity, and subjective rating of the overall game experience. Most of the items can be answered on a 5-point Likert scale with the exception of the item involving the participant’s subjective rating of the overall game experience, which was set on a 10-point Likert scale with “1” representing “Poor” and “10” representing “Perfect”.

5.4.1.5: Procedure  
Participants in the Violent VR and Non-Violent VR groups underwent six weekly 1-hour sessions, with participants in the No game group completing pre- and post-experimental sessions at the beginning and end of the six-week period. During the first session, all participants were given an informed consent followed by a battery of pre-experimental assessments that consisted of demographic information, SD3, CAST, and TME measures. After the pre-experimental assessments had been completed, those in the Violent VR and Non-Violent VR conditions were placed into the first of their three games for 30 minutes, with the game order for each condition being randomized to prevent potential order effects. Those in the
No Game group were also given the opportunity to experience VR in the form of Tilt Brush for the same amount of time. Following the VR gameplay portion of the session, those in the Violent VR and Non-Violent VR conditions were given the PQ and SSQ measures to complete while No Game participants were dismissed. Once each of the participants had finished their first session, their comments on the videos that they had chosen to watch for the TME were recorded before being deleted.

For the remaining sessions, participants in the Violent VR and Non-Violent VR conditions began each experimental session with the VR game followed by PQ and SSQ measures. A new game would be introduced during sessions 3 and 5, and during sessions 2, 4, and 6, sessions in which participants would have played their randomly assigned games a second time, the GEQ was given to them to complete in addition to the PQ and SSQ measures. After the VR gameplay portion in session 6, the battery of post-experimental measures that included the SD3, CAST, and TME measures were administered alongside the GEQ, PQ, and SSQ measures.

5.4.2: Results
5.4.2.1: Manipulation Check
A one-way analysis of variance (ANOVA) was conducted to analyse any differences in game enjoyment between the six games used in the study. No significant differences were found in relation to enjoyment \( (F(5,36) = 0.218, p = 0.95) \), difficulty \( (F(5,36) = 1.795, p = 0.14) \), interactivity \( (F(5,36) = 0.247, p = 0.94) \), and subjective rating \( (F(5,36) = 0.450, p = 0.81) \). Significant differences were found, however, in relation to graphics \( (F(5,36) = 3.765, p = 0.01) \) and game pace \( (F(5,36) = 3.751, p = 0.01) \), which indicated that there were differences in the games’ graphical style and the speed in which it played.

Another one-way ANOVA was used to analyse PQ and SSQ responses, and found no significant differences between the six games in relation to sub-measures of Realism \( (F(5,36) = 0.960, p = 0.46) \), Possibility to Act \( (F(5,36) = 1.212, p = 0.32) \), Quality of Interface \( (F(5,36) = 1.592, p = 0.19) \), Possibility to Examine \( (F(5,36) = 1.395, p = 0.25) \), Self-Evaluation of Performance \( (F(5,36) = 1.657, p = 0.17) \), Sounds \( (F(5,36) = 1.453, p = 0.23) \), and Haptic \( (F(5,36) = 0.348, p = 0.88) \). No significant differences were also found
for simulator sickness symptom sub-categories of nausea ($F(5,36) = 1.178, p = 0.34$) and ocular-motor ($F(5,36) = 1.790, p = 0.14$).

5.4.2.2: TME
Two evaluators were tasked with reading each Youtube comment and determine whether the comment constituted flame trolling based on responses on the TME with particular focus on the participant’s intent and content of the comment. Comments were then coded as “0” for “No Flaming” and 1 for “Flaming,” and a one-way ANOVA was used to determine whether there were any significant differences in the prevalence of flame trolling between each condition. No significant differences were found between the groups at the pre-experimental ($F(2,60) = 1.00, p = 0.37$) and post-experimental ($F(2,60) = 1.00, p = 0.37$) assessments.

5.4.2.3: SD3 and CAST
A one-way ANOVA was conducted to analyse responses from the SD3 and CAST questionnaires. No significant differences were found between each condition at the pre-experimental phase for Machiavellianism ($F(2,18) = 0.420, p = 0.66$), Narcissism ($F(2,18) = 0.650, p = 0.53$), Psychopathy ($F(2,18) = 0.545, p = 0.59$), Direct Verbal Sadism ($F(2,18) = 0.193, p = 0.83$), Direct Physical Sadism ($F(2,18) = 1.179, p = 0.33$), and Vicarious Sadism ($F(2,18) = 0.012, p = 0.99$). There were also no significant differences found at the post-experimental phase for Machiavellianism ($F(2,18) = 0.650, p = 0.53$, $\eta^2 = 0.07$), Narcissism ($F(2,18) = 0.218, p = 0.81$, $\eta^2 = 0.02$), Psychopathy ($F(2,18) = 0.843, p = 0.45$, $\eta^2 = 0.09$), Direct Verbal Sadism ($F(2,18) = 0.204, p = 0.82$, $\eta^2 = 0.02$), Direct Physical Sadism ($F(2,18) = 2.446, p = 0.12$, $\eta^2 = 0.21$), and Vicarious Sadism ($F(2,18) = 0.388, p = 0.68$, $\eta^2 = 0.04$).

5.5: Discussion
Academics and laypeople have long debated whether entertainment media can serve as a causal influence on heightened aggression and violence, and the latest entertainment medium at the core of the debate is video games. While research into the effects of video games on aggression and violence has existed for decades, there were several fundamental issues with many of the experimental designs used
to identify any potential effects, such as inferences of violence and aggression based on seemingly unrelated tasks like the HSP and RRTT (Adachi & Willoughby, 2011; Ritter & Eslea, 2005), and the mismatch of games used for comparisons (Bartholow & Anderson, 2002; Ferguson, 2015). The present study sought to address some of these issues by performing a 6-week study that included a variety of games built primarily for VR gameplay, utilize a method to explicitly observe an act of cyberaggression, and ensure that game experienced were balanced in terms of enjoyment.

Findings from the present study ultimately found no evidence that VR games have any significant influence on the individual’s aggressive tendencies, indicative of both the self-report measures for the Dark Triad and sadism as well as the YouTube commenting task used to observe any potential flaming behaviours. The latter was designed to meet conditions in which individuals would be most likely to enact flaming behaviours, such as commenting anonymity and choice of video to watch (Bishop, 2013), but even so, there were almost no signs of comments that could be considered as flaming, and there were no significant differences between the Violent, Non-Violent, and No Game groups. While findings from the TME are in no way indicative of future physical aggression or violence as the measure was designed to evaluate relational aggression, findings from the SD3 and CAST measures further suggest that there are no significant differences between the three conditions in traits that would suggest more aggressive and violent tendencies.

While the present study was largely successful in demonstrating that gaming experiences, particularly VR experiences where the game is more immersive and interactive compared to traditional games, do not have any significant influence on one’s aggressive tendencies, there are a few limitations to note. The main limitation for the present study was sample size, primarily due to time and resource constraints. While the present study believes that the findings would not change drastically with more participants, having a larger sample size would have further reinforced the current findings. Furthermore, as the study focused on cyber-related relational aggression, it does not necessarily address the violent
video game debate’s focus on physical aggression and violence. While, again, measures such as the SD3 and CAST were included to partially account for a participant’s tendency for aggression or violence, it still does not serve to observe actual aggression and violence on the same level that the TME was used to observe cyberaggression. Despite these limitations, it is safe to assume that while VR programs can be capable of desensitization as demonstrated in Study 1, repeated exposure to violent VR video games does not desensitize an individual to lead to more aggressive tendencies as the GAM has suggested (Bushman & Anderson, 2002). Combining the findings from the present study and Study 1’s VR-based, self-directed exposure therapy, the possibility of utilizing VR games as a catalyst for carrying out self-directed treatment protocols is more optimistic. Furthermore, this is one of, if not, the first study that has examined the potential behavioural influence of VR games with an observable measure of aggression.

Chapter 6: Influence of VR Gaming on Prosocial Behaviours (Study 3)

The purpose of this chapter is to examine the potential effects of VR gaming on prosocial behaviours as a supplement to the findings from Study 2; while findings from Study 2 indicated that repeatedly playing VR games did not have a significant influence on the player’s aggressive tendencies, the same cannot necessarily be said with prosocial tendencies. This chapter will outline the various factors that are believed to contribute to an individual’s tendency to enact prosocial behaviours, as well as the limited research that has been conducted to examine the relationship between video games and prosocial behaviours. The aims of this chapter are to outline:

1. The dispositional and situational factors that influence prosocial behaviours
2. The difficulties underlying research into prosocial behaviours
3. The effect of VR gaming on prosocial behaviour

6.1: Introduction

Prosocial behaviours can be defined as any behaviour that is beneficial to others (Knafo & Plomin, 2006; Padilla-Walker, Nielson, & Day, 2016) without the underlying positive (e.g. donating to an important
cause) or negative (e.g. cooperating with someone to gain a favour or spite another person or group) motivations of the individual (Eisenberg & Miller, 1987). A prototypical prosocial behaviour is often construed as a voluntary, self-sacrificing action that costs the individual acting upon their prosocial tendencies time, money, or some other resource to perform (Padilla-Walker et al., 2016; Snippe, Jeronimus, aan het Rot, Ros, Jonge, & Wichers, 2017). Prosocial behaviours are, in essence, the antithesis to aggressive and violent behaviours.

In contrast with the established literature on the relationship between violent video games and aggression, research into the relationship between video games and prosocial behaviours could often be perceived as an afterthought. Most studies that did attempt to examine the relationship between video games and prosocial behaviours were often a by-product of findings from the violent video game and aggression literature. As one would expect, studies that concluded that video games were a causal factor for an increase in aggressive behaviours consequentially suggested that levels of prosocial behaviours were inversely affected (Greitemeyer & Osswald, 2010).

At its core, the existing literature for both prosocialness and aggression are largely the same, with both having examined the development of the respective behaviour and potentially influential factors that were experienced during childhood or adolescence (Padilla-Walker et al., 2016). While the aggression literature has both the GAM and CM to explain how aggressive tendencies form over time, the prosocialness literature also considers the individual’s decision-making process and potential targets that the individual may be most likely to act prosocially towards (Snippe et al., 2017). Just like the aggression literature, however, the research behind prosocialness can be boiled down to the nature vs. nurture debate, with nature factors including genetic influences (Knafo, Israel, & Ebstein, 2011), dispositional traits (Eisenberg, Fabes, Karbon, Murphy, & Wosinski, 1996), and gender (Eagly, 2009), and nurture factors including parenting styles (Clark, Dahlen, & Nicholson, 2015; Knafo & Plomin, 2006), the quality of parent-child relationships (e.g. connectedness; Yoo, Feng, & Day, 2013), and environmental stressors (e.g. war;
Keresteš, 2006). Other notable factors that have been examined for prosocialness include religiosity (Shariff & Norenzayan, 2007), incentives (Bénabou & Tirole, 2006), and trauma exposure (Frazier, Greer, Gabrielsen, Tennen, Park, & Tomich, 2013), which have not been studied as extensively in the aggression literature.

As there have been a lot of factors that have been examined and linked to both prosocialness and aggression, it becomes increasingly clear why video games have been repeatedly shown to have no significant influence on the player’s behaviour. Factors such as gender and genetic influences long precede the individual’s exposure to video games, and parenting styles could determine what kind of games the child is exposed to as well as how the child processes events and situations depicted in a game. As research dedicated to the influence of video games on prosocialness largely operate under the same theoretical foundations of the video game and aggression literature outlined in Study 2, it is important to dive into some of the factors examined in the prosocialness literature to better understand a part of why the established literature has failed to find any significant behavioural influences due to video gameplay.

6.1.1: Dispositional Factors of Prosocial Behaviours
6.1.1.1: Genetics

Twin studies have long been an exemplary approach towards examining genetic influences on prosocial behaviours, especially in relation to prosocial tendencies and empathy (Knafo, Zahn-Waxler, Davidov, Van Hulle, Robinson, & Rhee, 2009). Through these types of studies, Israel et al. (2009) and Knafo et al. (2008) were able to identify genetic polymorphisms, which can be used to identify inherited traits, in oxytocin receptors (OXR) and arginine vasopressin 1a receptors (AVPR1a) that were associated with donating money to strangers during a Dictator Game. Furthermore, Chester et al. (2015) found that DRD2 receptors, which are responsible for coding for lower dopaminergic functioning, could be associated with aggression and higher sensation seeking tendencies, while another dopaminergic gene receptor, DRD4, was associated with selflessness in young women (Bachner-Melman, Gritsenko, Nemanov, Zhoar, & Ebstein, 2005). While some studies believe findings linking prosocialness to genetic traits may actually be
due to situational factors (van Iizendoorn, Bakermans-Kranenburg, Pannebakker, & Out, 2010), there is still substantial evidence that genetics does, in part, have significant influence on one’s prosocial tendencies.

**6.1.1.2: Gender**

A substantial portion of the prosocialness literature has focused on whether there were any differences in relation to the type of prosocial behaviour and its frequency with regards to the individual’s gender, gender role, and gender identity. These types of studies often examined different targets (e.g. strangers and companions) alongside various social settings (e.g. work, community, and war), as these factors were especially important to consider if individuals are expected to behave in a way that is prototypical of their gender (e.g. associating Western males to act chivalrously and more assertive than women; Eagly, 2009).

In terms of interacting with and helping strangers, men were generally found to be more likely to help when the situation required them to take the initiative (e.g. helping someone who had fallen), but less likely to respond to a request for help (e.g. giving money to a beggar). This can change depending on the target or situation, however, as men were also found to be more likely to help a woman in need rather than another man, as well as being more likely to help if onlookers were present (Eagly & Crowley, 1986). Males were also observed to have exhibited more heroic acts, which can be defined as any behaviour in which the helper takes a considerable risk in order to help another person when a job (e.g. police officer, firefighter, etc.) or parental responsibilities did not require them to do so (Eagly, 2009).

Whereas men were more likely to help strangers or during situations that called for heroic, physically strenuous acts, women were found to be more likely to provide emotional support within a close relational context (e.g. friends and family). Women typically spend twice as much time caring for and helping family members than men, and were also found to be more likely to take on caregiver roles for the elderly. These findings persist even as the premise of the traditional family, one in which men serve
as the primary economic provider and women serve as the primary household support, is slowly changing towards a variety of other family dichotomies, such as both the men and women share equal responsibility for household finances and support (Eagly, 2009). Both sexes also tend to seek out women for emotional support, which further exemplifies the notion that women are perceived to be far more superior and reliable in terms of relational and emotional support than men (Kunkel & Burleson, 1999).

6.1.2: Situational Factors of Prosocial Behaviours

While dispositional factors outlined throughout Section 6.1.1 demonstrate some innate influences towards one’s prosocialness, the examination of whether video games can significantly influence the player’s behaviour is a part of an examination of to what degree situational variables can shape both prosocial and aggressive behaviour. The direction of the established prosocial literature also appears to favour more in terms of situational factors, as studies that focused on dispositional factors tended to note various situations in which individuals will be more likely to act prosocially. This is particular evident in Section 6.1.1.2, as male and female prosocial tendencies largely depended on the type of person, situation, and prosocial action type (e.g. physical and emotional). The following subsections aim to detail a few of the more notable situational factors that the prosocial literature have investigated, such as parenting styles and religion.

6.1.2.1: Parenting Styles

Studies that investigate parenting styles, which is defined by the approach in which the parent(s) take in raising a child, have often been used to evaluate how much of an effect a particular style has on the child’s overall behavioural development. There are three main parenting styles: authoritarian, authoritative, and permissive (Clark et al., 2015), each of which carry various degrees of parental warmth, support, and hostility (Padilla-Walker et al., 2016). Authoritarian parents typically place high demands on the child with little regard to the child’s needs, and can assert power through yelling, corporal punishment, and anger to coerce the child to comply with the parent’s demands. Permissive parents can be viewed as
the polar opposite of authoritarian parents, as the permissive style features a high degree of warmth and acceptance, but no attempt is made by the parents to control or discipline the child. The authoritative style is a balance between authoritarian and permissive style, where parents would utilize inductive disciplinary techniques (e.g. reasoning) for when the child misbehaves while still maintaining an environment of warmth and acceptance rather than hostility (Clark et al., 2015). While these parenting styles do tend to describe the parents’ approach towards raising their child, it is also important to consider the child’s perception of how they are being raised (Keresteš, 2006).

Of the three parenting styles, children raised by authoritative parents are generally more likely to exhibit prosocial behaviours, empathic responses, and cooperation compared to those raised by authoritarian or permissive parents, while also being more likely to develop more positive relationships with both their parents and peers (Baumrind, 1971; Roth, 2008; Spinrad & Stifter, 2006). Children raised by either authoritarian or permissive parents, however, tend to display more relational aggression and exhibit poor behavioural control (Kuppens, Grietens, Onghena, & Michiels, 2009; Sandstrom, 2007). Further evidence can also be found in Newton and Thompson’s (2016) study, which found that mothers who actively guide their toddler’s awareness towards others’ needs and emotions helped to aid the toddler’s own prosocial development, but if the mother does not, the toddler may enlist the aid of other individuals towards developing more prosocial behaviours. In short, children with a balanced relationship with their parents in terms of closeness and autonomy, which represents the authoritative parenting style, tend to grow up to be more empathetic and prosocial compared to children raised by authoritarian and permissive parents (Yoo et al., 2013).

6.1.2.2: Religion

Religion and religiosity are concepts that have both been positively linked to prosocial behaviours, with the former being defined as a social construct in which people with like-minded views congregate to worship a divine, spiritual, sacred, or holy being(s) with an intent to establish and foster a connection with
the avatar(s) of their worship (Batara, Franco, Quiachon, & Sembrero, 2016), and the latter being the aspects that constitute one’s religion (e.g. beliefs, church attendance, moral values, etc.; Van Cappellen, Saroglou, & Toth-Gauthier, 2016). Like the link between gender and prosocialness, however, there has been an extensive amount of research into the conditions in which religious individuals would most likely act prosocially (Everett, Hague, & Rand, 2016).

One of the main points of contention within the literature linking religion and prosocial behaviours is the concept of religious parochialism, which is the notion that religious individuals (i.e. theists) tend to be more prosocial towards other theists belonging to the same or similar religion. With religious parochialism, the prosocial behaviours exhibited by theists can be framed as in-group bias rather than indiscriminate prosocial behaviour. While some studies have concluded that theists tend to be more altruistic than non-theists, specifically in the form of donating money (e.g. offerings or charity), it is difficult to ascertain as to whether theists are being prosocial because of religious influences (e.g. religious teachings on giving back to the church), conformity, or innate desire (Galen, 2012). Although the reasoning behind a theist’s prosocialness is unclear, some studies have pointed to the notion that group members are more inclined to act more prosocially towards those belonging to the in-group (Piff, Dietze, Feinberg, Stancato, & Keltner, 2015), and as religion tends to spawn a large, cohesive social community, non-theists (e.g. atheists, agnostics, etc.) would not belong in the religious in-group (Shariff, Piazza, & Kramer, 2014).

Another point of contention refers to the idea of supernatural and secular monitoring, with the former being held by theists as the belief that they are being monitored by an omniscient deity at all times, and the latter being held by non-theists as the knowledge of being monitored by a secular organization (e.g. police, government, etc.). Theists who ascribe to supernatural monitoring tend to believe that there is no real sense of privacy: every action and thought can be observed and used by their avatar(s) of worship to judge the individual, therefore it is important to act prosocially at all times. While non-theists tend to act more prosocially when primed for secular monitoring, they are not significantly more inclined
when aspects of supernatural monitoring (e.g. someone is always watching you) are incorporated with the secular organization (e.g. Big Brother; Sharif & Norenzayan, 2007; Shariff et al., 2014).

Both types of monitoring beliefs also extend to the individual’s sense of morality, which in turn influences the situations in which the individual may choose to act prosocially. As theists hold that their deity or deities are absolute, the moral code described in the religious text constitute an absolute law in which the theist must (e.g. treat everyone equally, respect your parents, etc.) and must not (e.g. do not kill, do not engage in premarital sex, etc.) do. For non-theists, however, morality is perceived to be subjective and relative to culture, therefore what is moral depends on the context of the situation. There are, of course, certain moral grounds in which both theists and non-theists can agree as being universally wrong (e.g. indiscriminate violence; Piazza & Landy, 2013; Shariff et al., 2014). In short, when considering potential in-group bias, monitoring type, and sense of morality, practicing a religion does not necessarily imply that an individual will be more prosocial, because like gender, the individual or group calling for help and the context of the situation can inform how likely the individual would be to act prosocially.

6.2: Video Gaming and Prosocial Behaviours

With consideration to various factors such as the ones outlined throughout Section 6.1, it is apparent that there are greater influences on one’s development of prosocial behaviours than video games, as these factors either precede the individual’s ability to play video games (e.g. genetics and gender) or are based on upbringing (e.g. parenting styles) or lifestyle choices (e.g. religion). It is still important, however, to examine what has been done to link video gameplay to potential changes in prosocial behaviour, as there are a few similarities and differences with the violent video game literature outlined in Study 2.

6.2.1: Theoretical and Methodological Comparisons to the Violent Video Game Literature

In general, studies that have exclusively examined the relationship between video games and prosocialness tended to follow the same methodological procedures and theoretical foundations as the
literature on aggression and video gameplay. Most notably, the prosocial video game literature largely follows a revised version of the GAM in the form of the general learning model (GLM); as the GAM was primarily focused on the development of aggressive behaviours, the GLM was established to account for other types of behaviours, especially prosocialness, while following the same process outlined by the GAM (Buckley & Anderson, 2006). There are no real fundamental changes between the GLM and GAM aside from the inclusion of more behaviours, and it still represents a social learning model in which there is a bias to examine the influence of situational variables on prosocialness over dispositional factors.

One notable difference between the two literatures is the prosocial literature’s ability to observe, rather than infer, prosocial behaviour. Whereas the aggression literature relied on tasks such as the HSP and RRTT, the prosocial literature had tasks that aimed to directly observe helping behaviour, such as picking up dropped materials, registering for future studies, or intervening when spotting a confederate harassing another individual (Greitemeyer & Osswald, 2010; Tear & Nielsen, 2013). While some studies have opted to use, or include on top of direct observation, tasks that would only be able to infer prosocial behaviours, such as the use of vignettes or questionnaires (Greitemeyer, Osswald, & Brauer, 2010; Rosenberg, Baughman, & Bailenson, 2013), the ability to directly observe prosocial behaviours allows for a clearer connection to its relationship with video gameplay compared to attempts at linking video gameplay to aggressive behaviours.

6.2.2: Criticisms of the Prosocial Gaming Literature

While the prosocial gaming literature does benefit from being able to utilize tasks to directly observe prosocial behaviours, a clear advantage over tasks that can only infer aggressive behaviours in the violent gaming literature, many of the methodological criticisms of the latter still apply to the former. The prosocial gaming literature often only evaluated the short-term, immediate effects on either helping behavior, self-reports of emphatic concern, and schadenfreude (e.g. Greitemeyer, 2013; Greitemeyer & Osswald, 2010; Greitemeyer et al., 2010; Tear & Nielsen, 2013). Furthermore, there were cases in which
the games used for prosocial group conditions still contained depictions of violence, such as the case in Greitemeyer and Osswald’s (2010) study in which there were portrayals of a suicide bomber and death animations featuring figures jumping off a cliff and splattering on the ground. Advocates of the harm view in the violent video game literature hold the belief that any depiction of violence would inevitably lead to higher rates of aggression, and while Greitemeyer and Osswald (2010) found some evidence supporting this notion, their study did not appear to find any detriment in the participants’ prosocial tendencies despite exposure to both the violent content and reward for carrying out violent actions (e.g. a suicide bomber being used to open up a path for other characters to pass through and complete the in-game objective faster).

This leads to another criticism that has applied to the violent video game literature: the mismatch of games between experimental conditions. It is possible, however, that this limitation could be due in part by the lack of available prosocial games rather than purely the study’s negligence; while there are many prosocial games that are available, these games are primarily targeted for children, and prosocial games without any violent content are rare or non-existent. One possible method to rectify this issue may be to incorporate interactive visual novels, a subgenre of narrative-focused games in which players can make choices and solve puzzles to change the course of a story, which would synergize with studies that also use vignettes to measures prosocial behaviours. Even if the content of the game can be divided between violent and non-violent classifications, however, another issue to consider is the mismatch of gameplay mechanics, such as the freedom to explore the game’s environment or requiring constant attention. Some solutions that the prosocial video game literature has adopted to address this criticism include using a neutral game (e.g. Tear & Nielsen, 2013) or using similar games with different objectives to achieve (Greitemeyer & Osswald, 2013), but more work would need to be done to fully address this limitation.
Lastly, the prosocial video game literature has also largely failed to administer pre-experimental assessments to compare with post-experimental measures. This has applied to studies that have used direct observation tasks (Greitemeyer & Osswald, 2010; Tear & Nielsen, 2013) and inferred behavior tasks (Greitemeyer, 2013; Greitemeyer et al., 2010), which only compared outcomes between groups, rather than comparing to a baseline measure. Just as it was important in Study 2, to better understand the influence of a video game on any behaviour, be it aggression or prosocialness, it is imperative that baseline measures are included to allow for within-group comparisons in addition to between groups.

6.3: Study Overview
Throughout the present study, several factors were examined to exemplify some of the more influential factors for an individual’s level of prosocialness, and while there have been other factors that have been found to also have a large influence on one’s prosocialness, such as personality (Ashton et al., 1998; Eisenberg et al., 2002), incentives (Bénabou & Tirole, 2003, 2006; Mellström & Johannesson, 2008; Gneezy & Rustichini, 2000a, b), and trauma exposure (Affleck, Allen, Tennen, McGraw, & Ratzan, 1985; Affleck, Tennen, & Gershman, 1985; Frazier et al., 2013; Tedeschi & Calhoun, 1996), video games have not been known to have the same level of influence on one’s prosocialness. Still, while Study 2 concluded that repeated exposure to VR video games does not heighten the players’ aggressive tendencies, it does not necessarily mean that the players’ prosocial behaviours were unaffected. The present study aims to examine prosocial behaviours exclusively as a supplement to the previous study’s findings while also building on the previous study’s methodology.

The findings and conclusions of Study 2 were largely congruent with past studies in the violent video game literature, particularly those that supported the harmless view (Breuer et al., 2014; Elson & Ferguson, 2014; Ferguson, 2015), but what separated Study 2 from most of the other established studies was the use of a longitudinal method and use of multiple games that, while following similar themes and content for each game within the group, had various gameplay mechanics (e.g. having the player move
their arm to fire a gun vs. having the player move their head to aim a turret). As there were very few differences between findings from the longitudinal design of the previous study and the single-session designs of past studies, the present study opts to streamline the process by introducing a shorter, two-session design and focusing on a single game per group. By streamlining the process, the present study hopes to address one of the main limitations of the previous study: low sample size. As it was difficult to recruit participants that could commit to coming in for six consecutive weekly sessions, reducing the number of experimental sessions to two would still allow for repeated testing, but would limit the games available for testing to one. As prosocial behaviours are largely social in nature, the present study has also opted to use games that exemplify social interactions, specifically local multiplayer VR games.

To follow up on the findings set by the previous study, the present study hypothesizes that repeated exposure to multiplayer VR gaming will have no effect on the player’s prosocial tendencies. While past studies have posited that the competitiveness and cooperativeness within games may influence higher tendencies of aggression and prosocial behaviours (Adachi and Willoughby, 2011), respectively, based on the outcomes observed in Study 2’s SD3 and CAST measures, the present study posits that incorporating these social elements would not be enough to facilitate the video game’s potential to influence the player’s behaviour.

6.3.1: Methodology
6.3.1.1: Design
A randomized controlled experimental design was implemented for the present study and focused exclusively on quantitative self-report measures to evaluate each participant’s level of prosocialness. As Study 2 concluded that there were no significant differences between gaming-based conditions and the no-game condition, the present study utilized two groups instead of three: Violent Competitive and Non-Violent Cooperative. Each participant underwent two one-hour sessions held weekly, and no monetary incentive was used for the present study.
6.3.1.2: Participants
A total of 20 participants (13 male, 7 female) were recruited via online tools and posters posted around the University of Bolton campus (n = 7) and in the general Eastern Tennessee area (n = 13). The average age of the participants ranged from 20 to 58 (M = 30.50, SD = 10.17), with most being Caucasian (n = 15), and the rest being Black (n = 2) and Asian (n = 3).

6.3.1.3: Instruments/Apparatus
• HTC Vive: The HMD used in the studies from Studies 1 and 2 were used again to display VR content for the present study. Participants that were based in the University of Bolton campus used this HMD exclusively for the experiment.

• Oculus Rift S: An additional HMD was used for the present study that mirrored many of the features of the HTC Vive. Minimum system requirements for the Rift S include a NVIDIA GTX 1050Ti or AMD Radeon RX 470 GPU, an Intel i3-6100 or AMD Ryzen 3 1200 CPU, 8 gigabytes of RAM, a DisplayPort 1.2 for video output, and a Windows 10 operating system. 360-degree head tracking is achieved through inside-out tracking, which utilizes five camera sensors located on the headset to track both the user’s position in the physical space as well as the position of the included controllers. The headset has the same 110-degree field of view as the Vive and also allows most prescription eyeglasses to be used with the headset. Participants that were based in the Eastern Tennessee area used this HMD exclusively for the experiment.

• Blue Effect VR: Developed by DIVR Labs, Blue Effect VR is an atmospheric FPS set in a science fiction setting (See Figure 13). The game features an asymmetrical multiplayer mode in which the VR user (the participant) plays the role of a human set to exterminate the aliens (the experimenter, playing on a laptop) in a dark environment. For the human to win, the participant must be able to survive for a period of 3 minutes, but if the aliens are able to deplete the human’s life meter within the time frame, the aliens win. Approximately 10 rounds are played within each 30 minute gameplay session. This game has not been rated by any of the official game rating
organizations, but contains potentially frightening imagery and was recommended by 88% (74) of the people who bought, played, and reviewed this game (84) as of 04-April-2017.

Keep Talking and Nobody Explodes: Developed by Steel Crate Games, *Keep Talking and Nobody Explodes* is an asymmetrical cooperative multiplayer game in which the objective is for the players to disarm a bomb with limited information (See Figure 14). The participant will be tasked with playing the game in VR, which assumes the role of a bomb disarmer that is able to see and manipulate modules on a procedurally generated bomb but has no knowledge on how to disarm the bomb. Meanwhile, the experimenter will be playing the game as the bomb manual instructor, who has knowledge of how to disarm the bomb as displayed on a laptop, but cannot see the bomb. Together, both the bomb disarmer and bomb manual instructor must communicate and work together to share the information available to them to disarm the bomb within a set amount of time. This game received a PG rating from the OFLC for mild violence and scary scenes, although
initial playthroughs did not reveal any depicted violence (if the bomb detonates, the screen only turns black with a loud explosion sound to indicate failure). Overall, 98% (3,385) of players who bought, played, and reviewed the game (3,439) recommended the game as of 04-April-2017.

*Figure 14: Keep Talking and Nobody Explodes*

- **Prosocialness Scale for Adults (PSA; See Appendix I):** The PSA, developed by Caprara, Steca, Zelli, and Capanna (2005), was used to gauge each participant’s prosocialness level in relation to helping, sharing, taking care of, and feeling empathic behaviours. A total of 16 items were included with the scale and could be answered through a 5-point Likert scale.
- **PQ:** The same PQ used in Studies 1 and 2 was used to evaluate the participant’s sense of presence for the present study.
- **SSQ:** The same SSQ used in Studies 1 and 2 was used to determine whether participants felt any symptoms of simulator sickness during VR gameplay.
• GEQ: The same GEQ used in Study 2 was used to evaluate the participant’s thoughts towards the game.

6.3.1.4: Procedure
Participants in both groups underwent two one-hour sessions with 30 minutes dedicated to VR gameplay per session. During the first session, participants were given an informed consent followed by pre-experimental questionnaires that included demographic information and the PSA. Once both questionnaires had been completed, the experimenter briefly explained both the experimenter’s and participant’s role in the game respective to the participant’s randomly assigned condition. Following the VR gameplay portion of the session, participants were given the PQ and SSQ to complete. In the second session, the participant started with the VR game followed by a battery of post-experimental assessments including the PSA, GEQ, PQ, and SSQ.

6.3.2: Results
6.3.2.1: Manipulation Check
An independent t-test was conducted to analyse any differences in game enjoyment between the two games used in the study. No significant differences were found in relation to enjoyment ($t(18) = 0.805, p = 0.43$), pace ($t(18) = -0.583, p = 0.57$), interactivity ($t(18) = -1.095, p = 0.29$), and subjective rating ($t(18) = 0.250, p = 0.81$). Significant differences were found, however, in relation to difficulty ($t(18) = -2.588, p = 0.02$) and graphics ($t(18) = -2.310, p = 0.03$). Based on the means for difficulty of Blue Effect VR ($M = 2.70$, $SD = 0.67$) and Keep Talking and Nobody Explodes ($M = 3.50$, $SD = 0.71$), the latter appeared to be more difficult to play than the former.

Another independent t-test was used to analyse PQ and SSQ responses, and found no significant differences between the two games in relation to sub-measures of Realism ($t(18) = 0.303, p = 0.77$), Possibility to Act ($t(18) = 1.025, p = 0.32$), Quality of Interface ($t(18) = 1.538, p = 0.14$), Possibility to Examine ($t(18) = 0.961, p = 0.35$), Self-Evaluation of Performance ($t(18) = 1.086, p = 0.29$), Sounds ($t(18) = 0.730, p = 0.48$), and Haptic ($t(18) = 0.129, p = 0.90$). No significant differences were also found for
simulator sickness symptom sub-categories of nausea ($t(18) = -0.450, p = 0.66$) and ocular-motor ($t(18) = -0.457, p = 0.65$).

6.3.2.2: PSA

An independent $t$-test was conducted to analyse responses from the PSA questionnaire, and while there was a significant difference between both the Violent Competitive and Non-Violent Cooperative conditions at the pre-experimental phase ($t(18) = -2.605, p = 0.02$), there were no significant differences found at the post-experimental phase ($t(11.360) = -1.634, p = 0.13$). Further analysis was done using a paired samples $t$-test to evaluate any potential changes within each condition, but no significant differences in prosocialness was observed for both the Violent Competitive ($t(9) = -0.567, p = 0.59$) and Non-Violent Cooperative ($t(9) = 1.041, p = 0.33$). Based on these findings, it appeared that the significant difference observed at the pre-experimental phase was based on the Non-Violent Cooperative condition exhibiting slightly more prosocialness ($M = 4.45, SD = 0.33$) compared to those in the Violent Competitive condition ($M = 3.93, SD = 0.54$), but these differences disappeared at the post-experimental phase ($M_{\text{Violent}} = 3.97, SD_{\text{Violent}} = 0.68; M_{\text{Non-Violent}} = 4.35, SD_{\text{Non-Violent}} = 0.25$).

6.4: Discussion

The present study represents one of, if not, the first study that examined the relationship between VR gaming and prosocialness, which was primarily conducted to evaluate whether the same findings from Study 2 could apply to prosocial behaviours. Combining the findings from both the present study and Study 2, it is safe to conclude that video games do not have any significant effect on the individual’s aggressive and prosocial tendencies. The present study did, however, still struggle with some of the limitations from Study 2 in the form of low sample size and inability to directly observe behaviour. It is possible that the significant difference in prosocialness observed between the two conditions in the pre-experimental phase may have been due to low sample size; even though there were more people per group in the present study ($n = 10$) compared to Study 2 ($n = 7$), a larger sample size could have been a
solution to rectify this issue and also reinforce the present study’s findings. Furthermore, there was an attempt to directly observe prosocial behaviour by “accidentally” dropping pencils and pens to see whether the participant would help pick them back up, which has been one of the more prominent methods to gauge and observe prosocial behaviour (Carpenter, Uebel, & Tomasello, 2013; Passmore & Holder, 2014; Peña & Chen, 2017). This method was tested early on with a few pilot participants but felt awkward and forced as the experimenter was the only one that interacted with the participant, therefore there was a risk of experimenter and participant biases to occur. While other methods were reviewed, such as vignettes (Greitemeyer, 2013), the PSA was ultimately chosen due to its quantifiability. Despite the limitations, the present study was able to demonstrate that social VR gaming experiences neither positively nor negatively and significantly impact the individual’s prosocial behaviour.

**Chapter 7: Epilogue**

VR is a technological medium that has been shaped and innovated upon for decades, but it was not until recently when the technology needed to support an immersive, interactive, and high quality VR experience was accessible for the general population. While current iterations of VR are still limited in its capabilities, it has taken many of the technological advancements established over the years to produce a medium that is greater than the sum of its individual parts, and with continued research and innovation, VR can become even more immersive and interactive.

The present thesis outlined many topics related to VR and its implications in relation to various types of behaviours, demonstrating that VR has uses that lie far beyond entertainment. In Chapter 3, a systematic review outlined many of the past VR studies as it related to research both using and into VR technology with prominent topics focusing on VR as a therapeutic tool as well as a substitute for dangerous situations. In Study 1, the potential for VR to be used as a device to carry out self-directed interventions for acrophobia was explored. In Studies 2 and 3, the influence of VR gaming experiences on both aggression and prosocial behaviours, respectively, were examined. This chapter will primarily cover:
1. The conclusions and collective implications from findings in each of the three experimental studies carried out in the present thesis

2. The current and future state of VR and its position in psychological research and therapy

7.1: Conclusions from the Current Thesis and the Contributions to Knowledge

The present thesis had three core objectives: 1) Investigate previously established VR-related literature, 2) Evaluate the potential for VR to carry out a self-directed treatment plan for acrophobia, and 3) Determine whether VR gaming experiences would significantly influence the player’s social behaviours in relation to aggression and prosocialness. Collectively, these objectives were established to fulfil a singular goal of introducing a novel, accessible VR-based self-directed treatment methodology.

In Study 1, a randomized, mixed-methods case study for three patients was conducted to evaluate the feasibility of a VR-based self-directed treatment procedure for acrophobia using a height simulator that was not intentionally designed for therapeutic use. Findings from this study were generally positive; while both the pure self-help and guided self-help patients were able to alleviate at least some of their acrophobia symptoms after completing their treatments, the guided self-help patient demonstrated continued, long-term gains based on follow-up data six months following treatment. Although objective ratings throughout this study generally suggested that the pure self-help patient did not experience any improvements, her subjective responses and observable behaviour indicated otherwise. While these findings are not generalizable due to the limited nature of a case study methodology, it does establish promising evidence for a self-directed version of classic VRET procedures that individuals with mild to moderate phobia symptoms could conduct independently, or with minimal help, from a trained therapist. Ultimately, the study demonstrated that with some minimal instructions about the basic processes of exposure therapy, the stimuli produced in a non-therapeutic VR program was enough to elicit phobia-related anxiety and avoidance, and with repeated exposure, the phobia symptoms can be alleviated.
In Studies 2 and 3, a randomized, quantitative controlled study was used to examine the influence of VR gaming experiences on aggression and prosocial behaviours, respectively. In relation to the violent VR video game study in Study 2, the study was developed to address some of the longstanding issues with past violent video game research by implementing repeated gameplay experiences, direct observation of aggression, and between and within-group game balance based on a myriad of factors. Study 3 served to compliment the findings from Study 2 by evaluating potential changes in participants’ prosocial behaviour due to VR games with multiplayer components. Despite both of these studies being plagued with low sample sizes, both studies generally point to the same conclusion: gaming does not significantly affect the player’s positive and negative behaviours.

Collectively, findings from the three experimental studies carried out in the present thesis establish a foundation for the implementation of a VR-based self-directed intervention for acrophobia, and potentially other specific phobias and anxiety-related disorders such as PTSD, through the use of standard, commercial VR programs. Furthermore, if a VR game were to be used as the stimuli for the self-directed intervention, it is highly unlikely that desensitization due to repeated exposure would negatively affect the user’s social behaviour. While a height-based VR game could have been used to demonstrate this more directly, the use of Richie’s Plank Experience in Study 1 was important on two levels: 1) The program did not have complex mechanics that could have introduced extraneous variables (e.g. game intensity, game objectives, etc.) that would have detracted from the stimuli itself, and 2) It demonstrated that even the most basic, barebones VR programs can be appropriated for therapeutic use to achieve long-lasting treatment gains, therefore positioning commercial VR programs to be more affordable and accessible compared to a program that may have been developed specifically for therapeutic purposes.

As there is now evidence that exposure to stimuli in the VE can sufficiently elicit phobia-related anxiety and avoidance behaviours, and repeated exposure can attenuate the phobia-related symptoms, there are many avenues of research that can be recommended to pursue based on the studies conducted
for the present thesis. Aside from replication studies with larger sample sizes, the next step to furthering this line of research would be to appropriate VR games that depict specific phobia-related stimuli to varying degrees. As exemplified throughout Studies 2 and 3, video games are a complex medium that integrates several mechanics and systems to present players with varying objectives and goals to complete. Future research should consider how a specific phobia’s stimuli is handled in the game; in the case of acrophobia, a game could use heights as an obstacle (e.g. To the Top’s focus on climbing up walls to reach the goal), or as an occasional level design that the player encounters (e.g. Arizona Sunshine where the player must traverse across bridges and balconies occasionally). Further research could also compare treatment gains from using basic, focused programs like Richie’s Plank Experience to potential gains made from using a VR game that prominently features heights as a gameplay mechanic. While the usage of games in therapy is not a new concept, exemplified by the numerous studies that have used games for physical therapy (Lohse et al., 2013) and CBT (Brezinka, 2012), there is little to no documented studies utilizing a self-directed approach using VR games. Under this notion, the present thesis has established a foundation towards this cause.

It should be noted that while the main objective of the present thesis was to establish a foundation in which an effective self-directed VRET procedure could be built, it is in no way an attempt to replace traditional treatment methods for specific phobias (e.g. CBT). For self-directed interventions to be successful, the individual must be able to maintain motivation to seek and complete the treatment process (Klein & Richards, 2001; Öst et al., 1998), a prerequisite that some will inevitably not be able to meet. While self-directed interventions for specific phobias have been demonstrated to be effective in the past (Andersson et al., 2006; Schneider, Mataix-Cols, Marks, & Bachofen, 2005), the studies opted to use a guided self-help methodology where some of the process was still primarily led by the therapist. Study 1 aimed to innovate upon previously established methodologies by utilizing VR instead of traditional in-vivo exposure, as well as making it so that guidance from a trained therapist, while beneficial as a
supplement, is not completely necessary to achieve comparable treatment gains. There will always certainly be a need for trained therapists to carry out traditional exposure therapies for specific phobias, as they can provide guidance and supervision where necessary, however, for those without ready access to a trained therapist, or for those who refuse to see a trained therapist for one reason or another, self-directed VRET may serve as one of the most accessible and effective treatment methods available to them.

7.2: The Future of VR in Psychological Research and Therapy
Technology is constantly advancing, and VR is no exception. Since modern VR’s launch in 2016, several improvements have been made in subsequent models since, featuring higher screen resolutions, larger field of view, and control schemes that incorporated hand presence, the ability for the VR user to see their hands in the VE. As VR advances, it is also imperative for psychological researchers and therapists to keep pace in order to better advance research and therapeutic practices into and using the technological medium; the present thesis has only demonstrated a small part of what VR is capable of. VR provides an opportunity to innovate therapeutic practices to be more accessible and effective (e.g. self-directed interventions), test scenarios that are otherwise dangerous or unethical in a real context (e.g. the Trolley Problem; Navarrete, et al., 2012), and develop alternative ways to tackle long standing debates within the scientific community (e.g. violent video game debate). As modern VR is still relatively new, it is also important to explore its potential implications to better understand the advantages and disadvantages of using the technology; without proper research, researchers and therapists would be missing a chance to further advance their fields.

7.2.1: Improving VR through the Cloud
At its current state, VR is a combination of multiple types of technologies that interact cohesively to produce an immersive, interactive experience within the VE. The majority of HMDs utilize stereoscopic displays to produce a sense of depth, 360-degree audio to allow users to locate sounds around them, and sensors to translate physical movements in the real world to actions in the VE. Up until recently, HMDs
also needed to be tethered to another device, be it a computer or smartphone, that would process the graphical and computational information needed to produce a cohesive VR experience. The advent of standalone HMDs such as the Oculus Quest, which contain all of the necessary hardware within the headset, have introduced a much freer VR experience compared to its computer-based counterparts as there are no wires to potentially trip over or restrict the user’s movements, and a much higher quality VR experience compared to its smartphone-based counterparts as VR programs can be better optimized for the hardware. Despite the multiple variations of VR in relation to technological capability, cost, and experiences, more improvements could be made to further increase its accessibility as adoption rates for VR technology have struggled (Laurell, Sandström, Berthold, & Larsson, 2019).

Looking forwards, however, there are a few important technological advancements that could further improve the overall VR experience for both the technology itself and for therapeutic and research purposes. While not entirely related to VR right now, there has been a trend in the entertainment industry to adopt streaming services, which is characterized by the delivery of content over the Internet, ranging from music (e.g. Spotify; Datta, Knox, & Bronnenberg, 2017) to film and television (e.g. Netflix; Huang, Johari, McKeown, Trunnell, & Watson, 2015) without the need to download the content onto a device. This is particularly notable as Google had recently announced a streaming platform for video games in the form of Stadia, which works by using Google’s servers to do the computational and graphical rendering that a video game requires and sends the visual and auditory stimuli to the player with minimal to no noticeable latency. This technological process, known as remote graphics rendering (RGR), generally requires high levels of network bandwidth (i.e. Internet speed) to succeed as there is a lot of data needed to be exchanged between player inputs and server outputs, but allows users to use virtually any Internet-connected device (e.g. computer, tablet, smartphone, etc.) to play games that would have been otherwise impossible due to the device’s weaker internal CPU, GPU, and RAM components (Choi & Ko, 2019).
In relation to VR, RGR would eliminate the need for HMDs to be tethered to powerful, but expensive, gaming computers, which can be attributed to part of the reason why modern VR has had a slow adoption rate—the less parts a potential VR user would need to buy for a complete VR experience (e.g. VR-capable computer), the more accessible it will be. By relegating many of the intensive processing to a server, HMDs can also focus more on components to improve stimuli presentation, such as higher screen resolution, more sophisticated tracking mechanisms, and battery longevity. While this is entirely posturing, as services like Google Stadia have yet to begin at the time of this writing to fully gauge its real-world capabilities, several public tests have demonstrated its effectiveness where similar services like Ouya had failed in the past.

7.2.2: A Call for Collaboration between the Games Industry and Psychologists

While the concept of using commercial video games for therapeutic purposes is not new, it is still a niche approach, at least in relation to the field of psychotherapy; whereas fields like physical therapy have found multiple uses for video games to promote rehabilitation for motor impairments and stroke (Bateni, 2012; Lohse et al., 2013), there has not been as many documented studies for treatments for psychological disorders. While it should be noted that serious games, games in which were designed for purposes other than entertainment (e.g. education, training, therapy, etc.), have been documented to be effective within psychotherapy, these games may not be as readily available for the general public or would require a trained therapist to operate and supervise the patient (Zielhorst et al., 2015). Furthermore, serious games may not be as enjoyable as commercial games, which would consequentially lead to a lowered motivation to complete or retain anything that could be gained from playing a serious game (Breuer & Bente, 2010).

Luckily, major developers in the games industry have gradually embraced the challenge of gamifying experiences beyond the purposes of entertainment while still retaining the level of fun and enjoyability that players have come to expect from those developers. For example, the Nintendo Wii
console has brought with it many games that have been used for physical therapy, such as *Wii Fit* (Agmon, Perry, Phelan, Demiris, & Nguyen, 2011; Barcala, Grecco, Colella, Lucareli, Salgado, & Oliveira, 2013; Bateni, 2012) and *Wii Sports* (Deutsch et al., 2011), which were instrumental to the patients’ treatment gains. Beginning with *Assassin’s Creed: Origins*, Ubisoft has integrated a Discovery Tour mode into the Assassin’s Creed franchise, which replaces the focus of the game’s main fighting mechanics with exploration tools to allow players to learn more about the setting the game was inspired by.

The gamification of therapeutic processes, at least for processes aimed at alleviating specific phobia symptoms, is an interdisciplinary goal that the video games industry and psychologists could pursue, as many of the systems and mechanisms that serve as the foundation for both gaming and therapy are similar. For example, both games and therapy have clear goals (Obtain “x” item or Be able to confront the object of the phobia, respectively), rely on feedback to correct any errors, have progressively difficult challenges, and sometimes involve processes of socialization to encourage individuals to play or continue in the therapeutic process, respectively. By utilizing commercial games for therapeutic purposes, patients can potentially be more engaged with the treatment and motivated to complete the treatment where they may have otherwise withdrawn from a standardized treatment procedure (Lohse et al., 2013). In short, the games industry has demonstrated its willingness to explore new avenues to provide novel gaming experiences, but psychologists must be able to provide the necessary guidance to pave the way for the utilization of commercial games for therapeutic purposes.

One final point towards the utilization of commercial games over specifically-made therapeutic games is the concept of modding, characterized by alterations or additions made by an individual or group outside of the original developer and publisher (Sotamaa, 2008). Mods can be as simple as replacing a character from one game with another character from a different game (e.g. replacing Mario from the *Super Mario* series with Link from *The Legend of Zelda* series) to complex additions such as expansions that add large amounts of content in the form of new quests, characters, items, and locations (e.g. *Fallout*
In the case for psychotherapeutic mods, however, using a commercial game minimizes the amount of time and resources needed to develop a game from the ground up, as modders would only need to focus on systems that meet the requirements to carry out a psychotherapeutic protocol. Applying this to Study 1, mods could be created to further facilitate the therapeutic process in the form of information presented through a heads-up display (e.g., heart rate, current altitude, etc.), levels designed to represent more traditional exposure stimuli (e.g., glass elevator), or tiered platforms that serve as objective markers to give the user a better sense of progression. A study by Freeman et al. (2019) tested a program specifically geared towards the automation of VRET through the integration of a scripted, virtual guidance system, but despite its initial positive findings, one limitation from developing the program was in its high costs and development time. While modding can still require time and money to develop, working with a pre-established game would greatly reduce costs while digital storefronts that support mods, such as Steam, ensure that mods can be distributed and accessible to anyone that owns the main game.

7.3: Final Conclusions
Since its initial commercial release in the 1980's, VR has struggled to achieve mainstream use as the technologies that it relies on were not powerful enough to establish an immersive, interactive, and accessible VR experience. While modern VR appears to be a promising step towards reaching the full potential of VR, it is apparent that there are still improvements that can be made to give the user a greater sense of presence. Nevertheless, the current iterations of VR HMDs carry wide implications for psychotherapy and psychological research, both due to its relatively novel nature and its capabilities to portray an endless number of environments and scenarios to fit the needs of a patient seeking help or an experimenter needing an environment where they have full control over potentially extraneous variables.

The primary objective of the present thesis was to establish a foundation for the implementation of a self-directed VRET procedure that the general population could utilize, and to that end, the present
thesis has met that objective alongside its secondary objective of ensuring that VR gameplay experiences would not negatively influence the user’s behaviour in any form. While a foundation has been established, more research must be done to better refine the protocols for the self-directed VRET procedure outlined in the present thesis, enhance its accessibility to reach those who need it, and to expand its use beyond acrophobia. For decades, psychologists have sought to unlock the near limitless implications that VR could have on both the field of psychology and the world in general, and despite the technology being a far cry decades ago compared to where it is today, it is with great hope that psychologists will continue to embrace VR to develop new treatment procedures and experimental methodologies just as the present thesis has done.
References


of the arginine vasopressin 1a receptor RS3 promoter region and correlation between RS3 length and hippocampal mRNA. *Genes, Brain And Behavior, 7*, 266-275.


Sotamaa, O. (2008). When the game is not enough: Motivations and practices among computer game modding culture. Games And Culture, 5(3), 239-255.


Appendix A

Acrophobia Questionnaire Pt. I

Below we have compiled a list of situations involving height. We are interested to know how anxious (tense, uncomfortable) you would feel in each situation nowadays. Please indicate how you would feel towards each item by selecting the number with the most appropriate label.

1) Diving off the low board at a swimming pool
   Not at all anxious; calm and relaxed
   0  1  2  3  4  5  6
   Extremely anxious

2) Stepping over rocks crossing a stream
   Not at all anxious; calm and relaxed
   0  1  2  3  4  5  6
   Extremely anxious

3) Looking down a circular stairway from several flights up
   Not at all anxious; calm and relaxed
   0  1  2  3  4  5  6
   Extremely anxious

4) Standing on a ladder leaning against a house, second story
   Not at all anxious; calm and relaxed
   0  1  2  3  4  5  6
   Extremely anxious

5) Sitting in the front of a second balcony of a theatre
   Not at all anxious; calm and relaxed
   0  1  2  3  4  5  6
   Extremely anxious

6) Riding a Ferris wheel
   Not at all anxious; calm and relaxed
   0  1  2  3  4  5  6
   Extremely anxious

7) Walking up a steep incline in country hiking
   Not at all anxious; calm and relaxed
   0  1  2  3  4  5  6
   Extremely anxious

8) Airplane trip
   Not at all anxious; calm and relaxed
   0  1  2  3  4  5  6
   Extremely anxious

9) Standing next to an open window on the third floor
   Not at all anxious; calm and relaxed
   0  1  2  3  4  5  6
   Extremely anxious

10) Walking on a footbridge over a highway
    Not at all anxious; calm and relaxed
    0  1  2  3  4  5  6
    Extremely anxious

11) Driving over a large bridge
12) Being away from window in an office on the 15th floor of a building
Not at all anxious; calm and relaxed
Not at all anxious; calm and relaxed
Extremely anxious

13) Seeing window washers ten flights up on a scaffold
Not at all anxious; calm and relaxed
Extremely anxious

14) Walking over a sidewalk grating
Not at all anxious; calm and relaxed
Extremely anxious

15) Standing on the edge of a subway platform
Not at all anxious; calm and relaxed
Extremely anxious

16) Climbing up a fire escape to the 3rd floor building
Not at all anxious; calm and relaxed
Extremely anxious

17) On the roof of a ten-story apartment building
Not at all anxious; calm and relaxed
Extremely anxious

18) Riding an elevator to the 50th floor
Not at all anxious; calm and relaxed
Extremely anxious

19) Standing on a chair to get something off a shelf
Not at all anxious; calm and relaxed
Extremely anxious

20) Walking up the gangplank of an ocean liner
Not at all anxious; calm and relaxed
Extremely anxious

Acrophobia Questionnaire Pt. II
Now that you have rated each item according to anxiety, we would like you to rate them as to avoidance. Indicate in the scale provided below each item as to how much you would avoid the situation if it arose.

1) Diving off the low board at a swimming pool
Would not avoid doing it
Would not do it under any circumstances
<table>
<thead>
<tr>
<th></th>
<th>Activity Description</th>
<th>Would not avoid doing it</th>
<th>Would not do it under any circumstances</th>
</tr>
</thead>
</table>
| 2 | Stepping over rocks crossing a stream  
Would not avoid doing it  
0 1 |                           |                          |
| 3 | Looking down a circular stairway from several flights up  
Would not avoid doing it  
0 1 |                           |                          |
| 4 | Standing on a ladder leaning against a house, second story  
Would not avoid doing it  
0 1 |                           |                          |
| 5 | Sitting in the front of a second balcony of a theatre  
Would not avoid doing it  
0 1 |                           |                          |
| 6 | Riding a Ferris wheel  
Would not avoid doing it  
0 1 |                           |                          |
| 7 | Walking up a steep incline in country hiking  
Would not avoid doing it  
0 1 |                           |                          |
| 8 | Airplane trip  
Would not avoid doing it  
0 1 |                           |                          |
| 9 | Standing next to an open window on the third floor  
Would not avoid doing it  
0 1 |                           |                          |
|10 | Walking on a footbridge over a highway  
Would not avoid doing it  
0 1 |                           |                          |
|11 | Driving over a large bridge  
Would not avoid doing it  
0 1 |                           |                          |
|12 | Being away from window in an office on the 15th floor of a building  
Would not avoid doing it  
0 1 |                           |                          |
|13 | Seeing window washers ten flights up on a scaffold  
Would not avoid doing it  
0 1 |                           |                          |
<table>
<thead>
<tr>
<th></th>
<th>Activity</th>
<th>Willing to Do It</th>
<th>Would Not Do It</th>
<th>Willing to do under any circumstances</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Walking over a sidewalk grating</td>
<td>Would not avoid doing it</td>
<td>0</td>
<td>Would not do it under any circumstances</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Standing on the edge of a subway platform</td>
<td>Would not avoid doing it</td>
<td>0</td>
<td>Would not do it under any circumstances</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Climbing up a fire escape to the 3rd floor building</td>
<td>Would not avoid doing it</td>
<td>0</td>
<td>Would not do it under any circumstances</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>On the roof of a ten-story apartment building</td>
<td>Would not avoid doing it</td>
<td>0</td>
<td>Would not do it under any circumstances</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Riding an elevator to the 50th floor</td>
<td>Would not avoid doing it</td>
<td>0</td>
<td>Would not do it under any circumstances</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Standing on a chair to get something off a shelf</td>
<td>Would not avoid doing it</td>
<td>0</td>
<td>Would not do it under any circumstances</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Walking up the gangplank of an ocean liner</td>
<td>Would not avoid doing it</td>
<td>0</td>
<td>Would not do it under any circumstances</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
Appendix B

**Attitudes Towards Heights Inventory**

For the following items, please indicate on a scale from 1 to 10 how you feel towards heights and/or elevated places.

<table>
<thead>
<tr>
<th>Bad</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pleasant</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Awful</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Safe</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Harmless</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Threatening</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>
Appendix C

Presence Questionnaire

Characterize your experience in the environment by selecting the appropriate number on the 7-point scale, in accordance with the question content and descriptive labels. Please consider the entire scale when making your responses, as the intermediate levels may apply. Answer the questions independently in the order that they appear. Do not skip questions or return to a previous question to change your answer.

1) How much were you able to control events?
   Not at all 1 2 3 4 5 6 7

2) How responsive was the environment to actions that you initiated (or performed)?
   Not responsive 1 2 3 4 5 6 7

3) How natural did your interactions with the environment seem?
   Extremely artificial 1 2 3 4 5 6 7

4) How much did the visual aspects of the environment involve you?
   Not at all 1 2 3 4 5 6 7

5) How natural was the mechanism which controlled movement through the environment?
   Extremely artificial 1 2 3 4 5 6 7

6) How compelling was your sense of objects moving through space?
   Not at all 1 2 3 4 5 6 7

7) How much did your experiences in the virtual environment seem consistent with your real world experiences?
   Not consistent 1 2 3 4 5 6 7

8) Were you able to anticipate what would happen next in response to the actions that you performed?
   Not at all 1 2 3 4 5 6 7

9) How completely were you able to actively survey or search the environment using vision?
   Not at all 1 2 3 4 5 6 7

10) How compelling was your sense of moving around inside the virtual environment?
    Not compelling 1 2 3 4 5 6 7
11) How closely were you able to examine objects?
   Not at all
   1  2  3  4  5  6  7
   Very closely

12) How well could you examine objects from multiple viewpoints?
   Not at all
   1  2  3  4  5  6  7
   Extensively

13) How involved were you in the virtual environment experience?
   Not involved
   1  2  3  4  5  6  7
   Completely engrossed

14) How much delay did you experience between your actions and expected outcomes?
   No delays
   1  2  3  4  5  6  7
   Long delays

15) How quickly did you adjust to the virtual environment experience?
   Not at all
   1  2  3  4  5  6  7
   Less than one minute

16) How proficient in moving and interacting with the virtual environment did you feel at the end of the experience?
   Not proficient
   1  2  3  4  5  6  7
   Very proficient

17) How much did the visual display quality interfere or distract you from performing assigned tasks or required activities?
   Not at all
   1  2  3  4  5  6  7
   Prevented task performance

18) How much did the control devices interfere with the performance of assigned tasks or with other activities?
   Not at all
   1  2  3  4  5  6  7
   Interfered greatly

19) How well could you concentrate on the assigned tasks or required activities rather than on the mechanisms used to perform those tasks or activities?
   Not at all
   1  2  3  4  5  6  7
   Completely

20) How much did the auditory aspects of the environment involve you?
   Not at all
   1  2  3  4  5  6  7
   Completely

21) How well could you identify sounds?
   Not at all
   1  2  3  4  5  6  7
   Completely
22) How well could you localize sounds?
Not at all
1 2 3 4 5 6 7
Completely

23) How well could you actively survey or search the environment using touch?
Not at all
1 2 3 4 5 6 7
Completely

24) How well could you move or manipulate objects in the virtual environment?
Not at all
1 2 3 4 5 6 7
Extensively
Appendix D

Simulator Sickness Questionnaire

Please indicate how much each symptom is affecting you right now.

1) General discomfort
   None  Slight  Moderate  Severe

2) Fatigue
   None  Slight  Moderate  Severe

3) Headache
   None  Slight  Moderate  Severe

4) Eye strain
   None  Slight  Moderate  Severe

5) Difficulty focusing
   None  Slight  Moderate  Severe

6) Salivation increasing
   None  Slight  Moderate  Severe

7) Sweating
   None  Slight  Moderate  Severe

8) Nausea
   None  Slight  Moderate  Severe

9) Difficulty concentrating
   None  Slight  Moderate  Severe

10) Fullness of the head
    None  Slight  Moderate  Severe

11) Blurred vision
    None  Slight  Moderate  Severe

12) Dizziness with eyes open
    None  Slight  Moderate  Severe

13) Dizziness with eyes closed
    None  Slight  Moderate  Severe

14) Vertigo (a loss of orientation with respect to vertical upright)
    None  Slight  Moderate  Severe

15) Stomach awareness (a feeling of discomfort just short of nausea)
<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Slight</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>16) Burping</strong></td>
<td>None</td>
<td>Slight</td>
<td>Moderate</td>
<td>Severe</td>
</tr>
</tbody>
</table>
Appendix E

Trolling Magnitude Evaluation Questionnaire

To answer the following questions, please refer to the comment you made in the video you chose to watch.

Video Title: ____________________________________________________________

Video Comment: _______________________________________________________

1) I made the comment at the spur of the moment
   Agree   Disagree

2) I thought about what I should comment about before submitting my comment
   Agree   Disagree

3) If someone thought my comment was offensive, I would...
   Apologize and retract my comment
   Apologize but stand by my comment
   Stand by my comment without apologizing/ignore the accusation
   Go out of my way to harass the person for a SHORT period of time
   Go out of my way to harass the person for a LONG period of time

4) I believe the nature of my comment is... (select all that apply)
   Supportive
   Critical and/or Argumentative
   Grossly offensive, Indecent, Obscene, and/or Menacing
   Funny
   Other

4A) If you selected “Other,” what was the nature of your comment? _____________________________

5) I believe others may view my comment as... (select all that apply)
   Supportive
   Critical and/or Argumentative
   Grossly offensive, Indecent, Obscene, and/or Menacing
   Funny
   Other

5A) If you selected “Other,” what was the nature of your comment? _____________________________

6) I went out of my way to make a comment to harass an individual and/or group
   Agree   Disagree

7) I made a comment to entertain an individual and/or group
   Agree   Disagree

8) I made a comment to entertain myself at the expense of another individual and/or group
   Agree   Disagree
9) If given the chance, I would create media content (Ex. Memes, GIFs, etc.) to harass the video uploader and/or other commentators
   Agree   Disagree

10) If I saw the video uploader or another commentator being harassed in the comments section, I would...
    Defend the video uploader and/or commentator
    Contribute to the harassment of the video uploader and/or commentator
    Ignore the harassing comment(s)

11) My comment was related to the content in the video
    Agree   Disagree
Appendix F

Short Dark Triad

Please indicate how much you agree with each of the following statements

1) It’s not wise to tell your secrets
   Disagree strongly 1 2 3 4 5
   Agree strongly

2) I like to use clever manipulation to get my way
   Disagree strongly 1 2 3 4 5
   Agree strongly

3) Whatever it takes, you must get the important people on your side
   Disagree strongly 1 2 3 4 5
   Agree strongly

4) Avoid direct conflict with others because they may be useful in the future
   Disagree strongly 1 2 3 4 5
   Agree strongly

5) It’s wise to keep track of information that you can use against people later
   Disagree strongly 1 2 3 4 5
   Agree strongly

6) You should wait for the right time to get back at people
   Disagree strongly 1 2 3 4 5
   Agree strongly

7) There are things you should hide from other people to preserve your reputation
   Disagree strongly 1 2 3 4 5
   Agree strongly

8) Make sure your plans benefit yourself, not others
   Disagree strongly 1 2 3 4 5
   Agree strongly

9) Most people can be manipulated
   Disagree strongly 1 2 3 4 5
   Agree strongly

10) People see me as a natural leader
    Disagree strongly 1 2 3 4 5
    Agree strongly

11) I hate being the centre of attention
    Disagree strongly 1 2 3 4 5
    Agree strongly
12) Many group activities tend to be dull without me
Disagree strongly 1 2 3 4 5 Agree strongly

13) I know that I am special because everyone keeps telling me so
Disagree strongly 1 2 3 4 5 Agree strongly

14) I like to get acquainted with important people
Disagree strongly 1 2 3 4 5 Agree strongly

15) I feel embarrassed if someone compliments me
Disagree strongly 1 2 3 4 5 Agree strongly

16) I have been compared to famous people
Disagree strongly 1 2 3 4 5 Agree strongly

17) I am an average person
Disagree strongly 1 2 3 4 5 Agree strongly

18) I insist on getting the respect I deserve
Disagree strongly 1 2 3 4 5 Agree strongly

19) I like to get revenge on authorities
Disagree strongly 1 2 3 4 5 Agree strongly

20) I avoid dangerous situations
Disagree strongly 1 2 3 4 5 Agree strongly

21) Payback needs to be quick and nasty
Disagree strongly 1 2 3 4 5 Agree strongly

22) People often say I’m out of control
Disagree strongly 1 2 3 4 5 Agree strongly

23) It’s true that I can be mean to others
Disagree strongly 1 2 3 4 5 Agree strongly
24) People who mess with me always regret it
   Disagree strongly  1  2  3  4  5  Agree strongly

25) I have never gotten into trouble with the law
   Disagree strongly  1  2  3  4  5  Agree strongly

26) I enjoy having sex with people I hardly know
   Disagree strongly  1  2  3  4  5  Agree strongly

27) I’ll say anything to get what I want
   Disagree strongly  1  2  3  4  5  Agree strongly
Appendix G
Comprehensive Assessment of Sadistic Tendencies
Please indicate how much you agree with each statement below.

1) I was purposely mean to some people in high school
   Strongly Disagree
   1 2 3 4 5 6 7
   Strongly Agree

2) I enjoy making jokes at the expense of others
   Strongly Disagree
   1 2 3 4 5 6 7
   Strongly Agree

3) I have purposely tricked someone and laughed when they looked foolish
   Strongly Disagree
   1 2 3 4 5 6 7
   Strongly Agree

4) When making fun of someone, it is especially amusing if they realize what I’m doing
   Strongly Disagree
   1 2 3 4 5 6 7
   Strongly Agree

5) Perhaps I shouldn’t have, but I never got tired of mocking certain classmates
   Strongly Disagree
   1 2 3 4 5 6 7
   Strongly Agree

6) I would never purposely humiliate someone
   Strongly Disagree
   1 2 3 4 5 6 7
   Strongly Agree

7) I enjoy physically hurting people
   Strongly Disagree
   1 2 3 4 5 6 7
   Strongly Agree

8) I enjoy tormenting people
   Strongly Disagree
   1 2 3 4 5 6 7
   Strongly Agree

9) I have the right to push certain people around
   Strongly Disagree
   1 2 3 4 5 6 7
   Strongly Agree

10) I have dominated others using fear
    Strongly Disagree
    1 2 3 4 5 6 7
    Strongly Agree

11) I enjoy hurting my partner during sex (or pretending to)
    Strongly Disagree
    1 2 3 4 5 6 7
    Strongly Agree
12) In video games, I like the realistic blood spurts
   Strongly Disagree | 1 2 3 4 5 6 7
   Strongly Agree

13) I love to watch YouTube clips of people fighting
   Strongly Disagree | 1 2 3 4 5 6 7
   Strongly Agree

14) I enjoy watching cage fighting (or MMA), where there is no escape
   Strongly Disagree | 1 2 3 4 5 6 7
   Strongly Agree

15) I sometimes replay my favourite scenes from gory slasher films
   Strongly Disagree | 1 2 3 4 5 6 7
   Strongly Agree

16) There’s way too much violence in sports
   Strongly Disagree | 1 2 3 4 5 6 7
   Strongly Agree

17) I enjoy playing the villain in games and torturing other characters
   Strongly Disagree | 1 2 3 4 5 6 7
   Strongly Agree

18) In professional car-racing, it’s the accidents that I enjoy the most
   Strongly Disagree | 1 2 3 4 5 6 7
   Strongly Agree
Appendix H

Game Enjoyment Questionnaire
Please think about the game that you just played to answer the following questions.

1) I found the game fun and enjoyable
   Disagree Completely  Agree Completely
   1  2  3  4  5

2) I felt that the game was...
   Extremely Easy  Extremely Hard
   1  2  3  4  5

3) The graphics in the game were...
   Cartoonish  Realistic
   1  2  3  4  5

4) The pace of the game felt...
   Very Slow  Very Fast
   1  2  3  4  5

5) The game was highly interactive
   Disagree Completely  Agree Completely
   1  2  3  4  5

6) How would you rate the game?
   Poor  Perfect
   1  2  3  4  5  6  7  8  9  10
Appendix I

Prosocialness Scale for Adults

The following statements describe a large number of common situations. There are no ‘right’ or ‘wrong’ answers; the best answer is the immediate, spontaneous one.

1) I am pleased to help my friends/colleagues in their activities
Never/April Never True
1  2  3  4  5
1  2  3  4  5
2) I share the things that I have with my friends
Never/April Never True
1  2  3  4  5
1  2  3  4  5
3) I try to help others
Never/April Never True
1  2  3  4  5
1  2  3  4  5
4) I am available for volunteer activities to help those who are in need
Never/April Never True
1  2  3  4  5
1  2  3  4  5
5) I am empathic with those who are in need
Never/April Never True
1  2  3  4  5
1  2  3  4  5
6) I do what I can to help others avoid getting into trouble
Never/April Never True
1  2  3  4  5
1  2  3  4  5
7) I intensely feel what others feel
Never/April Never True
1  2  3  4  5
1  2  3  4  5
8) I am willing to make my knowledge and abilities available to others
Never/April Never True
1  2  3  4  5
1  2  3  4  5
9) I try to console those who are sad
Never/April Never True
1  2  3  4  5
1  2  3  4  5
10) I easily lend money or other things
Never/April Never True
1  2  3  4  5
1  2  3  4  5
11) I easily put myself in the shoes of those who are in discomfort
Never/April Never True
1  2  3  4  5
1  2  3  4  5
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<th>1</th>
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<th>4</th>
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<tbody>
<tr>
<td>12) I try to be close to and take care of those who are in need</td>
<td>Never/Almost Never True</td>
<td></td>
<td></td>
<td></td>
<td>Almost Always/Always True</td>
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<tr>
<td>13) I easily share with my friends any good opportunity that comes to me</td>
<td>Never/Almost Never True</td>
<td></td>
<td></td>
<td></td>
<td>Almost Always/Always True</td>
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<tr>
<td>14) I spend time with those friends who feel lonely</td>
<td>Never/Almost Never True</td>
<td></td>
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<td></td>
<td>Almost Always/Always True</td>
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<tr>
<td>15) I immediately sense my friends' discomfort even when it is not directly communicated to me</td>
<td>Never/Almost Never True</td>
<td></td>
<td></td>
<td></td>
<td>Almost Always/Always True</td>
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