Down the Rabbit Hole:
Feeling Present in Virtual Reality

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Abstract

Representations of Virtual Reality Technology (VR) in science fiction often treat the experience as the separation of consciousness from the body and the transportation of that consciousness to a surrogate within a virtual environment. Meanwhile, the user's physical body remains behind, hooked up to the simulation via neural implants. An occasional twitch or a flicker under the eyelids is the only indication that the person is still alive. The person is, for all intents and purposes, in another world.

In recent years VR has once again been drawn into the public consciousness, although this time it appears as though technology might finally be able to facilitate the profound virtual experiences so often depicted in science fiction. This paper presents an examination of the concept of 'presence' and questions whether it is possible to induce a sense of 'being there' through the use of immersive virtual reality technology. This question is addressed through a qualitative analysis of contemporary presence theory as well as an investigation of potential sensory stimulation through VR. Lastly, the role of content in virtual environments and the relationship between users and virtual avatars will be interpreted as a means of fostering a sense of presence in the experience of virtual environments.

Preface

Expectation in Everyday Activity

I imagine that you, the reader, opened this paper with certain expectations, that you judged a book by its cover essentially. I do not mean that you made any major assumptions about the subject matter but that you instead have a number of expectations based on the context in which you are reading this. You might expect that this research paper, since it has been prepared for a master's in Interactive Digital media, will adhere to certain academic conventions. What would be your reaction, I wonder, if these expectations were proven incorrect? What if, for example, I had neglected to carry out any form of referencing? In this case your expectations for the paper might have been undermined although perhaps not dramatically enough for you to disregard the paper from the offset. Now imagine if I had opened this paper with the statement "Warfare was often a central feature of ancient narratives". This would naturally cause a great deal of confusion and you might quickly glance at the cover to check if you had opened the wrong paper. The reason I raise these questions is that I am hoping to draw attention to a central concern of this paper, which is the importance of personal or cultural expectation when engaging with various forms of media.

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Introduction: 'Being' in a Virtual Environment

"This will feel a little weird."

Morpheus, *The Matrix* (1999)

This quote, taken from the 1999 science fiction film, *The Matrix*, is a warning issued by Morpheus to Neo upon his first time entering the Matrix. Following this the camera cuts to a metal jack being plugged into a socket connected to Neo's brain. A synth-like siren rises to a crescendo as the camera quickly cuts to Neo's body convulsing in pain. Morpheus then presses a load button on a touch interface and as the camera again returns to Neo the ominous music and his apparent suffering both halt abruptly. Neo's consciousness appears to have been liberated from his body and been transported to a virtual world, the Matrix. His attention and senses are now exclusively attending this new environment, his physical body lying dormant, awaiting his return. Popular representations of virtual reality in science fiction often adopt this dualistic separation of virtual and physical experience. The current generation of VR equipment, such as the Oculus Rift and HTC Vive, is thankfully less intrusive than that featured in *the Matrix*. I wonder, however, if this equipment, usually a head-mounted display (HMD) paired with motion controllers, is capable of producing a comparable sensation of 'being' in a virtual environment (VE)? This paper will attempt to investigate how a sense of presence might be fostered in VR. What do I mean by the term 'presence' however, and what does feeling 'present' in a virtual environment entail? I do not suggest that it is comparable to Neo being 'plugged' into the Matrix but that it is in fact more akin to a sense of one's self-location and ability to act in relation to an environment. In further contrast to its popular representation in science fiction I suggest that virtual environments should not be thought of as divorced from reality, as a world in itself. Instead, they should be treated as an

extension of reality, and any experience therein should be thought of as an experience that is not distinct from that of the real world. I additionally posit that when entering and interacting with a virtual environment we draw upon our past experience and cultural knowledge, whether consciously or unconsciously, and use this experience or knowledge to form expectations based on what we are presented with in the virtual environment. If these expectations are fulfilled then we might experience a sense of presence, however, if these expectations are challenged, the experience immediately becomes slightly more alien and we are forced to re-evaluate our assumptions of the medium, an act that might prevent us from feeling present.

I will conclude this introduction with the question of whether presence is a continuous sensation or if it occurs in ebbs and flows? In the words of Carrie Heeter (2003, 343): “Do we feel more presence on bumpy roads than on smooth roads?”

Methodology

Presence is universally acknowledged as a subjective phenomenon. To gain a more thorough understanding of the concept of presence a qualitative review of secondary literature was required. As will be discussed in the subsequent chapter, there are two primary strands of presence research. The first of these is the subjective reaction of the user to the environment mediated by the technology. The second, meanwhile, is concerned with the relationship between self and environment and the consequent interplay between these two as a means of developing presence. In experimental conditions the subjective experience of presence is most often measured via questionnaires or through the tracking of physiological behaviours

such as heartrate or skin conductance. Through the examination of both experiment reports and more theoretical, and mostly phenomenologically framed, literature I hope to establish a model of presence which might be used to investigate the influence of other factors such as hardware or character design on the potential for a user to feel present through VR. The focus of this paper is thus not on how presence might be measured but is instead concerned with the factors that foster or inhibit presence.

The research questions I intend to address then are as follows:

1) What does the term 'presence' refer to?
2) How does a sense of presence arise?
3) To what extent can presence be facilitated through hardware?
4) How can presence be fostered and maintained through content in virtual environments?

To address these questions I have adopted the following approach:

Chapter 1 – Literature Review: In order to more clearly delineate what I mean by the term 'presence' I first present a survey of the two major interpretations of this term in relation to virtual reality, media presence and inner presence. This is followed by a theoretical examination of the relationship between self and environment drawing heavily on sensory anthropology. I conclude this chapter with a brief critique of contemporary means of measuring presence followed by a short investigation of the relevance of technical specification reports to such experiments.

Chapter 2 – Being Present through VR: In this chapter I will provide the interpretation of 'presence' used throughout this paper. I then refer to the 'three layers of presence' model as

a means of understanding how presence arises through interaction with one's environment. I will further investigate the development of presence through action by noting the status of tools as objects which might be adopted as an extension of the self and consequently allow continued presence. Lastly, I refer to a 'flow state' as an example of a mode of experience in which presence might be acutely demonstrated.

Chapter 3 – Immersion in VR: The third chapter of this paper is concerned with the concept of 'immersion' which refers to the capacity of the VR hardware to create an environment for the user to occupy. In this chapter I will address the division of physical and virtual stimuli which is often featured in popular representations of VR. Following this I highlight the inherent subjectivity of perception and how that might influence virtual experience. I will then conclude with a brief survey of various forms of sensory stimulation and the potential for this to be incorporated into a virtual environment.

Chapter 4 – Populating Virtual Worlds: In the final chapter I attempt to address one of the core components of presence as defined in this paper. That is, immediate feelings of presence are affective while continued feelings of presence are a combination of affective and cognitive responses. To better understand the experience of presence as informed by cognitive interaction with a VE I investigate how users respond to the characters and evocative content therein. I will examine the notion of identification with digital avatars and embodiment in virtual environments. I will also discuss how users interact with other characters in the virtual world, both digital agents and avatars representing other users. I will further broach this subject in relation to realism in the representation of virtual characters and the concept of the 'Uncanny Valley'. Lastly, I will conclude with a brief discussion of the problem of adhering

to traditional narrative structure within a VR which will be followed by a cursory overview of the relationship between emotionally engaging content and presence.

Chapter 1: Literature Review

An immediate obstacle for anyone hoping to study the notion of presence felt through virtual reality is the sheer abundance of ambiguous terms related to the field. Terms such as 'presence', 'immersion', 'engagement', and 'integration' have each been used to describe the general concept of a person feeling 'present' in a virtual world. This confusion has been compounded by the addition of a number of prefixes to refer to more specific forms of presence. Although terms such as 'social presence', 'spatial presence', 'cultural presence', and 'psychological presence' attempt to distinguish between experiences across various mediums or situations, these are not derived from a single definition of presence and are in fact offshoots of a litany of interpretations. In this paper I hope to distinguish my research by attempting to provide a more holistic description of the phenomenon of presence experienced through VR. I will draw on the theories of a number of presence researchers and identify the interpretation of the term I will be adhering to. In the literature outlined below there is often a fixation on a single aspect of this experience. I hope to demonstrate that presence is an experience which is dependent on the successfully operation of a multitude of factors associated with virtual reality.

By carrying out this literature review I intend to draw attention to some of the ideas which will serve as a foundation for the remainder of this paper. I further intend to identify a number of failings I have noticed in the research of presence. In order to proceed, I will first attempt to elaborate on a terms which will be used in this paper. I will begin with a brief survey of the use of the term presence in relation to virtual experience. This will be followed by sections addressing the notion of embodiment in a virtual environment and the distinction between that embodied self and the environment. I will conclude with a brief critique of the methods

by which presence is most often measured and refer to what I perceive of as a degree of carelessness with regard to maintaining constants within experiments.

1.1 Defining Presence: Media Presence

The interpretations of presence can, for the most part, be grouped into two categories: ‘media presence’ and ‘inner presence’. The earliest definition of ‘media presence’ was proposed by Jonathan Steuer (1992 cited by Weibel et al. 2015, 45) who asserted that it “is the extent to which one feels present in the mediated environment rather than in the immediate physical environment. This definition suggests that presence is characterised by a user’s experience of a given medium. Mel Slater (2003) provides the following analogy to demonstrate his belief in the importance of technology for the facilitation of media presence. Slater invites us to imagine a scenario in which a user is listening to orchestral music on a quadraphonic sound system. The user might exclaim that the experience is “just like being in the theatre where the orchestra is playing” (Slater 2003). This, Slater posits, is a statement of presence. The audio fidelity of the sound system is sufficient to create the illusion of a live performance. Slater then imagines that the user’s attention begins to drift and they lose interest in the music. He suggests that this is in no way related to an unfulfilled sense of presence but is in fact solely related to the content delivered by the medium failing to maintain the attention of the user. According to Slater (2003), media presence is determined by form, or more specifically, by “the extent to which the unification of simulated sensory data and perceptual processing produces a coherent 'place' that you are 'in'.”

Slater (2003) further suggests that the term ‘immersion’ be reserved for the objective study of the technology facilitating the experience. This distinction between immersion (what the

technology delivers) and presence (the human reaction to that technology) has been quite widely adopted by media presence theorists (Calleja 2013, 224).To further clarify this notion of immersion in relation to presence we might briefly contrast presence in film or text versus presence in virtual reality. In each case the experience of presence is filtered through a technical medium, however, it is obvious that the sense of presence fostered by virtual reality differs greatly from the more passive presence induced through film or text. To more effectively distinguish between presence and immersion in ergodic media (e.g. VR) and non-ergodic media (e.g. film and literature) we can turn to Diane Carr (cited in Nabi and Charlton 2014, 190), who, in *Space: Navigation and Affect* suggests that the distinction should be made between psychological immersion (through imagination or mental absorption) and sensory immersion (through sensory stimulation in a virtual environment). This distinction is most prominent if presence through reading is contrasted with presence through virtual reality. Literary media, as abstract content, must be realised internally. In other words, the world in which a user might feel present is not self-evident but must be interpreted through the act of reading and then constructed by the reader's imagination. Waterworth, et al. (2015, 40) argue that to feel present (through sensory immersion) "the media content must be realised externally and experienced as part of the other".

Perhaps the most influential interpretation of media presence is that put forward by Lombard and Ditton (1997) which alleges that presence is the "perceptual illusion of non-mediation". It is important to acknowledge that media presence researchers do not believe that this illusion of non-mediation is comparable to the belief that the virtual environment is 'real'. In fact, as will be discussed in greater detail in Chapter 4, it is widely acknowledged that attempts at replicating reality can be detrimental to the sense of presence in VR. The illusion of non-mediation instead refers to the potential for users to behave as though their actions were not

being filtered through technology. However, those users will, at a fundamental level, remain aware that they are experiencing a virtual environment (Coelho et al. 2006, 27). This notion of non-mediation is perhaps more accurately reflected in the term 'transparency' which implies intuitive and unobtrusive interface designs that aim to allow the user to interact with the VE as directly as possible (Lombard and Ditton 1997).

A prominent criticism of media presence is that it presents a dualistic view which treats virtual environments, and virtual experiences, as distinct from the experience of the physical world. Gordon Calleja relates that such a view assumes "a unidirectional dive of human subjectivity into a containing vessel, a split between the physical "here" and the virtual "there" that is overcome temporarily when the phenomenon is experienced" (Calleja 2013, 222). In contrast to such dualistic views Ijsselsteijn and Riva, among others, suggest that there is no intrinsic difference between virtual stimuli and real world stimuli and that rather than treat the experience of each as oppositional we should view virtual experience as an extension of real world experience (Ijsselsteijn and Riva, cited in Calleja 2011, 19; Bittarello 2013, 107). This concept of virtual experience is reflected in the work of theorists who advocate the notion of inner presence.

1.2 Defining Presence: Inner Presence

Inner presence, unlike media presence, is not dependent on the experience offered by a medium. Instead it might best be thought of as "a broad psychological phenomenon, […] the effect of which is the control of the individual and social activity" (Riva and Waterworth 2013, 205-6). This definition of presence is applicable to both the physical world and to virtual worlds yet a lexical distinction is still made between virtual presence and physical/real world

presence. This is achieved through the application of the term 'mediated presence' to presence in virtual environments (Waterworth and Waterworth 2013, 589). To contrast the notion of inner presence against media presence, Riva, et al. (Riva et al. 2011, 25) refer to a number of questions which are noticeably unaddressed by proponents of the latter. They ask: "What is presence for? Is it a specific cognitive process? What is its role in our daily experience?" The failure of media presence theorists to account for such questions renders their definitions of presence more akin to a 'suspension of disbelief' (Waterworth and Waterworth, cited in Waterworth et al. 2015, 37).

In further contrast to the views of media presence theorists such as Mel Slater, inner presence researchers acknowledge the role of content (in addition to form) in establishing and maintaining presence. Two of the most prominent supporters of inner presence, Giuseppe Riva and John Waterworth, posit that presence can be more intensely felt in "a perceptually poor virtual environment where [one] can act in many different ways than in a lifelike virtual environment where [one] cannot do anything" (Riva and Waterworth 2013, 215). Moreover, inner presence allows for presence to be experienced at varying levels of intensity. Presence is not a binary sensation but is experienced as a continuum on a moment by moment basis (Calleja 2013, 230-1).

1.3 Embodiment in Virtual Environments

A prerequisite for presence in virtual environments common to both media and inner presence is a sense of embodiment. Embodiment in virtual reality is the sense of ownership which accompanies a feeling that one is located within a body through which their real world motions can be accurately tracked and translated into action within a virtual environment

(Kilteni, Groten and Slater 2012). If a virtual experience does not allow a user to manifest themselves in the game's world in some embodied form there can be no medium through which the user can experience presence in that environment. Take the game of *Tetris* for example. A player can become engrossed in this game and while they can directly act on the objects in the virtual world these actions are carried out at a distance. There is no sense that the player is embodied within the game world. Gordon Calleja (2013, 228) refers to this form of engagement as 'immersion as absorption'. For presence to occur 'immersion as transportation' is required which necessitates some form of character for the player to be embodied in (Calleja 2013, 229).

1.4 Self and Environment

In addition to becoming familiar with some of the major presence theories we must also attempt to clarify the relationship between a user and the virtual environment they find themselves in. To this end I will draw upon elements of Descartes' Cartesian dualism, Maurice Merleau-Ponty and Tim Ingold's sensory anthropology, and Heidegger's comments on the relationship between subject and object.

In *The Perception of the Environment* Tim Ingold (2011, 20) treats an 'environment' as a relative term. That is, an environment exists in relation to the organism existing within it. Ingold (ibid.) concludes that a person's environment "is the world as it exists and takes on meaning in relation to [them], and in that sense it came into existence and undergoes development with [them] and around [them]". The scene in *the Matrix* referred to in the introduction to this paper presented a Cartesian division of mind and body, and a consequent division between body and environment. Ingold's interpretation of the relationship between

self and the environment rejects such divisions. When writing about the self and the perception of its environment Ingold states that “perception is not an ‘inside-the head’ operation, performed upon the raw material of sensation, but takes place in circuits that cross-cut the boundaries between brain, body and world” (Ingold 2011, 244) . This concept of the relationship between mind and body, and between body and environment is comparable to that presented in Merleau-Ponty’s *Phenomenology of Perception* (Merleau-Ponty, cited in Turner 2015, 66). For Merleau-Ponty (ibid.) our embodiment is the means by which we access the world and it is through embodiment that we are able to orient ourselves in relation to our environment. In order to better understand how this orientation within an environment occurs we might turn to the concept of ‘practice theory’. Practice theory holds the position that “cultural knowledge, rather than being imported into the settings of practical activity, is constituted within these settings through the development of specific dispositions and sensibilities that lead people to orient themselves in relation to their environment and to attend to its features in the particular ways that they do” (Ingold 2011, 153). The way we orient ourselves in relation to an environment then, is determined by our past experiences and knowledge of how those experiences could be applied to our current situation. This response to our environment can be affective, by which I mean pre-cognitive and pre-reflective. Heidegger wrote that we first encounter our environment as ‘available’ (Heidegger, cited in Turner 2015, 62). The availability of our current environment is a reflection of the potential for us to act within it although Heidegger rejects a dualistic relationship between the embodied self and the objects upon which it acts (Heidegger, cited in Turner 2015, 64). Instead, he suggests that we view the components of our present environment as ‘beings’ with which we can interact. He does not mean to endow our surroundings with sentience, on the contrary, he suggests that we engage with these beings based on their resemblance to

more archetypal beings and their consequent suitability for interaction. Turner, in his summary of this argument, presents a chair as an example (Turner 2015, 64). He suggests that we might evaluate a chair-like being based on its chair-ness (chair-ness representing our interpretation of what chairs ought to be used for i.e. their suitability for sitting on). In essence, our engagement with objects, or beings, in our environment is carried out based on our past experiences and the knowledge that certain objects have fulfilled certain functions for us before.

In summary, practice theory holds that we do not exist as disembodied minds but as embodied agents located in relation to our present environment. Our relationship with that environment is heavily informed by prior experiences and personal knowledge which we draw upon when acting with and within it.

1.5 Measuring Presence

An initial problem one encounters when examining reports for experiments measuring presence is the evident difficulty in ensuring consistency with regard to the variables and constants of the experiment. One such example is that, as stated earlier, the person or group conducting the experiment often present differing definitions of presence. Furthermore, to avoid influencing subject responses researchers often neglect to ensure that the subject's interpretation of the term presence is related to their own. The very nature of questionnaires makes this unavoidable though. The subject's opinion of both the term 'presence' and notion of 'being' in VR might contain a number of caveats which they do not refer to in the questionnaire. The subject might also retroactively reinterpret their experience in light of the questions posed and might then report non-existent sensations (Weibel et al. 2015, 47).

Additionally, these questions often rely on a rating system to indicate how present a user felt during the experiment which suggests that the entirety of the virtual experience was characterised by a uniform feeling of presence. These measurements do not allow for presence to be measured as a sensation which varies moment by moment. For this reason it has been suggested that questions should be asked in terms of frequency of occurrence rather than strength of occurrence (Heeter 2003, 340-1). Some presence researchers, such as Mel Slater, have advocated for the physiological measuring of presence, arguing that this presents a more objective reading of the phenomenon (Weibel et al. 2015, 47). These physiological measurements most often track skin conductance and heart rate, yet both of these present further problems which are effectively demonstrated in an experiment measuring anxiety experienced through VR. The researchers carrying out this experiment concluded that their physiological readings were typical indicators of anxiety and did not necessarily suggest that the subject felt present in the VE (Bouchard et al. 2008, 386-7). These researchers (ibid.) further posited that physiological indicators of presence in a virtual environment should be comparable to the same indicators of presence in the physical world. This would require duplicate experiments to be carried out, one in a VE and the other in reality.

A further issue I encountered with experiments measuring VR – and one which is also applicable to more theoretical investigations of presence – is that, while the role of technology in facilitating the experience is acknowledged, the individual technological components and render settings allowing that experience are not recorded in their entirety. As will be discussed in Chapter 3, there are minimum hardware requirements for presence to be facilitated in VR. For example, if a HMD is used, aspects of its display such as field of view (FOV) or refresh rate must meet certain standards (Abrash 2014). That is not to say that fulfilling these requirements automatically induces a sense of presence but rather that if

component in the hardware or display settings are lacking the experience will be significantly diminished.

1.6 Conclusion

In this chapter I have presented a cursory overview of some of the research related to the experience of presence in VR. I have drawn attention to the terminological divisions among presence theorists and the two broad definitions most widely followed, media presence and inner presence. I have sought to briefly characterise each of these positions and draw particular attention to how they represent the relationship between presence and technology, and virtual presence and real world presence. This was followed by a more general investigation of the relationship between self and environment, and more specifically how we interact with our environments. This section will be particularly relevant to the next chapter in which I examine how presence in an environment occurs. Lastly, in the final section of this chapter I made note of some of the more prominent issues I have noticed in various experiments and papers which seek to measure or define presence. In many of these experiments both the specificity of the virtual reality hardware and the rendering settings of the virtual environment heavily influence the virtual experience yet are frequently omitted. In the coming chapters I hope to present a more holistic description of the phenomenon of presence in VR which acknowledges the subjective nature of the experience while also addressing the objective components of virtual reality and virtual worlds which might facilitate or impair presence.

Chapter 2: Being Present through Virtual Reality

In the previous chapter I briefly referred to the notions of 'immersion as transportation' and 'immersion as absorption' as a means of distinguishing between feelings of presence in virtual reality and feelings of presence through mediums such as literature, film, or theatre. When engrossed in a book or film we might say that we feel present in its world. However, despite our feeling of presence, that presence is in no way acknowledged by the medium. Virtual reality, on the other hand, enables the user to not only feel present within the virtual environment but to also have that virtual environment acknowledge and respond to their presence. This chapter will examine how the sensation of presence arises in an environment and how that sensation can then be maintained. I will begin by drawing on some of the theory referred to in the previous chapter in order to establish the interpretation of the term 'presence' I will be using in this paper. Following this I will illustrate the role of user activity in the formation of presence. To better understand this relationship I will make use of a model which applies a tripartite division to user actions and behaviour in a VE. I will further elaborate on user activity in virtual environments with specific regard to the use of physical tools and the incorporation of those tools as an extension of the embodied self. Lastly, I will provide an account of 'flow states' which are states of being in which presence in a virtual, or physical, environment can be most acutely felt.

2.1 Defining Presence for This Paper

I will be adhering to a definition of presence as an "active awareness of our embodiment in a present world around us" (Waterworth and Waterworth 2014, 590). I will closely follow J.

Waterworth, E. Waterworth, and G. Riva in their position which treats presence as an evolved bio-cultural mechanism that allows a "subject to position himself in a space – real, virtual or social – through the distinction between "internal" and "external" and the definition of a boundary" (Riva, Waterworth and Murray 2014, 1.3). Consequently, the self is considered present if he or she is aware of their embodiment in an environment and their potential to act within that space. Furthermore, I maintain that the relationship between self and environment is, as outlined in the previous chapter, composed of an embodied-self oriented in relation to their environment and interacting with that environment based on their prior experiences and interpretative apparatus (Calleja 2011, 20-21; Ingold 2011; Turner 2015; Giannachi 2012, 50-53).

I will also be rejecting the notion that a virtual environment should be examined independently of the user's real world location and experience therein. I oppose the dualistic idea that virtual environments should be thought of as distinct from the user's physical location and that for presence to manifest itself sensory stimulation from the physical world must be restricted (Fox, Arena, and Bailenson 2009, 95; Ess 2013). As an example to illustrate this consider a group of people playing the split-screen co-operative game mode in the zombie survival game *Left 4 Dead.* If one of the group lets out a cry for help because their in-game character is being attacked this real world stimuli need not detract from any sense of presence the group might be experiencing. That cry for help might actually re-affirm a sense of presence since it can easily be incorporated into the context of the virtual experience (Calleja 2013, 232). The game world or virtual environment does not need to be thought of as a delicate construct which could be shattered by interference from real-world stimuli, stimuli which might actually serve to enhance the sense of presence if deployed effectively and – as will be addressed in the next chapter – are, above all, vital for user safety.

As a concluding side note, if presence is an indication of a person attending to the external world then I will adopt the term 'absence' to represent "a state of absorption in an internal world detached from the current perceptual flow" (Waterworth et al. 2015, 37). Waterworth and Waterworth treat absence as engagement with abstract, conceptual, processing in contrast to the concrete, perceptual, processing of a presence state (Heeter 2003, 341; Waterworth et al. 2015).

2.2 Acting in a Virtual Environment: Layers of Presence

"Most interactions with an environment are possible because we have an internalized knowledge of how various aspects of that environment work" (Calleja 2011, 20-21). The notion of prior experiences influencing present responses to our surroundings is a fundamental component of presence in virtual environments. If we are presented with situations with which we have no points of reference to influence our actions, or if our anticipations are not met, our mode of being becomes more critically removed and we must reassess our position and potential to act in that environment (Calleja 2011, 21).

J. Waterworth, E. Waterworth, and G. Riva (2004) have suggested that if we are to investigate this phenomenon in greater detail we must attempt to understand how humans act in relation to their environments. To this end they created a presence model featuring three layers of presence which draw on the 'three layers of self' identified by Antonio Damasio (Waterworth, Waterworth and Riva 2004; Riva et al. 2011; Riva and Waterworth 2014). This model distinguishes between levels of human intention and action in everyday activity and suggests that the union of these levels is vital for a feeling of agency in relation to the

environment, and consequently, a sensation of presence. The three layers of presence identified are: proto presence, core presence, and extended presence (Riva et al. 2011, 30). Proto presence is described as "the process of internal/external separation related to the level of perception-action coupling (Self vs. non-Self)" (ibid.). It is concerned with the orientation of the self and the immediate relation of one's actions to the environment. In a virtual environment proto presence might be achieved through the accurate tracking of motion and orientation via a head mounted display and controllers allowing a user to situate themselves within the environment (ibid.). Core presence, meanwhile, is defined "as the activity of selective attention made by the Self on perceptions" which might be manifested as action towards a single object in the environment (Riva et al 2011, 30; Riva and Waterworth 2014, 207). In a virtual environment core presence might be achieved through high resolution stereoscopic visual displays in a HMD (head-mounted display). Lastly, extended presence serves to "verify the relevance to the Self of possible/future events" and might thus have both intra-virtual and extra-virtual implications (Riva et al. 2011, 31; Brey 2013, 49). Extended presence might be fostered through the inclusion of emotionally or intellectually stimulating content which serves to motivate the user's actions towards the completion of worthwhile objectives (Riva et al. 2011, 31; Brey 2013).

To give a more practical demonstration of this theory Riva and Waterworth (2014, 207) imagine a tennis player competing in the final at Wimbledon. During match point the player might move to the right side of the court (proto-presence) in order to return the tennis ball with a forehand groundstroke (core presence) which if successful would win them the competition (extended presence). The union of these three layers of presence is possible through the levels of interactivity facilitated within virtual reality. In contrast, other mediums such as literary media are unable to foster a comparable sense of presence because they do

not allow for the union of these three layers. In the case of reading or watching a film extended consciousness can indeed be engaged in the experience. However, proto and core presence are not being stimulated (Riva and Waterworth 2014, 216).

This theory of presence consequently suggests that actions are essentially scientific hypotheses, carried out with the expectation or hope of a certain outcome, yet this outcome is by no means a certainty. If the anticipated outcome occurs then presence is more greatly felt; if the outcome does not occur the user must attempt to reassess their future actions in light of this failure. In contrast to Slater's concept of media presence, Riva and the Waterworths suggest that presence is not a binary experience but that it is possible to feel varying degrees of presence. Presence is most acutely felt when the three layers of presence are in union and, conversely, presence is reduced by any conflict between them (Riva and Waterworth 2014, 211). For an example of conflict between the three layers we might turn to the video game *Mass Effect 3* (2012). In the *Mass Effect* series players were free to craft the personality of their in-game character through a number of narrative based choices. The game acknowledged these choices by including a number of different game endings specific to certain play styles or in-game decisions. It was with an understandable amount of frustration, then, that as many players reached the conclusion of the series they were presented with an ending which jarred against their earlier behaviour in the narrative (Plunkett 2012). In this case proto and core presence were in union while extended presence was not fulfilled. The actions of these players were carried out with the expectation, based on prior knowledge of the series, that they would have specific and relatively unique consequences. Instead, players were presented with a very small number of potential endings, heavily undermining the player's sense of agency. The union of the multiple layers serves as an effective means of inducing greater presence, however, if the experience

attempts to cater to multiple levels and if any one of these levels is poorly implemented, the impact of this failure on the player's experience of presence will likely be far more damaging than if the developer had sought to only cater to one or two layers of presence. Virtual Reality developers should consequently strive to ensure that they are able to induce maximal presence for the experience they are offering. To do this they must identify the layers of presence they intend to target and decide how the actions associated with each layer will be prompted (Riva et al. 2011, 34).

2.3 Tool Assisted Actions and Presence

The majority of contemporary VR headsets currently rely on motion controllers to detect user input. The use of these controllers however, need not detract from a sensation of presence. Instead, if the purpose of these controllers in virtual experiences is optimised and is sufficiently intuitive there is evidence to suggest that a user could incorporate these controllers as extensions of the self in the virtual environment.

The concept of first and second order mediation with regard to perception suggests that our experience of the environment is filtered through various levels or mediums of perception. Lombard and Jones (2015, 22) relate that first order mediated experience is our perception of the environment as filtered through our biological sensory apparatus. Second order mediated experience, meanwhile, represents perception filtered through technology. An example of this is the use of glasses or contact lenses for visual correction; yet those of us who rely on glasses or contact lenses for visibility are acutely aware of the extent to which they become part of the 'self'. This tendency for us to embrace technology as an extension of the self was demonstrated by George M. Stratton in his 1896 prism glasses experiment.

During the experiment Stratton's eyesight was filtered through a set of glasses which inverted his view. He noted that his mind eventually compensated for this altered perspective and reinverted his view so that everything was once again correctly aligned (Blascovich and Bailenson 2011, 16-17). This 'adoption' of technology by the self occurs on a regular basis through prolonged interaction with tools. After a certain point we reach a level of familiarity with an object which allows us to act 'through' it rather than act 'on' it. A modern example of this is our use of computer keyboards. When dealing with a keyboard alignment we use on a daily basis many people are able to type without casting their eyes down to confirm their key presses. Someone unfamiliar with typing meanwhile must interact with the tool in a far more deliberate and conscious manner (Riva et al. 2011, 27).

This relationship of self and tool would suggest that a virtual reality controller could theoretically become so familiar to a user that it might eventually be considered an extension of the self. For this to happen however, interaction with the controller must demonstrate consistent results, a requirement made problematic by the diversity of in-game control schemes for virtual reality games or experiences.

2.4 An Ideal State: Flow

The sensation of presence can be at its greatest during a 'flow' state. A person can be said to be in such a state when their "experiences occur in a continual stream; in which self and environment, stimulus and response, and past, present, and future are blended together; and self-consciousness and sense of time are lost" (Nabi and Charlton 2013, 190). Heeter (2003, 337-8) characterises this state of being as treading the line between boredom and anxiety. He suggests that flow occurs when a person is attending to an activity which is sufficiently

challenging to demand their full attention but not so much as to induce anxiety. Flow represents a degree of attention to a specific activity in its totality rather than towards a single more specific objective. For example, a football player might experience a flow state while playing particularly well in a match but might not enter such a state while practicing free-kicks in training. Mihaly Csikszentmihalyi (cited in Heeter 2003, 338) posits that while in a flow state one's "[c]oncentration is so intense that there is no attention left over to think about anything irrelevant, or to worry about problems." The sensation of presence felt while in a flow state is consistent with the layers of presence model outlined above. While in such a state a person's behaviour and actions are oriented towards a specific activity, this reflects a thorough degree of cohesion between the three layers.

2.5 Conclusion

This chapter has sought to draw on some of the concepts outlined in the preceding chapter in order to present a more coherent description of what it means to feel present and how that sense of presence arises in virtual reality. The experience of presence has been characterised as an awareness of one's embodiment in a specific environment and the consequent ability to interact with aspects of that environment. The implementation of the layers of presence model allows for a more structured understanding of user behaviour by distinguishing between low-level activity and actions which might have more long-term intra or extra-virtual consequences. The successful implementation of this model would allow a user to more intuitively interact with their virtual environment, enhancing the sense of presence (Riva and Waterworth 2014, 217). Following this we briefly examined the potential for tools to become extensions of the embodied self in a virtual environment. Lastly, the

notion of a ‘flow’ state was described as a mode of being in which the user presents a level of concentration and focus in which feelings of presence are particularly profound.

Chapter 3: Immersion in VR

This chapter will evaluate the capability of contemporary VR hardware to facilitate the experience of presence and the potential for multi-sensory stimulation to further enhance such experiences. I will first address an issue which I have referred to a number of times in prior chapters. That is, the blocking of real world stimuli while using virtual reality. I will then address the inherent subjectivity of perception and the relevance of this to the sensation of presence. Lastly I will present an introduction to sensory stimulation in contemporary VR hardware and explore whether it would be possible to introduce alternative forms of sensory stimulation such as more sophisticated haptic or olfactory feedback.

3.1 Isolating the User from Their Physical Location

Biocca and Levy (1995, cited in Fox et al. 2009, 95) believe that for a VR experience to be engaging stimuli from the user's real world location must be blocked. Imagine that a VR user finds themselves walking through a virtual castle. If they were to suddenly hear a police siren it would be quite challenging for them to incorporate this sound into the virtual experience. As they hear this sound they might enter a temporary state of limbo in which they are momentarily more aware of the duality of their experience. The sound of the siren immediately draws them back to the physical world while their eyes continue to receive information from the virtual environment. I noted in the previous chapter that it would be possible for real world stimuli to be incorporated into the virtual experience and I will certainly admit that certain stimuli might cause a break in mediated presence, however, such a break in presence might be a necessary aspect of virtual experience. For example, the HTC Vive has introduced a 'chaperone' system which attempts to prevent users from bumping into

physical objects through the inclusion of a camera on the front of the device which records the user's physical location and superimposes a wireframe barrier in the VE when the user is beside a wall or object (Jones 2015). The intrusion of real world stimuli into virtual experience needs to be restricted to ensure that the user can attempt to more fully engage with the VE, however, there are a number of real world stimuli which are too important to block, such as the sound of an alarm or the smell of smoke. At the moment these stimuli are not effectively blocked by virtual reality hardware, however, if sound proof headphones or an olfactory stimulation headpiece were to be introduced then the safety of the user would be at risk. As we examine multi-sensory stimulation in this chapter such concerns should remain in our minds.

3.2 The Subjectivity of Perception

Perception is not the objective interpretation of a remote environment. On the contrary, and as stated in Chapter 1, our perception takes place through the interaction of self and environment. Perception might better be thought of as a system of association which can be influenced by traits such as age, sex, linguistic experience, and personality (Ingold 2011, 244; Chambers 2013, 605). We draw upon our experiences and use them to interpret our surroundings and to gauge the potential usefulness of the objects we see. This is most often an affective process. For example, Lindegaard et al. (cited in Turner 2015, 63) carried out an experiment measuring user responses to web pages and reported that we can decide whether we like the aesthetic of a webpage within fifty milliseconds of it loading.

Furthermore, our senses infer continuity based on similarity. This trait is reflected in the notion of 'colour constancy' which is the association of colour by proximity (Blascovich and

Bailenson 2011, 11). A similar effect is observed when viewing optical illusions such as the Kanizsa triangle which presents a triangle visible through the spatial proximity and consequent aggregation of a number of distinct shapes (Massumi 2013, 57). These perceptual behaviours might be manipulated in VR to minimise real-time rendering times although these perceptual tendencies are not universal, nor are they consistent. It is possible to actually 'see through' each of these by changing our examination of the scene from a 'counts as one' to a more in depth 'countable by one' interpretation (Massumi 2013, 59).

3.3 Developing Immersion

The majority of commercially available VR hardware requires considerable power to operate efficiently. This demand is reflected in the rather narrow range of senses stimulated by this technology. At the moment VR immersion primarily occurs through visual, auditory, and relatively simple spatial feedback. While there have been attempts at including more sophisticated olfactory, haptic and spatial reponses the technology required for this is, at the moment, too impractical (Nakamoto et al. 2009, 75; Gallace and Spence 2013). Yet there is evidence to suggest that even rudimentary multi-sensory stimulation can effectively induce a sense of presence. Gallace and Spence (2014, 12) argue that "since we typically only pay attention to a small part of our environment, there is little point in accurately simulating what falls outside of the focus of our attention." Furthermore in a presentation discussing presence in VR, Michael Abrash, the technical director at Oculus, suggested that there might be a number of low level stimuli which form the building blocks of our perception (Abrash 2014). He then theorised that if these low level cues could be identified it might be possible to create

a convincing virtual environment by selectively stimulating specific aspects of our pre-cognitive perception (ibid.)

3.3.1 Visual Immersion

As stated in prior chapters virtual reality does not need to be mimetic for presence to occur, however, there do appear to be set standards which must be adhered to for a virtual experience to be sufficiently immersive and for presence to consequently be facilitated. Abrash (2014) notes that the following features are subject to a set of minimum requirements for the naturalistic experience of a virtual environment. Moreover, these features, particularly those associated with display response times, are intricately related to feelings of proto and core presence since they are required for the coupling of physical motions with virtual actions within the VE. These features are: a high resolution stereoscopic display; a wide field of view to mimic eyesight; a low pixel persistence to avoid image blurring; a high refresh rate; a display with global pixel illumination; and a low latency rate. If any of these are not adequate motion sickness will likely occur and the user's interaction with the environment will be made more difficult, diminishing the potential for presence to be felt. The purpose of these standards it to ensure that virtual experience does not significantly differ from our physical experience. Unfortunately, there is no easy way to allow a user to focus on specific aspects of a scene, although it might be possible to direct user attention by selectively altering the resolution of specific sections of the display. This would artificially simulate focus by creating a circular gradient of decreasing resolution (Gallace and Spence 2013, 212).

3.3.2 Auditory Immersion

Dolby has recently developed *Atmos*, a sound system designed for virtual experiences (Bishop 2015). Instead of adding more sound channels Dolby have apparently made *Atmos* 'object based' which, rather than directing sound through a specific channel, treats individual sounds as objects emerging from a specific position in a 3-D plane. This system should be able to render the depth, height, and accurate location of a sound source which should serve to create a more immersive environment. The potential for this to promote a sense of presence was examined by Kobayashi et al. (2015) in an experiment in which a subject sat in a cubicle surrounded by ninety six speakers linked to a microphone around which a number of people walked while clapping. The participants of this experiment reported greater feelings of presence when listening to spatially accurate sounds and some reported feeling goose bumps when the actors sounded particularly close to the subject (Kobayashi et al. 2015, 171). Lastly, an experiment carried out by Zampini and Spence (2004, cited in Chambers 2014, 611) demonstrates that the introduction of another layer of sensory stimulation could compensate for a perceived deficit in regard to another sense. In this experiment subjects reported that stale potato crisps tasted fresher when accompanied by an electronically generated 'crispy' sound.

3.3.3 Haptic Immersion

Gallace and Spence (2014, 3) refer to the 'infallibility' of touch by drawing attention to its role in distinguishing between internal and external experience. For example, we might often jokingly ask someone to pinch us to ensure that we are not dreaming. In the field of VR haptic

feedback is most often supplied through gloves which vibrate to induce a feeling of contact. However, there is far more to touch than physical contact. There is a noticeable difference, both in gesture and symbolism, between bumping into someone on the street and shaking someone's hand. This aspect of touch is dependent on context and one's relationship to the person you are interacting with (Gallace and Spence 2014, 4). This depth of social meaning attached to many forms of physical contact is particularly challenging to replicate in a virtual environment.

Furthermore, while it is currently possible for haptic technology to simulate the shape and solidity of an object there is currently no means of simulating the properties of a surface or the weight of an object (Gallace and Spence 2014, 208).

3.3.4 Spatial Immersion and Motion

Spatial immersion refers to the ability of VR hardware to accurately track the position and orientation of the user's body, head, and limbs. This is most often tracked via lasers and accelerometers, however, experiments have examined the potential of alternative tracking methods such as treadmill-like structures (Gallace and Spence 2014, 211) or simulating the sensation of movement by artificially inducing tendon vibration (Leonardis et al. 2014, 255). In the latter of these examples test subjects reported sensations of walking and embodiment in the virtual environment. However, they also reported the peculiar feeling of walking with another person's gait (Leonardis et al. 2014, 261). This is not yet of significant concern to those using contemporary virtual reality hardware since movement is currently restricted to body orientation and low distance movements.

With regard to gestures using motion controllers Gallace and Spence (2014, 208) suggest that the key to successfully translating motion to virtual action is to, where possible, make the motion mimetic. For example, they report that the success of many games released on the Nintendo Wii was due to the naturalistic translation of motions to actions in virtual games such as golf or bowling (ibid). For motions to be successfully incorporated into the experience they must be intuitive and suit the context of their use. This is heavily related to the notion of interacting with one's environment based on prior experience. Motions which have paradoxical virtual consequences inhibit the potential for a user to interact with their environment in the manner required for presence to occur.

3.3.5 Olfactory Immersion

Olfactory stimulation, unlike each of the forms listed above, cannot be reproduced electronically. Instead chemical components need to be combined in order to craft a certain smell. This requires separate and relatively cumbersome hardware which the user will have to periodically replace. While difficult, olfactory stimulation is not impossible. In fact, experiments have shown that the introduction of smell can greatly enhance presence in VR.

Chambers (2013, 607) reports that our sense of smell is not able to accurately detect varying concentrations. Chambers (2013, 608) further relates that many smells are composed of a number of key odorants and if a wide range of these odorants were to be used a versatile range of smells could be recreated from a small amount of chemicals. If a smell is to be introduced within a VE a number of properties must be considered. Should the smell be emitted continuously or only when the player approaches a certain object. How is the smell emitted (i.e. via mask or via separate dispenser)? (Nakamoto et al. (2008, 75)

In 2009 Ramic-Brkic et al. (cited in Chambers 2013, 608) carried out an experiment to investigate the ability of smell to compensate for varying levels of visual fidelity in a virtual environment. The smell of grass was combined with a VE representing a grassy plain. There were two versions of this VE, one high quality model with shadows and anti-aliasing and one without them. When no olfactory stimulation occurred the majority of subjects could tell the difference between the two environments. However, when the smell of grass was introduced only half subjects could differentiate between the high and low quality environments.

3.4 Conclusion

Sensory perception does not occur at a consistent rate. Instead, our attention is captured by sudden shifts in our environment. When sitting at a desk we are not constantly aware of the clothes resting against our skin or the feeling of sitting on the chair. That is not to say that the stimuli produced through interaction with these objects stop occurring. Rather, we disregard them if they remain constant for a certain period of time (Gallace and Spence 2014, 211). This suggests that sensory stimulation in VR could be selectively targeted, although it might still be necessary to maintain a low level of sensory stimulation for senses not actively targeted since a sudden absence of sensory stimulation might be quite noticeable. A number of experiments measuring multi-sensory stimulation in virtual environments have provided conclusive evidence that the inclusion of a second or third form of stimulation, even if paired with poor visual feedback can result in a significant increase in feelings of presence. While many forms of sensory feedback are currently unfeasible the prospect of their integration with VR promises profoundly immersive experiences.

Chapter 4: Populating Virtual Worlds

"Users need to need to enter worlds that are alive: where questions are answered by real people, where meaningful social and intellectual knowledge can be gained, where synchronicity happens, and where the environment is so well designed that it senses your presence and addresses what you want"

Damer and Hinrichs 2013, 27.

'Avatar' was originally a Sanskrit word which referred to the corporeal embodiment of a deity when they journeyed to the temporal world (Nabi and Charlton 2014, 200). Given the freedom users have in tailoring their in-game characters 'avatar' is an eminently appropriate term which reflects both the potential for altering appearance and the strength of the relationship between the user and their digital surrogate. In Chapter 2 I posited that embodiment was a key component of presence in virtual environments. This chapter will be concerned with that embodiment and the relationship between users and their avatars. I will further examine how virtual worlds can be populated with characters, whether user controlled or computer controlled, and how these characters can enhance feelings of presence, or perhaps more accurately, how a failure in the design of these characters can diminish presence. Lastly, I will ascertain the role of emotion in the experience of presence in virtual worlds.

4.1 Embodiment in an Avatar

Johnny Søraker (2011, cited in Ess 2013, 689) argues that the nature of virtual reality demands that a user become embodied in a single avatar and that their experience of that embodiment be filtered through a first-person perspective. He contends that "you cannot participate in multiple realities simultaneously any more than you can be in more than one spatiotemporal place simultaneously in physical reality" (ibid). Through repeated use in virtual environments it appears that the relationship between a user and their avatar can become comparable to the relationship between self and tool addressed in Chapter 1, that is, as an extension of the self. One study measured neural activation patterns during avatar use and reported that some users' emotional connection with their avatars was comparable to the connection to their biological selves (Ganesh et al, 2012 cited in Scarborough and Bailenson 2013, 132). This attachment is greater when users are able to create their own avatars (Lim and Reeves 2009, cited in Scarborough and Bailenson 2013, 135). If users were able to create their own avatar and consequently act through that avatar in a virtual environment the likelihood of experiencing presence would increase due to the innate attachment to the character.

4.2 Interaction among Avatars

If a user creates an avatar with a human form social norms come into immediate consideration, the gender of the avatar and their appearance (clothing, height, attractiveness etc.) invites certain behavioural characteristics which can be deployed when interacting with other avatars (Yee 2014, 200). A number of experiments have demonstrated that the appearance of a user's avatar can significantly influence their behaviour both inside and outside virtual environments. Some of these studies demonstrated that there is a direct correlation between perceived avatar height and attractiveness and user confidence (Yee

2014, 150-1; Fox, Arena, and Bailenson 2009, 100; Waterworth and Waterworth 2010, 188-9). A similar experiment concerned with gender behaviour in the game *Second Life* found that interaction among female avatars featured higher levels of eye contact and closer proximity between avatars while the opposite was reflected in interactions among male avatars (Fox, Arena, and Bailenson 2009, 102). It is also interesting to note that the interaction between avatars and agents (computer controlled characters) adhered to social norms associated with interpersonal interactions (ibid.)

It has been rather comprehensively argued that when first encountering characters in virtual environments users automatically assume that the character possesses agency and intelligence (Mennecke et al. 2011, 420). However, if users attempt to interact with them they expect those characters to demonstrate certain behavioural traits and if these are not found the interaction becomes immediately more sterile. This phenomenon has been given the name 'the uncanny valley'

4.3 The Uncanny Valley

Angela Tinwell provides an analysis of the uncanny valley which portrays the phenomenon as a consequence of an evolutionary survival mechanism (Tinwell 2013). She posits that the uncanny valley arises from the failure of a digital interlocutor to demonstrate certain behavioural cues. She suggests that the feeling of discomfort associated with the uncanny valley arises from a perceived lack of empathy when interacting with a digital character. This lack of empathy becomes apparent when we are not able to draw on the facial or bodily expressions of an interlocutor and are thus prevented from mimicking their behaviour. She emphasises the importance of behavioural reciprocity in social interaction and notes that a

character devoid of facial or body expressions denies a user the opportunity of promoting empathy by mimicking their expressions (Tinwell, 179). Tinwell draws on the 'attachment and loss' theory of John Bowlby which posits that, from infancy, we have an innate requirement for mimicry in our social interactions. If mimicry fails to occur the victim of the interaction (i.e. the one whose expressions were not reciprocated) experiences a pattern of protest, despair, and detachment as they withdraw from the interaction and alienate themselves from that person (Bowlby 1969, cited in Tinwell 2013, 180). Tinwell concludes that this phenomenon "is related to issues of survival […] because it acts as an adaptive alarm bell to remind the person of the importance of being able to form attachments with others, a necessary survival technique to avoid death" (Tinwell 2013, 181). The consequence of this for presence in VR is that – if a user encounters a character with whom they can converse with or interact with via gesture and that character behaves in an asocial manner the user risks becoming withdrawn from that encounter and becoming more critical of both that specific character and the virtual environment more generally. Phil Carlisle believes that rendering the complexity of human emotion is, at the moment at least, too complex to be replicated in a virtual environment. He instead advises that the aspects of human expression most associated with emotion and empathy should be isolated and recreated in VR. This would potentially allow for more naturalistic interactions among avatars and agents (Carlise 2013, 518).

The problem of the uncanny valley is most closely associated with mimetic characters and as stated in prior chapters, mimesis in VR is not required for the experience of presence. The uncanny valley problem can therefore be avoided altogether by the inclusion of more anthropomorphic characters. B.M. Blumberg (1997, cited in Carlisle 2013, 520) refers to the 'ease' at which we perceive the emotional states of animals, or at the very least, the

emotional states we infer based on posture, motion, or eye gaze. It is consequently easier to imply an emotional state in a non-human character since the complexity of human expression need not be portrayed. This approach is visible in the heavily stylised characters found in many animated films and was adopted in the VR film experience '*Henry'* produced by the *Oculus Story Studio* (Etherington 2015).

4.4 Narrative and Emotion

The definition of presence adopted in Chapter 2 of this paper acknowledge the role of content in maintaining a user's sense of presence in a VE. Riva et al. (2011, 32) argue that "[n]arrative, by its nature, is distancing from the present. To design for maximal mediated presence is to create stories we can inhabit as fully as possible." An immediate challenge designers of virtual experiences face is directing user attention within an experience. As Riva et al. argue, narrative is distancing, particularly narrative associated with interactive experiences such as video games. For exposition to take place inside an interactive environment the interactive elements of the experience are often temporarily curtailed so that dialogue can take place. In video games this often takes the form of a cut scene, temporarily fixing the point of view of the player so that their attention can be effectively directed. Such a technique is not possible in VR since a core component of the experience is the freedom of the user to control their engagement with the environment (Carlise 2013, 514).

There have been a number of experiments which have sought to measure the influence of emotionally engaging content in the formation of presence. One of the most popular formats of such experiments features the challenge of walking across a narrow beam suspended over a significant drop. In this experiment an assistant might often be required to catch the

participant if they fall. The reason these assistants are needed is because this experiment has proven to be particularly presence inducing (Yee 2014, 149). While walking participants are evidently nervous and if they fall their reaction is involuntarily dramatic. Many of these experiments manipulate common phobias, such as acrophobia. An initial problem in such experiments is that a common means of estimating presence is the physiological measuring of a user's heart rate. Where a phobia is represented in VR a higher heartrate is far from indicative of a sense of presence. On the contrary, a higher heartrate is the exact response one would expect from a person subjected to their phobia. In the plank experiment it is difficult to determine whether the fear of falling induces presence or whether the VE induces presence so effectively that the fear of falling arises (Bouchard et al. 2008, 377). Regardless of whether the presence or emotion comes first it is certain that the inclusion of emotionally stimulating content in a VE is associated with a higher level of presence. In the case of anxiety inducing virtual experiences the problem of user exploration becomes apparent. In an experiment in which user's encountered a number of snakes many participants claimed to be reluctant to explore the virtual environment for fear of encountering more creatures (ibid. 386). In this case an immediate feeling of presence, or initial anxiety provoked by the VR experience, resulted in the potential for further presence being prevented.

4.5 Conclusion

Embodiment in a virtual environment has firmly been established as a requirement for presence to arise. Furthermore, it has been noted that the ability to personalise an avatar can result in increased feelings of attachment or embodiment in that avatar. This feeling of embodiment is further reflected in the behaviour of the user when they immediately depart

the virtual environment. Embodiment is not presence inducing in itself however, and being able to customise an avatar does not automatically guarantee an immersive experience. The purpose of this chapter has been, in part, to assert that the design of avatars and the design of other characters is a crucial aspect of maintaining presence. If a user is presented with the opportunity to interact with other characters the unnatural behaviour of those characters can result in an immediate decline in presence.

The role of emotionally engaging content or emotionally evocative virtual environments in fostering a sense of presence continues to be quite ambiguous. There is conclusive evidence that the inclusion of such content in VR results in greater feelings of presence than in environments which are more emotionally neutral (Riva et al. 2007, 54). The extent to which varying degrees of emotional stimulation influences presence is uncertain though (Bouchard et al. 2008, 388). Bouchard et al. conclude that, provided that its inclusion is contextually appropriate, emotion can effectively induce greater feelings of presence. However, while inappropriate use of emotion in VR, such as forcing a user to face their phobia, might result in a temporary spike in presence the user might then be reluctant to progress through the experience and the potential for continued presence will be severely limited.

Conclusion

"Unfortunately, no one can be told what the Matrix is. You have to see it for yourself."

Morpheus, *The Matrix* (1999)

There is no convenient checklist when it comes to feeling present in an environment, regardless of whether that environment is virtual or real. Furthermore, there is actually no widely acknowledged concept of presence which applies to both virtual and physical experience. This paper has sought to present a definition which treats presence as a subjective experience that varies moment by moment as we interact with our environment. As a user lowers a head mounted display over their eyes and enters a virtual environment they are presented with an entirely different experience and a different set of sensory stimulants. They might initially pivot their head left and right, with their mouth likely agape, as they become absorbed in the immersive environment. As they take a step forward or lean towards an object they might feel an initial sense of presence. This response is primarily affective and the sensation of presence might soon fade if the user is not presented with further and more meaningful means of interacting with the virtual environment. The layers of presence model outlined in Chapter 2 of this paper presents a method of deconstructing virtual experiences and framing them in terms of potential actions the user may carry out in relation to their environment. This model provides a means of understanding presence as a product of the relationship between self and environment and acknowledges the role of prior knowledge and experience in orchestrating interaction with one's environment.

The later chapters in this paper sought to incorporate aspects of virtual experience which are often ignored in definitions and conceptualisations of presence. While I agreed with the

distinction between immersion (what the technology offers) and presence (a reaction to the environment produced by that technology) I wanted to emphasise the intimacy of the relationship between them. In presence research immersion is often mentioned in passing, usually as a brief listing of equipment without due mention of its calibration. I hope that I have demonstrated the influence technical specifications and forms of sensory stimulation can have on a sense of presence in VR.

Lastly, the final chapter of this paper broached the relationship between users and virtual characters, whether avatars or agents, and also examined the relationship between emotional reactions to virtual environments and the potential for presence to accompany those reactions. I reached the conclusion that while characters did not immediately promote a sense of presence their design was a crucial aspect of maintaining presence throughout the experience. With regard to emotionally engaging virtual environments I found that if introduced appropriately emotion could lead to an immediate increase in presence. However, the misapplication of emotionally evocative content could render the user frozen with apprehension and consequently undermine any further feelings of presence.

Future Questions and Research

I have attempted to argue for the importance of intuitive interfaces and interactions between a user and a virtual environment. This is related to my belief that there is continuity across virtual and physical experience. An example of this is the greater immersion and enjoyment achieved through motion based games such as bowling or golf which bear similarity to their real world equivalent. One question which I have yet to see addressed is related to the

importance of the naturalistic experience of virtual environments. That is, how would our experience of a virtual environment differ if we were embodied in a non-human form? An installation which demonstrates such a concept is entitled ‘Birdly’ (Robertson 2014). This installation attempts to provide the experience of flight as a bird. A platform supported by pistons allows the user to tilt right or left and pitch up and down; a fan blows in their face to simulate wind; and there is a degree of olfactory stimulation to provide the smell of rivers and the sea as the user soars above them. If immersion is considered to be the objective characteristic of the technology then ‘Birdly’ is a thoroughly immersive experience. Is it presence inducing though? A core component of my argument has been the role of action in, and interaction with, an environment in the development of presence. In this installation the user is embodied as a bird and can receive sensory stimulation from the environment. Furthermore, they can experience a degree of proto and core presence through the flight mechanic. Can they identify with and become embodied in a bird though? I would certainly like to see future experiments question the level of presence that can be experienced in more abstract forms of embodiment.

Lastly, I would add a further voice to what must now be a cacophonous outcry for the need of a more widely acknowledged and more comprehensive definition of presence as it occurs across varies mediums. The issue of terminological ambiguity currently plagues the research of presence and immersion in virtual environments. As virtual reality continues to become more widely available a move toward a consensus should be made so that presence might be more effectively induced by developers of virtual reality hardware and virtual environments.

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