GETTING VR LEGS: A PHENOMENOLOGICAL INVESTIGATION OF PRESENCE AND THE AFFECTIVE BODY'S ENACTMENT OF SPACE IN VIRTUAL ENVIRONMENTS

Jason Coley

Submitted in Partial Fulfillment of the Requirements
for the Degree of

DOCTOR OF PHILOSOPHY

Approved by:
Prof. Rebecca Rouse, Chair
Prof. Ben Chang, Chair
Prof. Tamar Gordon
Prof. James Zappen
Prof. Lissa Holloway-Attaway

Department of Communication and Media
Rensselaer Polytechnic Institute
Troy, New York

[August 2019]
Submitted July 2019

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

I would like to thank Dr. Rebecca Rouse for her patience, encouragement, and guidance through this dissertation. My appreciation for her tutelage is beyond words. Moreover, I would like to thank the rest of my committee for their contributions: Prof. Ben Chang, Dr. Tamar Gordon, Dr. James Zappen, and Dr. Lissa Holloway-Attaway. Their probing questions and perceptive comments were seminal in helping me grow into a scholar. My sincere gratitude also extends to Jenn Mumby, keeper of the flames, for her help and empathy throughout my PhD study. To the entire community at Rensselaer Polytechnic Institute, I want to express my deepest gratitude for their contribution to my development as a scholar and human being.

Further thanks are given to Prof. Tom Sgouros, Mr. Sebastian Sarbora, Mr. Donn DeLane and his staff, as well as Red Studios for taking the time to share their thoughts and experiences about working with presence and virtual reality. I learned a lot from all of them that I will pass on to my students and inform future research.

I would also like to give my heart-felt gratitude to my colleagues at Maria College, particularly Mr. Jon Coller-Takahashi, Mr. Andrew Ledoux, and Sr. Victoria Battell, who not only have been supportive of my doctoral research but also have taught me much about transformational leadership and purpose-driven organizational work culture, which have influenced my approach to research and its impact in improving human lives.

Finally, I want to thank friends and family, both here and passed, who never doubted that I would finish graduate school. It would take many lifetimes to see a befitting return on their investments, but I aim to make the world a little better in the time I have left. I want to especially thank my wonderful wife, Eunai Joh, for sharpening my intellect, opening my mind, and, most importantly, growing my heart. She merits a gratitude worthy of its own dissertational research in scope and scale. Without her, I would not be writing this acknowledgement today.

ABSTRACT

Although decades of scholarship have attempted to classify and measure many diverse experiences of presence, there has yet been satisfactory explanations for the operational mechanisms for the phenomenon. Without fully understanding the underlying cognitive processes responsible for experiencing presence, designers and developers of immersive experiences cannot take full advantage of the potential of virtual reality technologies for interfacing with the human body. This research seeks a better understanding of presence by adapting Bergson's work on embodied perception and Hansen's theories of the affective body to introduce a new theoretical framework for presence that positions affectivity—the body's capacity to affect and be affected—as one operational mechanism for spatial presence. Under this proposed theoretical framework, presence is recharacterized as a human body-computer interaction in which the normally nonconscious mechanisms for perceiving circumambient space confront the incorporeality of the digital stimuli supplied by the virtual reality technology, resulting in an affective awareness of virtual space pressing upon the body. Extrapolating upon Hansen's arguments for the affective body as the ideal interface for digital information, this theoretical framework further posits that embodied movement—gestures, postures, and locomotions that are imbued with meaning according to affective spatial schemas—can be leveraged to enact compelling experiences of presence in virtual environments. To investigate this hypothesis, the author applied an auto-phenomenological approach and conducted interviews with global community practitioners to investigate a specific experience of presence: "getting VR legs," the process by which the body learns to orientate and navigate itself within virtual environments. As part of the phenomenological study, the author visited research sites and participated in several commercial and industry virtual reality and immersive technologies and experiences to investigate the phenomenological structure of the enaction of virtual space and its relation to presence. The author interviewed designers, developers, researchers, and entrepreneurs who are reproducing a dominant model of gameplay in their efforts to create optimal experiences of presence and helping users acclimate to simulated forces and objects. The data for both the auto-phenomenological studies and interviews were analyzed using the process of horizontalization; significant statements were analyzed for meaning and then clustered thematically. Findings support the posited hypothesis that the body privileges those embodied movements that trigger the affective registers responsible for distal attribution in virtual environments, an affective appetite that can be leveraged to create more compelling experiences of "being there" in virtual spaces. Two theoretical implications for achieving presence by satiating these affective appetites are identified: the body's desire to (1.) manipulate its environment affectively and (2.) participate in roleplay. These theoretical implications are incorporated into a topological map for the conceptualization of a directionality of presence, an intended starting point for aiding designers and developers to create evermore compelling experiences of presence by exploiting the affective body's desire to perform affective embodied movements.

1. THE PROBLEM WITH PRESENCE

The design study examines the phenomenon known as "getting VR legs," a term referring to the users' orientation and navigation of virtual environments while abating the effects of simulator sickness, and its intersection with the experience of presence. This research seeks to understand why some users enact virtual spaces more quickly than other users who appear highly susceptible to simulator sickness, a clear impediment not only to experiences of presence but also adoption rates of virtual reality technologies as a mass media platform. The body's enaction of virtual space is in fact a conscious reckoning of the normally unconscious processes of perception that become exposed as users learn to orientate, navigate, and manipulate virtual environments; exposure to these processes may reveal new avenues of research for better understanding of the operational mechanisms responsible for compelling experiences of presence. Adapting Hansen's (2006b) arguments that the affective body is the premier interface for our ever-growing digital world, this dissertation proposes a new theoretical framework for presence that situates Hansen's (2006b) affective body as the principle organizer for experiences of presences that vary in kind and intensities; this theoretical framework is extrapolated to further investigate how affectivity shapes experiences of presence by imbuing qualitative properties, such as meaning and value, according to the body's movement and rhythms governing the spatial experience. The significance of this investigation into the operational mechanisms of presence may reveal greater insight into the phenomenon that designers and developers of virtual reality platforms may leverage to create more immersive experiences of presence. This qualitative study applies both an auto-phenomenological methodology and interviews with VR community practitioners to investigate the nature of the affective body's enaction of virtual spaces, and its relation to sensations of presence: A phenomenological approach provides a thick description of the phenomenon, and open-ended interviews and observations with designers and developers of immersive experiences to assess effective strategies for creating compelling experiences of presence. The outcome of this research aims to map these distinct intensities and types of experiences with presence into a kind of topology of the phenomenon, positing that there is a phenomenological dimension to presence known as *directionality*—to encourage designer and developers to explore more kinetic, bodily approaches for creating compelling experiences of presence.

To create this topological map, a specific phenomenon unique to presence is examined: the body's initial enaction of virtual spaces. Although designers and developers can implement options to make virtual reality (VR) more comfortable to navigate (e.g., adding sliders to calibrate the interpupillary distance or implementing a snap rotation system to avoid nausea), these design principles do not always work effectively initially; on the contrary, some users seem to acclimate over time to new virtual environments—sometimes a few minutes, other times after many hours. Users may, for example, learn to relax their eyes in the way one would view an autostereogram or other optical illusion; in VR games, some players have conditioned themselves to navigate virtual environments via "tank controls": locomotion in which the player only travels in the direction faced, avoiding strafing and sudden movements. In both examples, users learn how to navigate virtual environments through motion, sensation, and memory—a repertoire of corporal skills that allows the affective body to construct circumambient space and thus the sensation of presence. Importantly, this enaction of virtual spaces demonstrates that the human body—not the VR system—is the instrument by which space is not only perceived but created: Designers and developers may implement features to help users customize their methods of locomotion, or even render environments in photorealistic detail, but in the end virtual environments do not become environments until the body perceives the volumetric space by means of motion, sensation, and memory. This orientation within virtual environments is known in designers and developers' parlance as "getting VR legs." Getting VR legs is a pun on "getting sea legs," maritime jargon that refers to the process of a learning how to move about a pitching and rolling ship deck without falling over or becoming seasick. This phenomenon begs the question: How, exactly, do we learn to navigate virtual reality spaces while sustaining presence and avoiding simulator sickness? What processes are responsible for this orientation within virtual spaces? A better understanding of the enaction of virtual spaces would reveal greater insight into the nature of presence and how our affective bodies enact space, aiding designers and developers in producing more powerful virtual reality experiences.

Moreover, presence often is framed as a technological achievement, resulting in experiences of presence organized according to the affordances of virtual reality system: Higher screen resolutions, better tracking mechanisms, and wider fields of view are considered benchmarks in demarking what is and what is not an authentic experience of presence (Abrash, 2014). For example, "hands presence" is associated with motions controllers, and "room-scale VR" denotes a VR system that can track users across a larger game space, as opposed to "seated VR," which indicates a VR experienced sitting in a chair. This language reflects an understanding that the technology dictates the experience, that the VR system creates the virtual environment independent of its encounter with the human body. This prioritizing of technology over body is problematic for two reasons: First, this framing cannot account for how the body enacts virtual spaces since prioritizing technology relegates enaction to solely a matter of design; second, emphasis on technology as the determiner of valid or invalid experiences of presence fails to recognize prior reports of presence in art and media history as legitimate since earlier technologies, such as the popularity of phantasmagoria shows in the 18th century or the panorama craze in the 19th century, are deemed too technologically primitive to create a convincing virtual environment. Moreover, the traditional immersive metaphors used to describe presence need to be questioned: The term *immersion* implies that the virtual environment pre-exists to its encounter with the body, as if virtual space were a swimming pool one could dip into with a VR system serving as some breathing apparatus that permits extensive sessions underwater. This metaphor makes many assumptions about the nature of presence and furthers solidifies notions that technology dictates the virtual environment, displacing the body's role in this phenomenon. Even "getting VR legs" can be understood as another alluring entrapment of language suggesting that virtual environments exist prior to their encounter with a human body, and time is all the user needs to learn how to navigate them.

This research contributes to scholarship in the field by investigating how bodies enact virtual space through the theoretical framework of Hansen's (2006b) affective body, which may offer move avenues of investigation into the nature of presence. The proposed theoretical framework for presence seeks to understand how the affective body twists, turns, and stretches to enact circumambient space; how simulated forces can influence the affective body's enacting of virtual environments; and how spatial schemas play a role in the enaction of virtual spaces. What is missing in the scholarship are explanations for the operational mechanisms, if any, that are responsible for producing these quantitatively and qualitatively distinct experiences of presence. How exactly does the body enact virtual spaces, and are these spaces really then virtual? Is the phenomenon of presence better understood as a sensation, the weight and friction of the virtual space against our affective bodies? This research attempts to answer these questions. Whereas presence in virtual environments can be distinguished in degrees of greater or lesser intensities (i.e., quantitatively) as well as in categories (i.e., qualitatively), a third, affective dimension to experiences of presence, termed here as *directionality*, emphasizes the embodied gestures, postures, and locomotions that help induce feelings of "being there" in virtual environments. This notion of directionality of presence is conceptualized as a topological map of presence that graphically diagrams the relationships among qualitatively and quantitatively distinct experiences of presence. Topology concerns the "properties of spaces and figures that remain unchanged under continuous deformations," such as studying the mathematical properties of knots (Epple, 1998, p. 299, 302); topological maps are designed to emphasize relationships between locales, where distance and scale are deemed less important than connectivity, such as mapping a wireless network (Gunathillake, Thilakarathna, & Jayasumana, 2018). The design study applies a similar cartographical approach to map the terrain of presence, identifying commonly experienced and recognized "landmarks" that hint at deeper structures not easily detected. Quantitatively, presence can be sensed in degrees of intensity: To feel more presence means to perceive a virtual environment with greater verisimilitude, as a higher-order, more immediate space distinct from the space the human body occupies outside the VR system, such as when a user's head reflexively dodges a virtual bullet, or her arm instinctively tries to rest on a virtual table. Qualitatively, presence can also be felt in kinds: terms such as "head presence," "hand presence," and "full body tracking presence" refer to experiences of distal attribution, which underscore the anatomical dimension to presence. Under the theoretical framework of the affective body proposed here, experiences of presence can be distinguished according to bodily movement. First, the affective body never ceases to feel the world around it, whether or not it reveals this to cognitive perception (i.e., that which is not perceivable by the conscious mind is not necessarily invisible to the affective body). Second, the affective body's capacity to affect and be affected shape experiences of presence in virtual spaces. This affective dimension to presence suggests that designers and developers can leverage certain movements to target affective registers with the goal of creating more powerful experiences of presence. To investigate the phenomenological nature of directionality, the design study investigates the first moments the body encounters a virtual environment: donning a head-mounted display and learning to navigate and interact through the instrument of the human body. These initial moments are worthwhile phenomena of investigation because researchers can more closely examine the body enacting circumambient space—instantiating a virtual environment around the body through a repertoire of movements, sensations, and memories—so that a greater insight into the relationship of presence and the affective body can be achieved.

1.1 Significance of the Problem Facing the Scholarship of Presence

One of the greatest challenges facing scholars and researchers is the fact that the phenomenon of presence is not fully understood in all its manifestations. Theories of presence have become a practice in theoretical acrobats to explain some experiences of the phenomenon, but not others: The scholarship cited in this review is a testament to the entangled theories that strain to explain the underlying mechanisms of such diverse experiences with media. *Presence* quickly has become an umbrella term attributed to nearly all acts involving a human and communication media: reading comics, watching television, speaking on phones, participating in a teleconference, playing video games, listening to music, and using voice-assistant technology (International Society for Presence Research, 2000a; Lee, 2004; Lombard & Ditton, 2006; Lombard & Ditton, 2000; Mennecke, Triplett, Hassall, Heer, & Conde, 2008; Sheridan, 1992; Slater, Linakis, Usoh, & Kooper, 1999; Steuer, 1992; Witmer, & Singer, 1998). The problem here is that these operational definitions of presence overly emphasis technological affordances rather than the human body as the determiner of presence. As previously mentioned, *presence* is a shortening of *telepresence* (Sheridan, 1992), and originally described experiences of *spatial* presence. Thus, looking for operational mechanisms that explain both piloting a submersible and speaking to AI via a natural-language user interface has yielded little satisfying results.

Despite the body of scholarship aimed at defining and classifying experiences of presence, few theories offer satisfying explanations for the operational mechanisms or processes responsible for the feeling of "being there" in a virtual environment. Spatial presence operates differently than other dimensions of presence and therefore is distinct phenomenologically. Distal attribution, an organism's ability to distinguish its body from its environment, is a defining feature of spatial presence and seems unlikely related to the same operational mechanisms that govern other conceptions of presence in the scholarship. Although Riva, Waterworth, and Waterworth's three layers of presence (2004) provides an outline of the phenomenon, the model does not supply the operational mechanisms among the layers. To complicate matters, users consciously experience the phenomenon of presence as continuous, but in reality, it occurs as an aggregate of "instances" (International Society for Presence Research, 2000b). What constitutes—much less causes—the instances is not well understood. Neuroscience, however, suggests that human bodies do not differentiate between stimuli supplied by the natural, external world from mediated stimuli (Rizzolatti & Arbib, 1998; Riva, Waterworth, & Waterworth, 2004); consequently, the operational mechanisms for the perception of one's body in circumambient space, in theory, are assumed to be the same processes applied in part in experiences of presence, as demonstrated in studies concerning phantom limb syndrome (Ramachandran & Blakeslee, 1998; Ramachandran & Rogers-Ramachandran, 2000) and the burgeoning field of mediated therapy with virtual reality technologies (Bailenson, 2018). Although advances in neuroscience and evolutionary psychology also have revealed insight into how we perceive space (Valera, 1991; Valera, 1999), the multitude of distinct, yet overlapping neural processes responsible for experiencing *spatial* presence—the sensation of being in a virtual environment—are not fully grasped and so remain in the realm of new media philosophy. Additionally, given the body's capacity to experience space affectively, any complete theory of spatial presence must account for not only how these underlying mechanisms operate to produce the sensation of being "inside" a virtual environment, but also the role of affect in framing spatial presence.

Without operational theories for how the human body experiences feelings of "being there" in virtual environments, designers and developers may lean too heavily on best practices used in other media, namely video games and cinema, to create immersive experiences of spatial presence: Practices that are not only highly ocularcentric but also overlook the role of the affective body as the framing mechanism for embodied perception. Building on Bergson's work on embodied perception and Hansen's theories on affective body as the framing mechanism of perception, the proposed theoretical framework posits that the phenomenon termed *spatial presence* is in actuality the conscious experiencing of one's own body enacting space: From the perspective of the affective body, to say that one *feels* present inside a virtual environment (i.e., to experience a computer-generated world as first-order perceptual experience) is to say one *feels* one's own affective registers, catalyzed by the novel, encompassing stimuli supplied by the virtual reality system, instantiating space around the human body. Hansen's theories on the affective body offer an operational mechanism for spatial presence and opens avenues of investigation into affect's role in how the human body perceives space: Adapting the phenomenological methodologies of Hansen (2006b), Kozel (2007), and Swink (2009) coupled with interviews of designers and developers working on immersive experiences, a new methodology is implemented to investigate spatial presence that centers the affective body as the principle organizer for experiences of presence.

1.2 The Theoretical Basis for the Study

This research's theoretical foundation is comprised primarily of Mark B. Hansen's notion of the affective body (2006b), Susan Kozel's poetics of responsivity (2007), and Steve Swink's six properties of game feel (2009). Mark B. Hansen postulates that the affective body is the instrument for embodied perception and claims that how and what the body feels frame the spectator's perception of the digital image, which he argues is the encounter between the human body and the inhuman digital information of the computer (2006b). Hansen outlines a phenomenology, heavily influenced by Henri Bergson's (1988) and Gilles Deleuze's (1986) work on affect, that underlines the importance of proprioception, tactility, and temporality in the perception of digital information.

Affectivity, Hansen's term of the living body's capacity to experience the body's own affective registers (Hansen, 2006b, p. 7), is the governing mechanism behind the perception of space, a theoretical position that opens new avenues of investigation for human-computer interactions. Hansen's theory of affect and embodied perception are extrapolated to hypothesize how the affective body enacts spatial and temporal properties of virtual spaces. How and what the affective body feels frames experiences of presence both quantitatively and qualitatively. The same mechanisms that discern the digital image from the affective body's encounter with digital information are responsible for creating the sensation of presence by via the embodied perception of space.

Susan Kozel's poetics of responsivity (2007) is a phenomenological framework built on Merleau-Ponty's notion of the body as flesh (1968; 2008) and Deleuze's notion of the body as forces (1988). Kozel has adopted this framework to reveal new insights in performance studies and virtual reality technologies. Kozel (Kozel, 2007) outlines a phenomenology for investigating the experiences of the body with forces and resistance, as detailed in her phenomenological accounts of her sensory experience with *trajets*[1], a "responsive installation" (Kozel, 2007, p. 178). Her poetics of responsivity draws on concepts from Merleau-Ponty's notion of flesh and Deleuze's idea of metabolism. This fusion of approaches emphasizes trajectories and proximities of bodies in a technologically mediated environment (Kozel, 2007, p. 178-9), which are in many ways analogous to experiences in virtual environments. Rather than a prescriptive analysis, Kozel's poetics offers a structure to her subjective experiences: "[T]he intention is to open up an experience through the

[1] *trajets* (2002) "consists of twenty-one trapezoidal screens suspended from a self-supporting structure. The screens are motorized, and a sensing floor provides the positional data to enable them to react to the proximity of the visitors: slowly spiraling away or toward the visitors according to a dynamic of magnetic attraction or repulsion. Images projected onto the screens are of moving bodies and their abstracted kinesthetic traces; the form of the bodies is less important than the visceral impact of a wide range of movement qualities—flying, falling, straining, flowing, disintegrating. The imagery, too, responds to visitors as they navigate the space through choreographies of where and when a clip is projected combined with a range of real-time visual effects." (Kozel, 2007, p. 190)

construction of a poetics, with potential impact upon the imagination, sensibility, and expression of those who read it" (Kozel, 2007, p. 181). Her poetics of responsivity is concerned with the space created between moving, living bodies: the kinesthetics, trajectories, and adjacency that bodies experience in a technologically mediated environment. Kozal's poetics of responsivity provides a phenomenological framework in which to structure subjective bodily experiences and allows for an investigation into the qualitatively and quantitatively distinct experiences of presence.

Steve Swink's contribution primarily rests on his work as a coder and developer for video games. His six properties of game feel **(**Swink, 2009**)** characterize the aesthetics of interacting with virtual objects and virtual forces, which provides both hard and soft metrics for assessing the effectiveness of virtual sensations. Swink captures this aesthetic dimension to interaction with digital media in his notion of *game feel*, as "real-time control of virtual objects in a simulated space, with interactions emphasized by polish" (Swink, 2009, p. 32-33). Game feel provides a way to describe how an intangible object in a video game can be characterized through its virtual mass, weight, and friction: Video game players may perceive an object to be "heavy" because it is rendered as a large rock, requires longer button presses to throw, and lands with a loud thud that shakes the screen. Game feel is significant for video game platformers like Super Meat Boy (Team Meat, 2010) or Hotline Miami (Dennaton Games, 2012), but the term can be applied more broadly to virtual reality applications. Swink has identified six properties of game feel that measure specific interactions with virtual objects and forces: Three of these properties are classified as quantifiable, hard metrics; the remaining three properties are more subjective and address a player's attitude toward an aspect of a virtual world. This framework allows for an investigation into how these virtual objects and virtual forces feel to the body and thus a better understanding of their role in shaping presence. Although Swink's aim is to provide a set of metrics for which developers can measure the type of virtual sensations experienced in a video game, Swink's metrics are adapted here as a phenomenological model for measuring the virtual sensation of space *itself*.

While all three approaches have a phenomenological nature, more importantly they open avenues to investigating the fundamental questions regarding the nature of presence—namely, how does the affective body enact virtual spaces—which may reveal greater insight into the operational mechanism governing presence. A theoretical framework for presence is proposed, one built upon the seminal theories of Hansen's affective body, Kozel's poetics of responsivity, and Swink's game feel that that reconceptualizes the phenomenon as a *mediated perceptual event* and explains this enaction of virtual spaces as an experiencing of the normally unconscious neurological processes responsible for the perception of circumambient space. This proposed definition of presence sidesteps the convoluted and seemingly disparate experiences of presence identified in the scholarship (i.e., Ijsselsteijn & Riva, 2003; IJsselsteijn, de Ridder, Freeman, & Avons, 2000; Lee, 2004; Lombard & Ditton, 2006; Regenbrecht, Schubert, & Friedmann, 1998; Riva, Waterworth, & Waterworth, 2004; Steuer, 1992) and reconceptualizes presence primarily as a temporal phenomenon in which distal attribution (i.e., the organism's capacity to experience the borders of its body) becomes mediated via technical subordination as digital stimuli (e.g., the photons from an HMD's display) and/or exclusion of natural stimuli (e.g., the much narrower field of view of most HMD's compared to natural human vision) by the technological apparatus (i.e., virtual reality and other immersive technologies). This proposed theoretical framework for presence places Hansen's affective body as the principle organizer for experiences of presence in both intensities and kind, and his corresponding notion of affectivity as the primary operational mechanism for presence. Framing presence as a sensation of the affective body not only provides explanations that account for how experiences of presence can differ quantitatively and qualitatively, but also points to an affective dimension to presence identified as directionality. The defining property of directionality is an emphasis on maintaining movement in a direction toward presence, an affective desire to enact perceptual models of circumambient spaces necessary for the organism to navigate and orientate itself in its environment, materialized as a repertoire of gestures, postures, and locomotions that contextually can trigger the human body's affective registers into powerful, yet categorically distinct experiences of presence. This study has been designed to investigate the validity of this proposed third affective dimension of presence to produce a topological map of the phenomenon that emphasizes the properties of relation and orientation among affective bodily movements through space. This topology of presence aims to aid designers and developers by reemphasizing the role of affective bodily movement in shaping experiences of presences, contributing to the metaphorical tool kit used to create more compelling experiences of presence for recreation, education, and therapy.

1.3 The Study

The study takes an enactive approach to understand the role of the affective body in creating experiences of presence. An enactive approach is a point of view that cognition is the result of the affective body's sensorimotor system encountering the external world (Varela, Thompson, & Rosch, 1991). This approach adopts a phenomenological investigation and enlist interviews with VR community practitioners to understand how cognition of presence in different kinds and intensities. How does the mind bring awareness to, present and disclose the virtual space of the virtual reality technology? This enactive approach allows the researcher to apply both phenomenological methodology and interviews to investigate this phenomenon. The deliverable of this research is a topological map of presence that reveals the relationships among gestures, postures, and locomotions associated with the triggering affective registers that contribute to the sensation of "being inside" a virtual environment. VR technologies offer potentially profound novel experiences of presence by highlighting the spatial- and temporal-making abilities of the affective body. The better the phenomenon of enaction is understood, the more effective immersive strategies can be applied to the development of VR applications across disciplines.

1.3.1 The Problem Statement

The central problem driving this research addresses the fact that currently little is understood about the operational mechanisms responsible for the varying quantitative and qualitative experiences of presence, an obstacle that, if circumnavigated, may lead to a better understanding of the nature of the phenomenon and therefore aid the design and development of virtual experiences. A review of the scholarship reveals that the term *presence* has become a catch-all for a set of broad, diverse experiences in which mediated stimuli supplant the natural stimuli as the technological apparatus disappears from the user's perceptual awareness, a nebulous definition that seemingly overlaps with other hyper-attentive states of consciousness, such as immersion and flow, rather than the term's original emphasis on *spatial* presence (Sheridan, 1992), resulting in disconnected hypotheses that buckle to explain how reading a fantasy novel is fundamentally the same phenomenological experience as playing a massive-multiplayer role-playing game in virtual reality (e.g., Lombard & Ditton, 2006; see literature review in this dissertation). Thus, the first problem identified in the scholarship on presence concerns a lack of consensus on the definition of the phenomenon, much less a cohesive theoretical framework that identifies the operational mechanisms that account for so many diverse and subjective experiences. The second problem regarding the discussion of presence is the misconception that bodies ignore sensory stimuli once mediated stimuli become first order, echoed somewhat in Bailenson's claim that "[p]resence in VR leads to absence in the physical world. Your mind can't be in two places at once" (Bailenson, 2018, p. 250). This sentiment for absence is reverberates in terms such as *immersion* and *flow*, which are defined as much as hyper-attentiveness as they are as unconscious awareness (see the literature review in this dissertation). While the first problem anchors the theoretical conceptions for diverse experiences of presence to technology (i.e., broadly media technology), the second problem privileges the consciousness as the higher-order determiner of presence, a hypothesis that pushes aside the fundamental role of affect and embodied perception in shaping presence. The theoretical framework for presence proposes that while the user of a technology may be unaware, even for a moment, of physical space, the affective body does not forget the physical space. Key to the theoretical framework is the privileging of the affective body as the primary determiner of experiences of presence. To investigate these problems in an attempt to identify possible operational mechanisms for presence, a specific manifestation of the phenomenon is targeted: the conscious and nonconscious process of learning how to navigate and orientate oneself within a virtual environment while avoiding the nausea, disorientation, and other symptoms manifested from simulator sickness (Biocca, 1992; Ebenholtz, 1992; & Sharples, Cobb, Moody, & Wilson, 2008). This phenomenon raises questions that the current scholarship not only cannot answer satisfactorily but also challenges popular conceptions of the nature of presence: Why, for example, do users of virtual reality technologies, such as consumer head-mounted displays, learn to navigate faster or slower than other users, while some users never able to orientate themselves at all? What are the underlying mechanisms that make such enaction of virtual spaces possible? How does the body reconcile perceptual conflicts, such as artificial locomotion? Phenomenologically, "getting VR legs" shares many features as experiences of presence, as both appear to operate on similar mechanisms that characterizes users' experiences as "being there" in a virtual environment. Therefore, an investigation into the phenomenon may reveal a better understanding of the operational mechanisms that govern presence, which may be leveraged for the development of more captivating experiences of presence.

1.3.2 Research Questions and Hypotheses

The proposed theoretical framework underscores movement as the driving force behind the perception of space, and understanding how the body learns to navigate a virtual environment can lead to insight regarding the affective body's enaction of circumambient space: What does the affective body prioritize to enact space? Why does the affective body respond more intensely in some spaces but not others? What does the affective body learn to do to sustain experiences of presence? Examining this moment of enactment of circumambient space can lead researchers, designers, and developers to a better understanding of distinct experiences of presence. Using phenomenological methodology and interviews, this research maps a topology of presence by investigating how the body learns to adapt to virtual reality environments. How does the body enact virtual spaces? How do designers and developers encourage this affective growth in virtual reality spaces?

RQ1: How do gestures, postures, and locomotions inform the affective body's enaction of virtual space in technologically mediated environments?

a. What does the body feel at the moment space and time are enacted by the affective body?

b. How is presence experienced as *quantitatively* distinct by the affective body, as felt in degrees of intensity (i.e., the intensity of verisimilitude)?

c. How is presence experienced as *qualitatively* distinct by the affective body, such as felt in specific anatomy (e.g., "hands presence"), space versus place (e.g., hinterland versus home), and feelings of sublime (i.e., terror and awe)?

RQ2: How do designers and developers encourage the affective body's enaction of space to virtual environments?

a. How do designers and developers create virtual sensations through virtual objects (e.g., weight, texture, physical properties) and virtual forces (e.g., gravity, inertia, temperature) to foster specific kinds of experiences of presence? Which virtual objects and virtual forces are avoided?

b. How do designers and developers engage the affective body emotionally to sustain presence (e.g., narratives, graphics, room-scale, input, 3D audio)?

c. How do designers and developers feed the affective body's desires to sustain presence (e.g., goals, rules, engagement with others)?

These research questions are intended to be investigated through a phenomenological methodology and interviews with VR practitioners reproducing dominant models of gameplay, as these approaches are better equipped analytically to provide answers.

1.3.3 Participants and Research Sites of the Study

The theoretical framework for presence outlined in Chapters 3, 4, and 5 informs the phenomenological methodology applied to the study. To investigate the underlying mechanisms of presence, the design study adapts a methodology that places the researcher as a "test subject" experiencing a variety of virtual reality/immersive projects at different labs around the United States, with emphasis on consumer head-mounted displays. In addition, the researcher conducted an open-ended interview study with developers and designers creating VR projects in these labs to better assess immersive strategies applied to create more compelling experiences of presence.

1.3.4 Data Collection Forms and Analysis Strategies

Interviews, observations, artifacts (e.g., software), and documents (e.g., design documents) are used as data collection forms. Data are analyzed for significant statements, meaning units or themes, textual and structural description, and the description of the phenomenon itself; in addition, data are collected from the community of practitioners reproducing dominant models of gameplay (i.e., the designers and developers' understanding, language use, and design/developmental approach to presence) for themes (i.e., common descriptions or conceptual models). However, this research does face two significant limitations. First, regarding embodied values, different cultures posit different values on bodily postures and proximities. Prioritizing one's own culture as the de facto standard by which other values are measured leads to research that is highly ethnocentric. This research must be predicated by the fact that it is examining relatively narrow scope of practitioners. There are many more communities of practitioners who are shaping globally the kinds of virtual spaces enacted, but that agenda is beyond the scope of this research. Second, experiences of presence are highly subjective. Producing viable research from subjective experiences can be difficult, as such research may result in a limited range of applications. Finally, this research adopts a phenomenological framework in order to structure these subjective experiences for greater utility.

1.4 Dissertation Outline

This dissertation follows a conventional outline for qualitative studies: The research problem is identified and justified, followed by a literature review of relevant scholarship on presence. The subsequent three chapters are devoted to the introducing and building upon the proposed theoretical framework; the auto-phenomenological method applied to this study is extrapolated in thick descriptions, including a discussion of the validity of the findings and in Chapter 6. The final chapter discusses the implications of the findings for designers, developers, and researchers, and ends with suggestions for future research. Specifically, the research intends to outline a topology of presence that reveals the relations among embodied movements that trigger the affective registers of the body in the enaction (i.e., the perception) of a spatial experience within a virtual environment. These movements are characterized as gestures, postures, and locomotions that are embedded with cultural and personal meanings that shape spatial experience; when applied to the design of virtual environments, this topology of presence can help creators of immersive experiences reach presence via a more kinesthetic interaction with the digital information of the virtual reality apparatus. For researches concerned with presence, this topological map offers a starting point into the affective dimensions of presence and the nature of enaction of virtual spaces. The higher-order aim of this research is to better understand the affective body's role in creating experiences of presence of various intensities and types. Current models of presence rely on the virtual reality apparatus as the organizing principle and thus cannot account for the socio-cultural influences that shape the phenomenon of presence as experienced throughout the history of art and media. Misleading metaphors for presence imply that space and time are homogeneous and exist apart from the body. Virtual reality technologies offer unprecedented stimuli that the affective body can use to create unique experiences of space and time; if the mechanisms underlying presence are to be better understood, there must be a turn from the privileging of the technological apparatus and instead focus on how the affective body enacts circumambient space and time rather than chasing technological innovations and discounting previous experiences of presences as inauthentic.

1.4.1 Chapter 2 Overview

This literature review outlines the major debates and challenges in defining, measuring, and theorizing experiences of presence and outlines the two major domains of the phenomenon: experiences of presence can be broadly characterized according to intensity (i.e., the feeling of being "more" present in a virtual space) and kind (i.e., distinct types of presence according to the nature of the relationship between user and medium). A review of relevant terms (e.g., *immersion* and *flow*) as well as the possible effects of presence are considered. In addition, the literature review examines the theories addressing the origin and evolution of presence, emphasizing the biological and psychological nature of the phenomenon, and how it has adapted a socio-cultural "layer" (Riva, Waterworth, & Waterworth, 2004). (A review of the scholarship regarding affect and embodied perception is saved for the following three chapters, as it merits a much deeper discussion in order to outline the theoretical framework proposed here.) Precisely because the scholarship on presence can become unwieldy as the definitions of the phenomenon make it more inclusive and complicated simultaneously, this literature review focuses specifically on scholarship pertaining to spatial presence and will argue for its validity in the chapters that address the theoretical framework for presence and the affective body.

1.4.2 Chapter 3 Overview

This is the first of three chapters that outline the theoretical framework in which the affective body is situated as the primary organizer of experiences of presence and affectivity as the primary operational mechanism for the phenomenon. This theoretical framework is contrived from Hansen's work on affect in which the affective body is cast as the framing mechanism for the embodied perception of space (2006b). The chapter begins with a review of sensation, emotion, and feelings and their specific meanings in this research, and then moves to a discussion on Hansen's affective body and the framing of embodied perception as an active process involving the three bodily modalities of proprioception, tactility, and temporality in perceiving circumambient space. Hansen's affective body frames perception as a bodily act in which affect is the motivation to perceive space. Theoretically, this chapter establishes that the perception and experiencing of space is highly informed by affectivity.

1.4.3 Chapter 4 Overview

Expanding on the theoretical framework introduced in Chapter 3, this chapter proposes a reconceptualization of the phenomenon termed *presence* via the theoretical perspective of affectivity and embodied perception. With the affective body as the principle organizer for the perception of space, presence becomes predicated on evoking distal attribution (i.e., the capacity for an organism to discern itself from its environment) and mediation (i.e., stimulating the sensorimotor system via the technical subordination or exclusion of natural stimuli). More noteworthy, this theoretical framework characterizes the affective body as being temporally dispositioned to being sensitive to change, underscoring the importance of duration in the experience of presence. After redefining presence, the chapter continues expanding the theoretical framework with a discussion of affectivity as the operating mechanism for presence, rather than the technical frame, and the highly autopoietic nature of affectivity. In short, the theoretical framework casts presence as the experiencing of one's own margins of indeterminacy (Hansen 2006b, p. 11) expanding to accommodate the mediated stimuli from the technological apparatus in the affective body's efforts to maintain distal attribution. The two domains of presence are then explicated under the proposed framework: (1) experiences of presence involving varying degrees of intensity correlates to the fluctuations of these margins of indeterminacy, and (2) dimensions, or kinds, or presence reflect the distal attribution processes of the phenomenal body. This chapter concludes with a discussion on the merit of virtual reality technologies as unique media with the potential to technologically capitalize on many of the theories presented here to further research and invocation with presence.

1.4.4 Chapter 5 Overview

This chapter concludes the theoretical framework for presence by exploring the affective spatial schemas employed by the affective body that give meaning and value to spatial experiences. The affective body organizes the space according to anatomical structures of the human body as well as each individual's cultural and personal experiences. This chapter argues the case that the affective body possess an innate desire for imposing meaning to spatial properties and schemas, an evolutionary adaptation that facilitates memory, communication, and reason through spatial structures. The affective body, this theoretical framework posits, has a insatiable appetite for interactivity: It wants to poke and prod the world and see if it pokes back. Furthermore, the affective body desires for interactivity intertwines with a desire of presence, the need for the organism to establish distal attribution by reconciling the meditated stimuli of the technological apparatus. The chapter concludes by drawing together these spatial schemas into a cohesive affective spatial schema, which is at the crux of the proposed theoretical framework for presence and the starting point for this study's investigation into the directionality of presence and the affective body's enaction of virtual spaces.

1.4.5 Chapter 6 Overview

This chapter details the design of the study used to investigate the phenomenon of enaction, delving deeper into the Kozel's poetics of responsivity (Kozel, 2007) and Swink's game feel (Swink, 2009) and their contribution to the phenomenological methodology as well as framing questions with designers, developers, and researchers of immersive experiences. Consequently, the research study consists of two parts: (1) an auto-phenomenological study in which the researcher investigates the phenomenon of presence by partaking in several virtual reality systems and labs; and (2) interviews with designers, developers, researchers, and entrepreneurs regarding how they encourage the affective body to enact virtual spaces. Specifically, this study has been designed to investigate the phenomenon of users of virtual and immersive technologies enacting virtual space as a means to construct a more accurate theoretical framework for presence. The findings are presented as a thick description of the phenomenon and data from interviews are analyzed for significant statements, meaning units, or themes.

1.4.6 Chapter 7 Overview

The concluding chapter is a discussion of the theoretical implications of the findings of the research study, as well as the production of a topological map of presence that identifies embodied kinematics associated with particular affective registers that inform the experience of space, and therefore presence. This chapter addresses the ways in which presence is framed as an affective response to the enaction of space to understand the underlying mechanics of presence more fully. As a result, a third domain of presence is proposed, one that shapes both the intensities and kinds of experiences of presence, and conceptualized in the aforementioned topological map of presence. In addition, avenues for future research are discussed, specifically in responding to the Hansen's call for more investigation into how the affective body corporealizes digital data (Hansen, 2006b, p. 11). Close examination of this enaction of space by multiple bodies may reveal greater insight into the mechanisms underlying presence. Another area of future research is the application of the topological map of presence as a starting point for designing interfaces for spatial computing.

2. REVIEW OF THE SCHOLARSHIP ON PRESENCE

Historically, presence has been difficult to define, problematic to measure, and contentious to theorize. One explanation for this dispute may be in the word's origin. The word *presence* has been shortened from *telepresence*, which denotes the degree of being present at a remote place, and originally referred to teleoperations, such as piloting submersible drones (Sheridan, 1992). Although the word has been expanded in definition and category (Lombard & Ditton, 2006), presence is commonly understood as the feeling of "being there" in a virtual environment, a "mediated experience that seems very much like it is not mediated" (Lombard & Ditton, 2006, par. 1). The International Society for Presence Research (ISPR), which supports academic research into presence, offers a succinct yet extensive definition of presence. The ISPR defines presence as an internal phenomenon in which a user perceives a mediated reality as a non-mediated reality.

> Presence (a shortened version of the term "telepresence") is a psychological state or subjective perception in which even though part or all of an individual's current experience is generated by and/or filtered through human-made technology, part or all of the individual's perception fails to accurately acknowledge the role of the technology in the experience. Except in the most extreme cases, the individual can indicate correctly that s/he is using the technology, but at "some level" and to "some degree," her/his perceptions overlook that knowledge and objects, events, entities, and environments are perceived as if the technology was not involved in the experience. Experience is defined as a person's observation of and/or interaction with objects, entities, and/or events in her/his environment; perception, the result of perceiving, is defined as a meaningful interpretation of experience. (International Society for Presence Research, 2000b)

This definition of presence, first proposed in 2000, is predicated on the technological apparatus fading away from human perception and replaced with a more compelling mediated environment.

Others have defined presence similarly (Ijsselsteijn & Riva, 2003; IJsselsteijn, de Ridder, Freeman, & Avons, 2000; Lee, 2004; Lombard & Ditton, 2006; Regenbrecht, Schubert, & Friedmann, 1998; Riva, Waterworth, & Waterworth, 2004). Ryan, who embraces Maurice Merleau-Ponty's phenomenological approach, defines presence as a sensation by which "the user feels corporeally connected to the virtual world" (Ryan, 2001, p. 14); Steuer, paraphrasing Gibson (Gibson, 1986), defines presence as "the experience of one's physical environment; it refers not to one's surroundings as they exist in the physical world, but to the perception of those surroundings as mediated by both automatic and controlled mental processes" (Steuer, 1992, p. 75). To state more concisely, the scholarship conceptualizes presence as a psychological phenomenon in which the user prioritizes the stimuli provided by media as first order rather than the everyday, real-world sensory stimuli that defines what we commonly refer to as reality. For the sake of clarity, this dissertation refers to this reality—as opposed to the mediated reality of a virtual reality—as "in real life," abbreviated from this point on as IRL. Philosophical debates aside, IRL is used widely among video game and role-playing communities ("IRL," 2019) and carries a clear, concise meaning: one's reality apart from a given communication medium.

2.1. The Two Domains of Presence

This literature review characterizes presence as constituted of two distinct yet overlapping domains: the capacity for presence to be experienced in *degrees of intensity*, and the capacity for presence to be experienced in distinct *dimensions*. The former describes presence quantitatively and can be expressed in terms or "more" or "less" intensity (i.e., towards optimal presence); the latter addresses a qualitative aspect of presence that distinguishes experiences by kind or type. Understanding how these domains interrelate can reveal greater insight into how the processes of presence operate, particularly if the goal is to craft experiences that aim to deliver optimal feelings of presence.

2.1.1 Presence Can Be Experienced in Degrees of Intensity

As mentioned above, a defining characteristic of presence is having first-order perception—that is, as one perceives the natural world with her bodily senses—superseded by a mediated perception provided by technology: technology supplies the body with stimuli that supplants the first-order stimuli of the natural world. Under this framework, presence can be characterized according to intensity (i.e., presence can be experience in greater or lesser degrees) and does not occur if the user is wholly aware of the representation created by the technology. On the other hand, presence is "maximized" when the user can no longer discern the representation from the IRL object and fails to perceive the technology behind the image (Chirico, Ferrise, Cordella, & Gaggioli, 2018; Riva, Waterworth, & Waterworth, 2004; Turchet, 2015). Not only can presence vary in degrees of intensity (i.e., a virtual environment reported as being correlated with stronger feelings of presence), but also presence can be experienced intermittently in discontinuous experiences, experienced one moment but not the next (Riva, Waterworth, & Waterworth, 2004; Slater, 2002; Slater & Steed, 2000). Presence may be perceived as uninterrupted, but the phenomenon is constituted of moment-by-moment experiences of presence, each of which may or may not be more intense than the previous moment. (For clarification, presence may appear to fluctuate in intensity during an experience, but it has yet been determined if that fluctuation is happening *within* an instant rather than imperceptibly *between* instances (International Society for Presence Research, 2000b). Measuring the degree to which a user experiences presence is useful for designing optimal presence (Regenbrecht, Schubert, & Friedmann, 1998; Juan & Perez, 2009; Steed, Friston, Lopez, Drummond, Pan, & Swapp, 2016; Hvass, Larsen, Vendelbo, Nilsson, Nordahl, & Serafin, 2017; Cooper, Milella, Pinto, Cant, White, & Meyer, 2018).

2.1.2 Presence Can Be Experienced in Distinct Dimensions

In addition to experiencing greater or lesser sensations of presence, users can also characterize these experiences as distinct yet overlapping. Since Sheridan's original definition of presence to describe the user's relationship to a virtual environment as analogous to teleoperating a remote submersible (Sheridan, 1992), theories on presence have been explicated to explain several diverse experiences between users and communication media (Lombard & Ditton, 2006). These classifications of presence are not necessarily mutually exclusive and can be aggregated for optimal experiences of presence (Lombard & Ditton, 2000). Because presence is defined in part by the technological affordances of a communication medium, Lombard and Ditton's six concepts (Lombard & Ditton, 2006) attempt to characterize a distinct kind of experience with presence differentiated by that medium's capacity to represent people, things, and events as convincingly or as compellingly as their IRL counterparts (see Table 2.1. below). Because the psychological mechanisms that drive experiences of presence are little understood, it is difficult for researchers to theorize this phenomenon operationally; nevertheless, a review of the scholarship reveals many studies that categorize these different experiences of presence into "domains," "properties," "paradigms," or "dimensions": Steuer (1992); International Society for Presence Research (2000b); Ijsselsteijn (2002); Ijsselsteijn and Riva (2003); Lee (2004); Riva, Waterworth, & Waterworth's (2004); Mennecke, Triplett, Hassall, and Conde (2010).

These studies aim at developing a theoretical framework that accounts for some but not all diverse experiences between users and communication media. As a result, theories of presence grow to become convoluted and unwieldy: The psychological processes driving presence are already complicated and largely unexplained, yet every new communication media seems to require a new theory of presence to accommodate it. Theories of presence strains to explain how reading *Lord of the Rings*, listening to a live baseball game on the radio, and speaking to Siri are all different manifestations of the same phenomenon. One of goals of this research is to argue for a different method of classification, one not centered on the technological affordances of the communication media, but one more focused on the affective body as the determiner of presence.

2.1.2.1 Spatial Presence

One of the most popular, and perhaps oldest (Lombard & Ditton, 2006), notions of presence as the experience of a mediated environment. The conceptualization of presence is commonly associated with the virtual environments created by virtual reality technologies, such as head-mounted displays (HMD's) and cave automatic virtual environments (CAVE's), but the former technology is in the greater public conscious. Presence as transportation refers to (1.) the capacity of a medium to mediate an artificial environment in place of the actual environment, (2.) the capacity of a medium to manifest virtual environments and virtual objects, and (3.) the capacity of a medium to induce presence by placing humans together in a virtual space (Lombard & Ditton, 2006). To sum, presence as transportation refers to experiencing a mediated environment as first-order perception (i.e., superseding the user's IRL environment with the computer-generated imagery of the VR system), whether that mediation is person, thing, or place. Spatial presence then occurs when the user's perceptional awareness does not acknowledge the part of the technological apparatus in mitigating the experience (International Society for Presence Research, 2000b). Lombard & Ditton (2006) further divide presence into three distinct types of transportation: *you-are-there*, *it-is-here*, and *we-are-together*. Presence as you-are-there originated in teleoperations (i.e., telepresence) (Minsky, 1980), and refers to the notion of traveling to another place (i.e., "being there") (Lombard & Ditton, 2006). Virtual presence describes a feeling of being present in a computer-generated environment (Sheridan, 1992). It-is-here describes a sensation that objects and people and brought into the user's space, as popularized in the anecdote of early twentieth century moviegoers scrambling away from a black-and-white image of an incoming train (Schoen, 1976).

The final form of presence as transportation is a kind of shared space. We-are-together describes users sharing a virtual environment together: Popular massive multiplayer roleplaying games, such as World of Warcraft (Blizzard Entertainment, 2004) and RuneScape (Jagex, 2001), attract millions of players who raid dungeons and partake on quests together for years in shared virtual environments.

Table 2.1. Lombard and Ditton's six concepts of presence (2006).

Concept	Explication	Exemplification
Presence as social richness	Presence defined by the capacity of a medium to be perceived as "sociable, warm, sensitive, personal or intimate" when communicating with other users. Users perform tasks and rate the experience along scales of *intimacy* or *immediacy* (e.g., impersonal-personal, unsociable-sociable, insensitive-sensitive, and cold-warm); the medium's capacity to express many intimacy cues or behaviors (e.g., eye-contact, laughter, facial expressions), which in turn allows users to control the immediacy, would score high in social richness.	Telephone calls are considered higher in social richness than personal letters due to the former's capacity to induce high feelings of presence between users (i.e., hearing a human voice, response in real time).
Presence as realism	Presence as realism is defined by the capacity of medium to be perceived as creating realistic representations of people, objects, and events. Presence as realism can be analyzed along two axes, *social realism* and *perceptual realism*. Social realism refers to the degree that the user can suspend her/his disbelief for a given social context. The believability of a given character and the plausibility of a plot can foster the sensation of presence if the user perceives these actions as somewhat analogous to real life. Similarly, users can experience strong sensations of presence when the representation of characters and places are mimetically accurate to the objects they are supposed to signify. The more photorealistic an object is perceived, the stronger experiences of presence are reported.	A theater performance of *Hamlet* with talented actors could foster a high degree of social realism, but minimal us of props might score low in perceptual realism.
Presence as transportation	Presence as transportation is evoked often in conversations around virtual environments or virtual reality. This is the capacity for a medium to mediate an artificial environment in place of the actual environment, the capacity of a medium to manifest virtual environments and objects into real spaces, and the capacity of a medium to induce presence by placing humans together in a virtual space. This concept frames presence as a spatial metaphor of *being there/here/together* and presented as the de facto definition for many advocates in the HMD industry. (Abrash, 2014)	Reading a fantasy novel with a highly detailed world, watching the World Series live on television, and playing a massive multiplayer online role-playing game can induce feelings of presence as transportation.

Presence as immersion	Whereas presence as realism is characterized by fidelity, presence as immersion describes the medium's capacity to fill and occupy the user's senses: the degree to which the technology comes between the user and the stimuli from IRL. Presence as immersion has two forms: *perceptual immersion* and *psychological immersion*. Perceptual immersion refers to how much of the media (i.e., displays, headphones, etc.) subsumes the user's senses from RL. Psychological immersion, also known as *flow* or *engagement*, describes the degree to which the user is absorbed/given attention to the mediated experience.	Consumer VR headsets, such as the HTC Vive and Oculus Rift, are regarded as having high perceptual immersion since the completely fill a user's field of vision and hearing; video games that require intense concentration, such as *Tetris*, can be characterized as having high psychological immersion.
Presence as social actor within medium	Presence as social actor within a medium describes how a user responds to the social cues in a mediated interaction. Lombard & Ditton cite studies in which people were reported speaking to television entities as if they were real people as examples of presence as a social actor. Users who report a strong experience of this type of presence ignore the fact that the interaction is being mediated by technology, such as someone on a video call offering a pen, and the user absent-mindedly reaching for it.	An audience yelling at the actors in a horror movie not to go into an ominous basement is an example of presence as social actor within a medium.
Presence as medium as social actor	Presence as medium as social actor describes *not* how people interact with one another in a given medium, but how convincing the medium *itself* can be at offering social cues. The Turning Test, which is an informal test that determines whether a computer can pass as a real human being, is in a sense another way to measure how "human" avatars appear in video games. This concept of presence speaks to the degree at which technology can pass for a living entity.	Many voice-assistant technologies, such as Apple's Siri and Amazon's Alexa, are often perceived as having degrees of presence as medium as social actor.

2.1.2.2 What Is Not Presence

Presence here is defined in part by the technological affordances of the medium. Thus, presence always is characterized by mediation. However, the human body is capable of experiencing alternate realities that are distinct of the everyday, communal IRL reality: hallucinations, dreams, the hearing of voices by those suffering from schizophrenia, experiences with psychedelic drugs, and perceptions created by role-playing games are by definition not experiences of presence since the role of technology is minimal (Riva, Waterworth, & Waterworth, 2004). However, the next chapter explores more fully these concepts of altered states and how the affective body's capacity to communicate ideas about dreams and hallucinations greatly impacted our perception of space (Lewis-Williams, 2004; Mithen, 1996; Tuan, 2011).

2.2 The Intersection of Presence, Immersion, and Flow

For a complete understanding of presence, it is necessary to define two concepts that often enter such a conversation: *immersion* and *flow*. For this research's purpose, *immersion* refers to a given medium's technological capacity to produce experiences of presence in its user (Slater, Usoh, & Steed, 1995). Since some of the conventional notions surrounding presence and immersion are challenged, articulating the relationship between immersion and the technological affordances of a given medium is paramount. Slater, Linakis, Usoh, and Kooper (1999) offer a more comprehensive definition of *immersion*.

> Immersion refers to what is, in principle, a quantifiable description of a technology. It includes the extent to which the computer displays are extensive, surrounding, inclusive, vivid and matching. The displays are more *extensive* the more sensory systems that they accommodate. They are *surrounding* to the extent that information can arrive at the person's sense organs from any (virtual) direction, and the participant can turn towards that direction receiving the appropriate directional sensory signals. The notion of surrounding also includes the greater the reproduction of the natural modes of sensory presentation (visual and auditory stereopsis for example). They are *inclusive* to the extent that all external sensory data (from physical reality) is shut out. Their *vividness* is a function of the variety and richness of the sensory information they can generate (Steuer, 1992). Vividness is concerned with the richness, information content, resolution and quality of the displays. Finally, immersion requires that there is *match* between the participant's proprioceptive feedback about body movements, and the information generated on the displays. (Slater, Linakis, Usoh, & Kooper, 1999, p. 73)

To state that a given medium has a high capacity for immersion is to say that the sensory displays provide ample and convincing stimuli to the body. The human body may even be biologically disposed to immersion that appeals to the mind's ability to perceive an "alternative reality," such as those from dreams, memory, and imagination, to other members of the species[2] (Lewis-Williams, 2004, p. 91, 123-126). To summarize, presence is the *experience* of the body prioritizing the stimuli from the technological medium (e.g., a book, film, or head-mounted display), and immersion is that technological medium's *potential* to provide such compelling stimulus (e.g., plot and character development, state-of-the-art special effects, or imperceptible tracking issues, respectively).

The other concept that needs to be delineated from presence is *flow*. Csikszentmihalyi (1990) defines flow as a theory of optimal experience: "the state in which people are so involved in an activity that nothing else seems to matter; the experience itself is so enjoyable that people will do it even at great cost, for the sake of doing it" (p. 4). Although researchers have not interpreted flow operationally the same, Riva, Waterworth, & Waterworth (2004) have identified two key characteristics of flow: (1) "a total concentration in activity" and (2) "the enjoyment which one derives from the activity" (Riva, Waterworth, & , Waterworth, 2004, p. 415); additionally, these authors name two factors that influence this experience of flow: (a) "a sense of control over one's environment" and (b) "the level of challenge relative to a certain skill level" (Riva, Waterworth, & , Waterworth, 2004, p. 415). For reasons explicated later in this chapter, flow will be subordinated under the larger phenomenon of presence by classifying the former as a characteristic of optimal presence—that is, when "a mediated experience arises from an optimal combination of form and content" (Riva, Waterworth, & Waterworth, 2004, p. 415).

2.3 Possible Effects of Presence

Researchers have identified several physiological and psychological effects associated with a mediated experience of presence. Physiological responses to mediated stimuli are indistinguishable

[2]"Core affect responds to the contents of consciousness whether based on reality or fiction. It varies with thoughts, imaginings, daydreams, memories, and anticipations. If one mentally focuses on a loss, then displeasure follows—even if the loss is imagined, fictional, a future possibility, or some other form of virtual reality." (Russell, 2003, p. 155)

from their IRL counterpart (Rizzolatti & Arbib, 1998), but the psychological and physiological effects of presence associated with mediated technology are of more interest to researchers: triggering arousal (Grigorovici, 2003), nausea (Nichols, Haldane, & Wilson, 2000), improved task performance (Stanney, Mourant, & Kennedy, 1998), sensations of vection (Bonato, Bubka, Palmisano, Phillip, & Moreno, 2008), and many more symptoms associated with simulator sickness in general[3] (Kennedy, Lane, Berbaum, & Lilienthal, 1993). Furthermore, these side effects may continue to linger after using the virtual reality technologies (Biocca, 1992; Ebenholtz, 1992; & Sharples, Cobb, Moody, & Wilson, 2008). For these reasons, the capacity for virtual reality technologies to induce such feelings are of interest to researchers who investigate the role of presence in a wide range of applications: PTSD treatment (Gerardi, Rothbaum, Ressler, Heekin, & Rizzo, 2008; Nelson, 2013) and psychotherapy (Suied, Drettakis, Warusfel, & Viaud-Delmon, 2013; Villani, Riva, & Riva, 2007), task completion (Welch, 1999), social anxiety (Rothbaum & Hodges, 1999), escapism and meditation (Riva, 2007), training and education (Psotka, 1995), tourism (Huang, Backman, Backman, & Chang, 2016), and real estate (Deaky & Parv, 2017).

2.4 Measuring Presence

The underlying assumption in studies that endeavor to measure presence is that the human body has a capacity to replace non-mediated stimuli with mediated stimuli (Riva, Waterworth, & Waterworth, 2004). Although presence may (or may not) be a unitary phenomenon, theoretically presence has been delineated into many distinct concepts to explain a diverse set of experiences (van Baren & IJsselsteijn, 2004; Riva, Waterworth, & Waterworth, 2004; Lombard & Ditton, 2006) in which the intensity of presence can be evaluated quantitatively (Slater, Usoh, & Steed, 1995; Witmer

[3] Kennedy, Lane, Berbaum, and Lilienthal' Simulation Sickness Questionnaire (1993) includes a plethora of additional symptoms associated with simulator sickness: blurred vision, breathing awareness, burping, difficulty concentrating, difficulty focusing, discomfort, dizziness, eyestrain, fatigue, increased salivation, stomach awareness, sweating, trouble concentrating/headache, and vertigo (Kennedy, Lane, Berbaum, and Lilienthal, 1993, p. 206).

& Singer, 1998). Measuring presence, therefore, has taken two broad approaches: those studies that attempt to measure presence objectively (e.g., measuring biological responses) and those studies that examine presence subjectively (e.g., using self-reporting questionnaires that evaluate psychological or behavioral indications of presence) (van Baren & IJsselsteijn, 2004).

2.4.1 Measuring Presence Objectively

Measuring the effect of presence on the body can be observed both physiologically and behaviorally (van Baren & IJsselsteijn, 2004). Measuring presence objectively is appealing to researchers because user responses are immediate, reflexive, and done with little conscious thought, thus avoiding some of the problems with the inconsistent, varying responses from subjective measurements (Ijsselsteijn, de Ridder, Freeman, & Avons, 2000). Early studies simply observed how effective a teleoperator could control a telerobot with concerns to training and learning (Sheridan, 1992). Measuring presence by observing the user's behavior is relatively easy and inexpensive: Researchers can measure a user's sense of presence by observing her or his performance with a given task before and after using a head-mounted display (Ijsselsteijn, de Ridder, Freeman, & Avons, 2000). Other observations include whether a user flinches or dodges a virtual ball being thrown at them, indicating a degree to which the user responds instinctively to this perceived incoming object (Held & Durlach, 1987; Sheridan, 1992; Slater, Usoh, & Chrysanthou, 1995; Freeman, Avons, Meddis, Pearson, & Ijsselsteijn, 2000). Because the body responds to the same to stimuli, mediated or not (Rizzolatti & Arbib, 1998; Riva, Waterworth, & Waterworth, 2004), measuring physiological responses to presence involve recording heart rate, blood pressure, respiration, skin conductance, ocular responses, and posture (Freeman, Avons, Meddis, Pearson, & Ijsselsteijn, 2000; van Baren & IJsselsteijn, 2004). Slater, Usoh, and Steed's famous "pit experiments" measured biological responses to virtual heights with the use of EKGs, galvanic skin temperature meters, and other devices (Slater, Usoh, and Steed, 1995). Measuring presence objectively, unfortunately, is typically expensive and challenging to administer (van Baren & IJsselsteijn, 2004).

2.4.2 Measuring Presence Subjectively

The scholarship primarily characterizes presence as a complex relationship between many psychological processes (van Baren & IJsselsteijn, 2004). As a result, self-reporting metrics, such as the "presence questionnaire" designed by Witmer and Singer (1998), have been one popular method for measuring presence. For example, users rate the intensity of presence experienced after participating in a "pit experiment" (Slater, Usoh, & Steed, 1995). These questionnaires also have the advantage of being inexpensive and easy to administer (van Baren & IJsselsteijn, 2004), and so there is no shortage of them in the scholarship. The OmniPres Guide and Compendium, another measurement compendium that summarizes and details both subjective and objective methods to presence measurement, details 28 questionnaires at the time of its publication in 2004 (van Baren & Ijsselsteijn, 2004). Rather than giving the user a questionnaire *ex post facto*, some experiments have users report in real time the intensity of presence (Ijsselsteijn, de Ridder, Hamberg, Bouwhuis, & Freeman, 2002; Freeman, Avons, Pearson & Ijsselsteijn, 1999).

However, regardless as to whether the metric is applied during or after an encounter with a virtual environment, subjective measures of presence have two considerable limitations. First, with so many questionnaires framing presence slightly differently, comparisons between studies becomes challenging, and participants may be unfamiliar the concept of presence as explained on some questionnaires (van Baren & IJsselsteijn, 2004). Second, as Freeman, Avons, Pearson and Ijsselsteijn (1999) have pointed out, many of these subjective measures have provided unreliable and uneven results (van Baren & IJsselsteijn, 2004).

2.5 Presence as an Evolved Psychological Mechanism

The scholarship points toward the body as playing an important role in enacting presence but stops short in explaining how the body accomplishes this perception. One of the goals of this design study is to produce a more applicable definition of spatial presence that takes the affective body into account: more specifically, the role of distal attribution in creating mediated environments. *Distal attribution*, or *externalization*, refers to the phenomenon of perceiving an external space beyond the borders of the body's sensory organs (Loomis, 1992). Distal attribution is the recognition of the self as distinct from the environment and can be understood "as a neuropsychological phenomenon evolved from the interplay of our biological and cultural inheritance" (Riva, Waterworth, & Waterworth, 2004, p. 405). Riva, Waterworth, and Waterworth's conceptualization of spatial presence grounds the phenomenon into human evolution: "a bio-cultural mechanism that helps the self in organizing the streams of sensory data: the more it can differentiate the external world, the more we experience a sense of presence" (Riva, Waterworth, & Waterworth, 2004, p. 405). Because distal attribution is a defining feature of how the body perceives space, its role in shaping presence needs to be better understood if designers and developers want to create optimal experiences of spatial presence. Riva, Waterworth, and Waterworth's bio-cultural approach conceptualizes presence as comprised of three distinct layers: *proto presence*, *core presence*, and *extended presence* (Riva, Waterworth, & Waterworth, 2004). These layers characterize spatial presence as the effect of a biocultural phenomenon millions of years in the making.

> [P]resence is the result of the evolution of the central nervous system in its attempt to embed the sensory-referred properties into an internal functional space…the appearance of the sense of presence allows for the nervous system to solve a key problem for survival: how to differentiate between internal and external states. (Riva, Waterworth, & Waterworth, 2004, p. 409)

Different media effect some or part of these layers of presence, either sustained or intermittently, and designing for optimal presence is to strive for an ideal combination of form and content (Riva, Waterworth, & Waterworth, 2004). Riva, Waterworth, and Waterworth's work (2004) will be seminal for the development of a topology that aids designers and developers creating optimal experiences of presence by accounting for the role of gestures, postures, and locomotions in shaping distal attribution.

2.5.1 Evolution of Presence

One of the fundamental questions evolutionary psychology seeks to answer regards how the cognitive processes evolved and how does this effect our behavior today. Evolutionary psychology is founded on the assumption that "certain features of human behavior…have been designed by natural selection to be useful for survival and reproduction in the environment in which humankind evolved" (Riva, Waterworth, & Waterworth, 2004, p. 406). Riva, Waterworth, and Waterworth (2004) proposed that some of these behaviors helped early humans form social bonds, for example, which increased their chances of surviving a harsh, unknown world.

> I am suggesting that we are addicted to soap operas (and all other condensed and elaborate social dramas we call theatre) because our ancestors literally endured similar circumstances in small groups of relatives and friends for thousands of generations, in which nothing was more important than experience and skill in manipulating the people and events involved, and such experience and skill came from observation as well as actual participation in particular events. (Alexander, 1990, p. 264)

This survival mechanism places a premium on communication: imbuing meaning into sounds, gestures, actions, and artifacts to give them symbolic significance, an adaptation supported by specific biological features, such as opposable thumbs, bipedalism, and "an impressive growth of brain structure in both mass and complexity" (Riva, Waterworth, & Waterworth, 2004, p. 406). The important takeaway is that humans have evolved to make use of symbolism to understand distal attribution. For zebrafish, distal attribution is a matter of meaning-as-comprehensibility (i.e., perception matches movement with no conscious awareness), but for humans, distal attribution has evolved an additional stratum, meaning-as-significance (Riva, Waterworth, & Waterworth, 2004). This use of metaphor allows us to understand our internal states as symbolic of several physiological and psychological processes: we have the ability to identify and communicate states of grief, to connect with other humans through art and media the notion of grief, and the capacity to recognize grief in other humans. Furthermore, unlike zebrafish, humans have the ability to conceptualize hypothetical events (e.g., causing grief in others may in turn lead to them causing grief in the individual) became an important survival mechanism (Riva, Waterworth, & Waterworth, 2004). Planning, predicting, and imagining future events is indicative of our *extended consciousness*, which "allows us to create an internal world in which we may suspend disbelief, as compared to a perceptual world experience outside the self" (Riva, Waterworth, & Waterworth, 2004, p. 407).[4] Juxtaposed to the extended consciousness is the *core consciousness*, which we presumptively share with the zebrafish. The core consciousness is "a simple biological phenomenon, the scope of which is the Here and Now. This basic, integrated representation of one moment and one place is independent of language, reasoning, and memory" (Riva, Waterworth, & Waterworth, 2004, p. 407). Responses to stimuli at the core consciousness level are reflexive and incapable of utilizing memory.

2.5.1.1 Three Layers of Self

To discuss the consciousness is to discuss the self. Core consciousness and extended consciousness refer to an awareness of the organism's body in a given environment, but the self is the recognition of such a consciousness (i.e., the organism is aware it exists). Riva, Waterworth, and

[4] In fact, the inability to distinguish hypothetical events from perceptual events can be an indication of severe mental health concerns (Riva, Waterworth, & Waterworth, 2004).

Waterworth capture succinctly the notion of the consciousness and the self: "the basis for conscious self is a feeling state that arises when organisms represent a non-conscious proto self in the process of being modified by objects [i.e., the environment]" (Riva, Waterworth, and Waterworth, 2004, p. 408). The authors further classify the self into three distinct layers: *proto self*, *core self*, and the *extended self* (see Table 2.2 below).

Table 2.2. Riva, Waterworth, & Waterworth's classification of self (2004, p. 407-408)[5].

Three Layers of Self	Description	Exemplification
Proto Self	"A coherent collection of neural patterns that map, moment by moment, the physical state of the organism"	A zebrafish's sense of an internal state is fundamentally a relationship between sensorial input and motor input: *something is happening*.
Core Self	"A transient entity which is continuously generated through encounters with objects"	Our awareness that sensory organs our sending us stimulus that needs our attention: *something is happening to me*.
Extended Self	"A systematic record of the more invariant properties that the organism has discovered about itself"	Our depository of memories, dreams, and imaginations gives us an understanding of these sensory properties: *knowledge of the feeling that something is happening to me*.

The "outer" two layers refer to two discrete conceptualizations of the self-consciousness, whereas the proto self is classified as a function of the nonconscious. Essentially, the self-consciousness relies on second-order mapping, argue the authors, of the proto self, which raises the awareness that "not just that something is happening, but that something is happening *to me*" (Riva, Waterworth, & Waterworth, 2004, p. 408). This second-order mapping reveals that organisms have a relationship to sensory streams (i.e., distinguishing between external and internal stimulus) and that this relationship effects the organisms in some way; ergo, any theory or presence begins with this mapping of "sensorial inputs" (Riva, Waterworth, & Waterworth, 2004, p. 408). Riva, Waterworth, & Waterworth illustrate how the mapping unfolds when we visit the Colosseum in Rome.

[5] Riva, Waterworth, & Waterworth's work (2004) with the three layers of self is largely derivative of Damasio's work (1999) on the evolutionary origins of the consciousness.

> We receive sensory signals from our eyes, ears, nose, and sense of touch that are mapped by the proto self—the feeling of something happening. Some microseconds later, this leads to a perceptual activity which is monitored by the core self and becomes the content of core consciousness—the feeling that something is happening to me. A few microseconds more are required for the activation of extended consciousness—the knowledge of the feeling that something is happening to me. Some milliseconds later, it adds dispositional records of that place (or similar places), records which typically include stored sensory, motor response and emotional data…The result is a single conscious experience integrating perceptions, emotions, and feeling. One the event has ended, it is restored in dispositional space with new data about our most recent experience. (Riva, Waterworth, & Waterworth, 2004, p. 408).

The theoretical framework for presence adapts an evolutionary theory of presence as an effect of a psychological phenomenon predicated on phylogenetically distinct layers of self (Riva, Waterworth, & Waterworth, 2004). Their theory of presence explicates the evolutionary development of the self into three layers of presence. The evolutionary rise of the sense of presence, the authors argue, is a fundamental survival mechanism that helps the organism "differentiate between internal and external states" (Riva, Waterworth, & Waterworth, 2004, p. 409). To arrive at a better understanding of how the body enacts circumambient space and, as a result, the sensation of presence, and explanation of Riva, Waterworth, & Waterworth's three layers of presence (2004) is in order. (See Table 2.3. below).

2.5.1.2 Three Layers of Presence

Each of the three layers of self are aligned with a corresponding layer of presence. These demarcations evolved to address some aspect of distal attribution (i.e., the differentiation between internal and external events) and, therefore, can be characterized by particular qualities (Riva, Waterworth, & Waterworth, 2004).

Table 2.3. Riva, Waterworth, & Waterworth's three levels of presence (2004).

Three Layers of Presence	Properties	Exemplification
1st Layer: Proto Presence	• Self versus non-self • Proto self is concerned with non-conscious mapping of the organism's physiological condition • Proto self makes predictions about the eternal world as experienced through the sensory organs • Such predictions require movement, as only through motility can the sensorimotor systems engage stimulus • Proto presence is imbodied presence on the perception-action level	A zebrafish's movement through the external world generates its sensorimotor systems, which contain the sensory organs. Those organs send signals through the fish's central nervous system and brain. The central nervous system responds to the stimulus, such as moving the body of the fish closer to a light.
2nd Layer: Core Presence	• Self versus present external world • Core self is a transient, yet conscious entity recreated in unperceivable moments • Core self assimilates specific sensorial inputs into discrete percepts • Such assimilation demands access to knowledge from previous experiences • Core present occurs when the core self tracks changes in the core affect	A dog sees the face of a human. The dog's brain interprets the stimulus from its sensory organs that the face has an association with past events. The dog's behavior (e.g., wagging its tail) reflects its awareness of self and other entity occupying a shared space.
3rd Layer: Extended Presence	• Self relative to present external world • Extended self arranges hierarchical goals that shape an individual's behavior (i.e., their personality) • Extended self associated with the extended consciousness and the ability to imagine oneself in hypotheticals • The ability to identify and track internal goals is a hallmark of a movement to meaning-as-significance • Extended presence determines the significance of experienced events	When we plan a vacation to an unfamiliar city, we can imagine ourselves in a space that we have never been. The ability to differentiate place from space (Tuan, 2011) (i.e., imbuing some spaces with symbolic meaning) is a function of the extended presence.

Proto presence. The first layer of presence is the oldest and least complicated. Proto self's evolutionary goal is simply to respond to external stimulus experienced through the organism's sensory organs. Consequently, proto presence must be able to distinguish "sensory referred properties of the external world with a separate internal sensorimotor representation of those properties" and respond to this with precise and immediate responses (Riva, Waterworth, &

Waterworth, 2004, p. 409). The organism's experience of this distal attribution is accomplished through *adaptive movement*. In order for the organism to engage with external stimuli, the organism's sensorimotor systems require motility: the constraints of the organism's body help the proto self model the external world. What a zebrafish can perceive or not perceive defines its sense of proto presence; the fish's sensorimotor systems read the photons emitted from a lamp as a positive stimulus, which unconsciously drives the zebrafish to the light source since the proto self has determined that the constraints around this stimulus are distinct from the constraints posed on the organism's internal operations. In other words, the zebrafish can differentiate internal stimuli from external stimuli because of the constraints that the sensorimotor systems encounter in "moving" through space. Thus, movement becomes a prerequisite to experiencing presence: The proto self distinguishes sensorimotor referents regarding internal biological processes and those referents concerning the external world. The more an organism is capable of coordinating its movement with perception, the greater its chance to make predictions about the state of the external world that can aid in survival and reproduction (Riva, Waterworth, & Waterworth, 2004). The more accurate the perception-action coupling can differentiate the organism from the external environment, the greater the sense of proto presence.

Core presence. The second layer of presence, core presence, concerns the role of affect in the conscious perception of the external world. One of the evolutionary goals of the core self, according to Riva, Waterworth, and Waterworth (2004), is to assemble sensorial input into discrete percepts. Perception leans on a depository of knowledge and a repertoire of practiced behavior to construct a persistent model of the world beyond the borders of the sensory organs: For example, when a door is closed, a dog's model of the external world remains largely intact. Another evolutionary goal of the core self is to track changes to the core affect in real time. The *core affect* is an organism's conscious awareness of its internal states that are commonly refer to as moods, emotions, and feelings. If there is a significant change in the core affect, then the consciousness looks for a cause (Russell, 2003). Even intense dreams can stir dramatic changes in core affect, a point worth raising since it demonstrates that core affect can be triggered by both the real and imagined (Riva, Waterworth, & Waterworth, 2004). The ability for the core self to distinguish between changes in the core affect that stem from the real or the imagine is an essential survival skill and is theorized to consists of *cognitive binding* and *temporal coherence* (Llinás & Paré, 1991; Llinás, 2001).

> [C]ognitive binding is done by the core self through the temporal linking of the independently operating neural mechanism included in the proto self. By inducing temporal coherence to different neural structures, the core self can produce a shift in attentional focus. This shift is also able to differentiate between dreaming and waking: in dreaming the intrinsic activity of the proto self does not correlate sensory inputs with the ongoing thalamocortical activity…making them invisible to the core self. (Riva, Waterworth, & Waterworth, 2004, p. 411).

Core presence is this attentional focus on core affect. The more an organism can selectively differentiate its sensorial experience apart from the biological processes that produced those feelings, the more an organism can be aware of the present moment, which can be interpreted as the organism having a greater sense of core presence (Riva, Waterworth, & Waterworth, 2004).

*Extended presen*ce. Final layer of Riva, Waterworth, & Waterworth's model for a theory of presence is associated with the extended self and the extended consciousness. According to the goal hierarchy mode of personality and motivation (Cropanzano, James & Citera, 1993), personality can be explained as "an interrelated series of goals that direct and organize an individual's behavior…goals are arranged hierarchically from abstract orientations (analogous to traits) at the top, through values, self-identities, and ultimately down to concrete, behavioral goals" (Riva, Waterworth, & Waterworth, 2004, p. 411). As mentioned previously, this ability to plan for hypothetical events, and prioritize them according to short- and long-term goals, is the primary function of the extended consciousness. Meaning-as-significance helps the organism determine which events are worth the resources it takes to undertake them or make predictions about other people's behaviors in a given situation (Riva, Waterworth, & Waterworth, 2004). The greater the extended self can validate the implication of experienced events, the greater the sense of extended presence.

2.6 A Note on Metaphysical Presence

To conclusion to this review of the scholarship on presence, a distinction must be made regarding the theoretical understanding of presence as pertaining to immersive technology from perceptual phenomenal presence, which is more concerned with the broader, experiential aspect of consciousness independent of any technology (Dorsch & Macpherson, 2018). More concern is given to the former than the latter, although it is acknowledged that theories for the affective body and embodied perception do intersect debates on phenomenal presence, such as Gestalt psychology (O'Dea, 2018) and enactive approaches (Kind, 2018), and consequently these theories will inform the theoretical framework for presence proposed from this research. Metaphysically, *presence* refers to the experiencing of the present (i.e., the Now), which Heidegger summarized as "being in time" and maintains that since the time of Aristotle, the West has privileged the present over the absent (Heidegger & Stambaugh, 1996, p. 2-3, 11), a the central accusation found in deconstructivism (Spivak, 1997, p. xvii). For Derrida, presence is just as important as absence as a critical deconstruction of a given text—that which is not present before our sense is nonetheless leaves "traces" in a given text (Spivak, 1997, p. lvii), which Derrida argues as the invisible "structure of the psyche, the structure of the sign" that is revealed once the present is "erased" from the text (Spivak, 1997, p. lvii). For both Heidegger and Derrida, absence—what is not readily apparent to our bodily senses or conscious thought—is a worthy philosophical investigation that resists the privileging of the here and now in order to reach some truer reality (Blackburn, 2008, p. 90). For Merleau-Ponty, presence is characterized by an intentionality and assurance of one's own existence, which he names the "certitude of the present" and permits the consciousness to hold an "objective" frame of reference:

> [T]here is an intention that outruns the presentness of the present, which posits it in advance as an indubitable 'former present' in the series of recollections, and perception as knowledge of the present is the central phenomenon which makes possible the unity of the ego and with it the ideas of objectivity and truth. (Merleau-Ponty, 2008, p. 51)

Merleau-Ponty, Derrida, and Heidegger are concerned with a type of presence of the here and now, one deeply connected to the body experiencing time, but also seek that which, in Derrida's terms, has been erased from the text—or the sign, or the image, or anything meant to communicate or represent some idea—but nonetheless has had profound influence on its making. This notion will be further explicated in the following chapters, but it is important to note that the theoretical framework proposed here does not address this more metaphysical aspect to presence; rather, this research is focused on specifically on experiences of spatial presence in virtual environments, experiences that are not phenomenologically possible without the role of technology. The theoretical framework outlined in the next three chapters is concerned with presence as a *spatial* phenomenon between a user and immersive technology—a distinct conceptualization of presence that enacts distal attribution (e.g., the organism's ability to discern its own body from its environment), which is simply not technologically feasible for some media, such as books, despite their advocates using the term *presence* nearly synonymously with *spatial immersion* (Ryan, 2001). The next three chapters outline the theoretical framework for presence, beginning with a discussion on Hansen's affective body and embodied perception (Hansen, 2006b) followed by a redefinition of presence as a perceptual mediated event; a third chapter address the role of affective spatial schemas in the experiencing of space.

3. THE AFFECTIVE BODY AS A THEORETICAL FRAMEWORK FOR PRESENCE

This chapter outlines a new theoretical framework for presence that addresses many of the problems with the current scholarship by (1) identifying an operational mechanism that accounts for the experiences of presence varying in degrees (i.e., quantitatively) and dimensions (i.e., qualitatively) and (2) opening new avenues of investigation that may yield a more complete understanding of the underlying neural processes responsible for experiencing space in mediated environments. Unlike the other kinds of presence that characterize feelings toward a given medium (Bracken, 2005; Green, Brock, & Kaufman, 2004; Hartmann et al, 2016; Lee, 2004; Lombard & Ditton, 2006; Schubert & Crusius, 2002; Tamborini & Skalski, 2006), spatial presence is the only experience of presence that addresses the stimulation of distal attribution, which is the externalization or proximal simulation a body performs to perceive space and the objects within it (Hartcher-O'Brien & Auvray, 2014, p. 422). The phenomenon known as spatial presence—the feeling of "being there" in a virtual environment—is a self-awareness of experiencing one's own affective body enacting space catalyzed by the stimuli supplied from an immersive medium. The mechanisms that operate our perception of space IRL are the same mechanisms that operate our experiences of presence but with one significant distinction: The stimuli supplied by technology is mediated and therefore *simulates* many of the stimuli we experience IRL. Because the technology required to supply every single one of the trillion of neurons the body employs to make contact with external space does not yet exist, immersive technologies have become specialized in targeting qualitatively distinct experiences of presence as a means to create compelling experiences: Although the body experiences space through the traditional five senses (e.g., vision, auditory, tactility, gustatory, and olfactory), even the most sophisticated immersive technologies cannot address these five senses simultaneously or completely, and therefore strategies are developed to compensate for the gaps in sensory perception. Thus, unlike the every-day experience of space IRL, spatial presence is unique because it is catalyzed by stimuli designed to "misperceive" our sensorimotor system to enact circumambient space. Distal attribution is achieved through a selection of the right stimuli at the right time, and where there are sensory gaps, appeals are made to the affective body's appetite to experience presence. Sharon Kendrick's 3D audio version of her erotic romance, *A Royal Vow of Convenience* (Kendrick, 2016), is a compelling example of how presence can be achieved solely by appealing to the affective body's capacity for binaural hearing to achieve distal attribution. That miniscule gap between when a sound wave reaches one ear drum before the other helps the affective body perceive the distance and direction of sounds. This is replicated with binaural software, and when accompanied with foley effects and an omniscient narrator, the participant can hear the voice actors and their footsteps cross the room to whisper in the participant's ear, or the sounds of glasses shattering on the floor an arm's length away from the participant's 2:00 o'clock position. The participant may even close her eyes—actively deferring stimuli of one sensory system—to concentrate more on listening and therefore assigning primacy to a single sensory system in order for the body to sustain this experience of spatial presence.

The proposed theoretical framework for spatial presence is built on Henri Bergson's theories of embodied perception (1988) and Mark B. N. Hansen's theories of the affective body as the framing mechanism for embodied perception (Hansen, 2006b). Their theories offer sound explanations of the operational processes behind perception, but Hansen diverges from Bergson in regard to affect's role in shaping perception: Whereas Bergson believed affect was a kind of contaminant that obscured an otherwise unfiltered world (Bergson, 1988, p. 103), Hansen argues that affect itself is the framing mechanism of embodied perception (Hansen, 2006b, p. 7-8). This chapter aims to connect the phenomenon of spatial presence directly to Hansen's theories of the affective body as an operational mechanism that not only accounts for experiences of being inside virtual environments, but also challenges the current paradigms for presence (Bracken, 2005; Green, Brock, & Kaufman, 2004; Hartmann et al, 2016; International Society for Presence Research, 2000b; Lee, 2004; Lombard & Ditton, 2006; Schubert & Crusius, 2002; Tamborini & Skalski, 2006) by positioning the primacy of spatial presence in the scholarship. Rather than organizing dimensions of presence around the technological affordances for immersion, this new theoretical framework for presence places the affective body as the central organizing principle of the phenomenon, resulting in the subordination of all other dimensions of presence to spatial presence. For the affective body, spatial presence is the *only* kind of presence, as the other dimensions identified in the scholarship do not engage in the same neural processes responsible for perception and distal attribution—two indispensable components to the phenomenon of presence.

With affectivity as the operational mechanism for presence, this new theoretical framework connects Hansen's theories on affect and perception (Hansen, 2006b) to Riva, Waterworth, and Waterworth's three layers of presence model (Riva, Waterworth, and Waterworth, 2004). More importantly, this theoretical framework draws attention to a unique biological phenomenon that occurs only in human beings: the capacity to use spatial metaphors to communicate conscious experiences with dreams, hallucinations, altered states, and other aspects of the nonconscious (Lewis-Williams, 2004). It is precisely this capacity to linguistically and figuratively communicate symbolic space that opens new avenues of research for affect's intersection with presence by taking a proprioceptive-centric design for compelling experiences of presence. Tuan's theories on the transformation of space to place (Tuan, 2011) highlight biological and cultural practices humans use to imbue cultural value on a space, which *experientially* informs how we perceive a given space: a cave becomes a threshold to the spiritual world for our Paleolithic ancestors who had crawled through a long, lightless tunnel—perhaps after having been primed via storytelling, communal ritual, and/or psilocybin—to emerge into a lamp-lit chamber adorned with paleolithic images of bison that transmute the cave walls into a "membrane" of the spirit world (Lewis-Williams, 2004, p. 199, 271).

Many organisms territorialize space by creating nests or migratory patterns, but only humans territorialize space through symbolic behavior[6] (Lewis-Williams, 2004, p. 97), and due to our shared biologies, have adopted similar biological practices for communicating properties of space symbolically (Tuan, 2011). Many survivors of near-death experiences, for example, report that the experience of traveling down a tunnel toward a light, a phenomenon echoed in many world cosmologies, a hallucination in fact brought about from the body-brain experiencing an autistic mode of consciousness (Lewis-Williams, 2004). A theoretical framework for presence that accounts for affect's role in shaping perception, as well as the relationship between perception and presence, must also account for our affective body's capacity to experience mediated space. Designers and developers seeking compelling experiences of presence should consider tapping into our affective capacity to enact space via mediation and how certain bodily gestures, postures, and locomotions may help catalyze these experiences by triggering a kind of self-affectation (i.e., having the body feeding its own affective experience) (Hansen, 2006b). The next three chapters outlines a theoretical framework for presence that situates affectivity as the operational mechanism of presence beginning with a discussion of Hansen's affective body, followed by the role of mediation on the perception of space, and ending on the affective body's us of affective spatial schemas to frame experiences of space.

3.1 Sensation, Emotions, and Feelings

A few clarifying definitions are in order. S*ensation* in its simplest meaning refers to the conscious experiencing of stimuli firing sensory receptors (Seeley, VanPutte, Regan, & Russo, 2011, p. 472). As an evolutionary mechanism, the capacity to sense is to become aware of electrical or chemical changes in the body before they can be ascribed to an emotion or feeling (Damasio, 1999,

[6] Symbolic behavior here is defined according to Lewis-Williams: "the ability to represent objects, people, and abstract concepts with arbitrary symbols, vocal or visual, and to reify such symbols in cultural practice" (2004, p. 97).

p. 67). Certain stimuli (e.g., pressure, temperature, wavelength, etc.) can trigger muscles to contract, endocrine glands to release hormones, or sequential neurons to forward electrical impulses (Clayman, 1989, p. 723). Sensory receptors (i.e., cold thermoreceptors stimulated by temperature changes) are capable of detecting a range of stimuli, both by kind and levels of intensity (Iggo, 1982), and once triggered send afferent signals to the central nervous system and neocortex (Ghazanfar & Schroeder, 2006): specifically, the cerebral cortex where sensory information is indexed into images, sounds, touch, etc. in the cerebral cortex (Clayman, 1989, p. 250). If the stimulus merits a response from the organism, say as the result of placing one's hand absent-mindedly on a hot stove, thermoreceptors fire neurons coded in a way to warn the body of danger (Iggo, 1982, p. 403-406). Damasio posits that sensation is the body's way of seeing itself responding to the world and informing the conscious mind to take some kind of action—known as action potentials—in an effort to maintain homeostasis (Damasio, 1999, p. 138; Seeley, VanPutte, Regan, & Russo, 2011, p. 472). It is this potentiality of action that is of interest to Massumi (2002), for, strictly speaking, sensation is an indirect bodily response to stimuli: We are not feeling the hot stove, but rather a collective of biological responses that have been characterized as "pain." For Massumi, the significance of sensation is that it is self-referential, a type of "analog" with no counterpart: "Sensation, always on arrival a transformative feeling of the outside, a feeling of thought, is the being of an analog…the analog processing by body-matter of ongoing transformative forces…coming into being, registering as becoming" (Massumi, 2002, p. 135). This is to say that to sense something is to consciously detect the body's response to physical energy (i.e., photons, sound waves, vibrations) from physical objects (Wade & Tavris, 2014, p. 181). It is a recognition of the "outside coming in" (Massumi, 2002, p. 135), or in Hansen's words, an "interface with the concrete virtual domain" (Hansen, 2006a, p. 6). Sensation is in a constant state of always becoming, a referent to nothing but itself, "incapable directly referencing anything other than its own variations"

(Massumi, 2002, p. 135): to consciously experience the neural processes of the nonconscious[7] framing the self against the backdrop of the external world, a point that will be returned to later with respect to Hansen's notion of tactility.

In contrast, *emotions* are the names given to a range of physiological responses (i.e., changes in respiration, activation of sweat glands, release of dopamine, etc.) oriented toward functional behaviors that operate to benefit our species' survival (Bradley & Lang, 2000, p. 242), such as initiating a fight or flight response. If the body senses a threat, it may trigger an emotion to prompt the organism into action: The sensation of pain may lead to the emotion of fear, for example. Emotions are rooted in the limbic system, specifically the amygdala (Seeley, VanPutte, Regan, & Russo, 2011, p. 447), and essentially are biochemical responses to sensations, which have been subjectively identified as happiness, sadness, fear, anger, surprise, and disgust (Damasio, 1999, p. 50; Wetherell, 2012, p. 3). The limbic system governs the automatic nervous system responses to emotions, mood[8], memory, and smell (Seeley, VanPutte, Regan, & Russo, 2011, p. 440, 448-449) in order to perform the two most fundamental survival skills, reproduction and the procurement of food and water (Seeley, VanPutte, Regan, & Russo, 2011, p. 499-500). Because they function to instigate a bodily response to sensation, emotions can be induced nonconsciously and difficult to control: A genuine smile or laugh is hard to fake because these bodily responses involve involuntary muscles that the consciousness has no direct control (Damasio, 1999, p. 48-49)[9]. Damage to the

---

[7] For this dissertation, Massumi's *nonconscious* refers to neural operations that are normally imperceptible to the waking mind, "bodily reactions occurring in the brain but outside consciousness," and distinct from the Freudian notion of *unconscious* and *preconscious* as "nonconscious perception" is unaffected by repression of emotions or memories (Massumi, 2002, p. 29); most of the sensations that the body encounters never leave the nonconscious, and Massumi applies nonconscious perception as the triggering of affective registers for perception that are *infraempirical* (i.e., too "small" or "insignificant" for conscious perception) and *superempirical* (i.e., too "large" or "complicated" to be expressed in perceptual form) (Massumi, 2002, p. 16).

[8] Emotions are distinct from *moods*, which are objectless (Blackburn, 2008, p. 113), and *drives*, which are motivations for an organism's survival (e.g., hunger, response to pain) and may trigger emotional states (Tranel, 2002, p. 218; Damasio, 1999, p. 286).

[9] Although, according do Damasio, we cannot prevent an emotion, we may learn to suppress one (p. 49); furthermore, some involuntary muscles can be directly controlled, such as the diaphragm, which may indirectly impact an emotion (Damasio, 1999, p. 49).

amygdala may result in pathological emotional problems, such as irrational fear, unprovoked anger, depression, and excessive crying (Clayman, 1989, p. 640-641)[10]. As emotions originate in the oldest parts of the brain and deeply connected to the most basic functions of life, they probably evolved prior to consciousness and typically manifest from the nonconsciousness (Damasio, 1999, p. 37) to initiate some bodily action in the name of homeostasis (Damasio, 1999, p. 39-40).

Similarly, *feelings* are concerned with the interpretation of body-state changes over time and rely on representation[11] to operate (Damasio, 1999, p. 283-284). Feelings are mental associations to sensory patterns that signal pain, pleasure, and emotions (Damasio, 1999, p. 55) and serve as a "regulatory mechanism" to "alert the organism to the problem that emotion has begun to solve…[giving] the organism *incentive* to heed the results of emoting" (Damasio, 1999, p. 284). Although Damasio further distinguishes "feelings" from "having feelings" (Damasio, 1999, p. 285), in this dissertation the term *feelings* references the cognitive awareness that something is happening to this body—Damasio's "the feeling that we know we have feelings" (Damasio, 1999, p. 285). Nociceptors trigger the sensation of pain, which in turn may instigate biological responses—such as accelerated heart rate and respiration, the release of adrenaline, and heighten awareness—that collective are interpreted as *fear* (or more accurately, fear of something). The consciousness may suddenly realize that they are experiencing fear: "I am experiencing fear, but I know that I am in know real danger." Whereas emotions are rooted in bodily responses that can be measured (e.g.,

[10] Damacio describes a patient who had suffered damage to his amygdalae and hippocampus (a brain structure associated with making of new memories) and was unable to learn new information. Consequently, the patient was unable to recognize any new face, voice, or name (Damasio, 1999, p. 43). The experiment revealed fascinating insight into the operational mechanisms of emotion. The patient had been exposed to three actors who had treated him warmly, indifferently, and brusquely, respectively, but had not been able to remember any of the actors. When showed photographs of the actors and asked to identify those with friendly faces and those with suspicious faces, David consistently chose those faces that had corresponded to his encounters with the actors (Damasio, 1999, p. 44-45). The experiment demonstrate that emotions can be induced nonconsciously, as the patient did not identify any of the faces he was shown but was still able to accurately guess who was the "bad cop" (Damasio, 1999, p. 47).
[11] Damasio's use of the word *representation* is synonymous with Hansen's term *image* (2006b), both of which refer to some recognizable perceptual form: an object, a face, a shape, a place., or just some indefinite thing in the most abstract sense.

pulse, heart and respiratory rates, dilatation of pupils, activation of brain waves, galvanic skin temperature, etc.), feelings are sensations and emotions indexed against memory, and therefore are more subjective and shaped by the life experiences of the individual and come to characterize the autobiographical self (Damasio, 1999, p. 222). More importantly, feelings operate mostly from the much younger part of the brain, the cerebrum (Damasio, 1999, p. 283), which is associated with consciousness and voluntary motor control (Clayman, 1989, p. 699). Although both emotions and feelings can arise in the nonconsciousness—we can suddenly become aware that we are sensing danger or experiencing fear, which implies that they were in effect prior to coming to our attention (Damasio, 1999, p. 36)—feelings are more deeply connected to the conscious experience: We can distinguish between *having* a sensation or emotion from *knowing* a sensation or emotion (Damasio, 1999, p. 284), an ability which Damasio theorizes may have been a prerequisite for consciousness itself, as organisms aware of their own emotions could incentivize adaptive responses (Damasio, 1999, p. 285).

In regard to the theoretical framework for presence being proposed here, sensation is concerned with the conscious experiencing of space and connected directly to the phenomenon of presence: Presence as the sensation of a mediated space pressing on the body, which can be qualified as emotions (e.g., fear due to a sense of vertigo while participating in one of Slater, Usoh, and Steed's pit experiments, 1995), or feelings (e.g., *I am experiencing acrophobia*). In the exploration of presence, the sociological distinctions between feeling and emotion are less of a concern, and more interest is given to how sensations trigger feelings and emotions to created more compelling experiences of presence. To achieve this, the discussion must turn to affect.

Affect, in Massumi's terms, is the unqualified "intensity" the body experiences in the nonconscious before it is qualified with sociolinguistic understandings that we call emotions (Massumi, 2002, p. 27). Affect always precedes consciousness and is the mode by which the body readies itself to perform some action: According to Massumi, "a prepersonal intensity corresponding to the passage from one experiential state of the body to another and implying an augmentation or diminution in that body's capacity to act" (Deleuze & Guattari, 1987, Notes on the Translation and Acknowledgements, p. xvi). Regarding perception, affect is the subtractive process of moving from the virtual (i.e., potential) to the actual via selection to produce perceptual forms (Massumi, 2002, p. 30). Affect is bias; it favors completeness. As the body is attuned to detect changes in these intensities, we can see that affect also possesses a temporal dimension of memory and duration (Hansen, 2006b, p. 258-9). To complete the proposed theoretical framework on presence, Hansen and Massumi's notion of affection (Hansen, 2006b; Massumi, 2002) as an autopoietic and autonomous function of the affective body are adopted. More specifically, Hansen's theories on affectivity—the body's capacity to experience its own affect (Hansen, 2006b, p. 7)—are examined and a theoretical framework that situates affectivity as the operational mechanism for presence is outlined. These implications will be examined in further detail.

3.2 The Affective Body as the Framing Mechanism for Perceiving Space

The theoretical framework for presence proposed in this chapter has been adapted from Mark B. N. Hansen's work in *New Philosophy for New Media* (2006b) in which he theorizes that perception is the product of our affective bodies selectively filtering information from the external world in order to create recognizable forms. The affective body that Hansen proposes is an active framing mechanism catalyzed by stimuli. Hansen refers to the body's encounter with "information" as the "digital image," a term which identifies the very process of how the affective body comes to perceive the world beyond the borders of the sensorimotor system. Like Bergson (1988), Hansen offers that the act of perceiving the objects and the world they occupy is a bodily activity: We do not simply perceive the world with any singular organ or system; we perceive the world with the entire Bergsonian "body-brain achievement" (Hansen, 2006b, p. 15) governed by processes in the nonconscious that are activated via bodily modalities. "[H]uman perception," Hansen states, "takes place in a rich and evolving field to which bodily modalities of tactility, proprioception, memory, and duration—what I am calling affectivity—make an irreducible and constitutive contribution" (Hansen, 2006b, p. 101). It is through our bodily modalities, according to Hansen, by which we perceive the external world, forming the basis of our bodily vision. For Hansen, the digital information supplied by new media draws attention to these processes:

> No matter how "black-boxed" an image technology (or technical frame) by seem, there will always have been embodied perception at/as its origin…the body now operates by filtering [digital] *information* directly and, through this process, *creating* images. Correlated with the advent of digitalization, then, the body undergoes a certain empowerment, since it deploys its own constitutive singularity (affection and memory) …to actually *enframe* something (digital information) that is originally formless. (Hansen, 2006b, p. 10-11)

Digital information affords the affective body the opportunity to experience its own capacity for affect. The digital information of "today's electronic technosphere," according to Hansen (2006b, p. 10), demands a return to a more embodied approach to interacting with new media; he cites several new media artists whose aesthetics provide models for how the affective body should encounter digital information:

> [B]y placing the embodied viewer-participant into a circuit with information, the installations and environments they created function as laboratories for the conversion of information into corporeally apprehensible images…As the process yields the image—that transforms formless information into an apprehensible form—framing is crucial to all contemporary new media art practices. (Hansen, 2006b, p. 11)

It is the incorporeality of digital information being enframed via embodied perception, Hansen argues, that triggers our affective registers, our affective body's attempt to give form to something innately incorporeal. New media, Hansen argues, has the potential to target those specific neural processes of the nonconscious to catalyze affective responses: Experiencing Robert Lazzarini's *Skulls* (2000)—a sculptural installation comprised of four skulls that have been dramatically distorted, reminiscent of the anamorphosis in Holbein's *The Ambassadors* (1533)—provokes an intense affective response in a viewer as the nonconscious struggles to build a perceptual model of a material object designed to resist those very neural processes:

> [B]ut the skulls themselves seem warped in a way that doesn't quite feel right, that just doesn't mesh with your ingrained perspectival sense…As you continue to explore them, you find yourself bending your head and contorting your body, in an attempt to see the skulls "head on." At each effort to align your point of view with the perspective of one of these weird sculptural objects, you experience a gradually mounting feeling of incredible strangeness. It is as though these skulls refused to return your gaze…as though they existed in a space without any connection to the space you are inhabiting. (Hansen, 2006b, p.198)

To experience the perspectival disruption encountered in Lazzarini's *Skulls* (2000) demonstrates new media's potential to expose some of the innerworkings of the preconscious responsible for perception. This "weird sensation" (Hansen, 2006b, p. 199) is the body consciously experiencing its own capacity to experience affect. In the case of virtual reality technologies, Hansen elevates the stakes by proposing that "what happens in the experience of these artistic VR environments can no longer be called perception: instead, it is the result of a 'body-brain achievement' that creates an internal, bodily space for sensation" (Hansen, 2006b, p. 15). Virtual reality technologies highlight the bodily basis of perception.

An ontological realignment of Hansen's new media philosophy from "image" to "space" is realigned: Whereas Bergson (1988) and Hansen (2006b) discussion perception as object-focus and so have applied terms related to imagery form, this research shifts the emphasis to space itself as the perceptual construction in which the body experiences the external world. Objects are not perceived divorced from space, no matter how abstractly a form may appear[12]. Even in a sensory deprivation chamber, bodies still know they occupy space through their bodily modalities of proprioception, tactility, and temporality (Heron, 1957). Whether object or space, the framing mechanism for both is the affective body actively selecting stimulus via its bodily modalities in order to produce a perceptual model of the environment and all things in it. The following sections outlines Hansen's notion of the affective body as the framing mechanism of experiencing space in order to connect affectivity to the phenomenon of presence. The discussion begins with Hansen's investigation of Bergson's notion of embodied perception (1988) followed by a deeper analysis of affectivity's role in framing our spatial sensibility in order to situate the phenomenon of presence within a larger theoretical framework for affect and perception.

3.2.1 Embodied Perception as Active Process

A philosophical discussion on presence begins with theories proposing that perception is a product of bodily activity. Hansen (2006b) traces his theories of the affective body to Bergson's theories on perception (1988), which underscore the role of the body in "filtering" stimuli so that it "selects, from among the universe of images circulating around it and according to its own embodied capacities, precisely those that are relevant to it" (Hansen, 2006b, p. 3). Bergson (1988) understands the body as a screen or net that catches relevant "images" among all the universe of aggregate "images" through a process of subtraction: The body distinguishes the perception of a material object from the material object itself *not* by aggregating a series of relevant components or parts but rather by *subtracting* aspects to form the percept, letting irrelevant stimulus pass without bodily response (Bergson, 1988; Hansen, 2006b, p. 4-5). In *Matter and Memory*, originally published in 1896, Bergson outlines how the body actively perceives the world by "discarding" the multitude

[12] Philosophical arguments regarding the virtual self as an object will be addressed later in this chapter.

of stimuli that comes into contact with the sensorimotor system, placing emphasis on the fact that perception is a process:

> This is as much as to say that there is for images merely a difference of degree, and not of kind, between *being* and *being consciously perceived*…Our representation of matter is the measure of our possible action upon bodies: it results from the discarding of what has no interest for our needs, or more generally, for our functions…Consciousness—in regard to external perception—lies in just this choice. (Bergson, 1988, p. 5-6)

Bergson's emphasizes the active role of the body in perception—a push back to contemporary theories that metaphorized the human body as a blank canvas on which pre-formed images autonomously impose themselves—and positions the body as a "center of indetermination" (Bergson, 1988, p. 36; Hansen, 2006b, p. 5), ground zero of human experience and point of reference to reality. Action, Bergson claims, is "a faculty attested to by consciousness and toward which all the powers of the organized body are seen to converge" (Bergson, 1988, p. 63). Perception, therefore, is a bodily exercise in which the nonconscious actively isolates relevant aspects of a desired "image" from the "midst of extended images" **(**Bergson, 1988, p. 63-4). The body frames the percept from the flux of stimuli supplied by the external world, an act achieved via the movement of the sensorimotor system.

As a biological construct, the *sensorimotor system* has come to define the complex interaction among the body's central nervous system, sensory system, and motor system (Riemann & Lephart, 2002) that evolved to help the organism make useful predictions about its environment. Operationally, the sensory system encounters external and internal stimuli that prompts some response—consciously and/or unconsciously—from the motor system, such as catching a ball, pulling one's hand away from a hot stove, or circulating blood through the body; evolutionarily, the sensorimotor system aids the organism in achieving homeostasis from the cellular level to the entire body (Riemann & Lephart, 2002). Homeostasis is the means by which the body maintains an internal equilibrium in a dynamic, external environment and "plays a vital role in the body because tissues and organs can function efficiently only within a narrow range of conditions, such as temperature and acidity" (Clayman, 1989, p. 544). To achieve this basic biological function, the organism must not only govern internal conditions, such as instructing the sweat glands to perspire to cool an overheating body, but also navigate its environment to find food or evade predators. Thus, the sensorimotor system is crucial in creating a reliable perceptual model on which an organism invests its most fundamental interactions with the external environment (Riemann & Lephart, 2002, p. 71). However, there are times when waiting for input from the sensory system may take too long, and the body must act nonconsciously or reflexively to a situation. The sensorimotor system achieves this "internal monitoring" via an "efference copy," which is an internalized model and reference point for the body's status (Flanders, 2011, p. 2), a theoretical model first proposed by von Holst and Mittelstaedt (1971). These anticipatory actions are heavily influenced by the organism's previous interactions with the stimulus (Riemann & Lephart, 2002), underscoring the role of memory in governing the sensorimotor's response to external stimuli.

Embodied perception, therefore, is a process by which the body actively frames relevant stimuli that meets the sensorimotor system while ignoring the rest of the nonrelevant stimuli. The body isolates, through bodily action, the forms it deems necessary for its need: Metaphorically, the sculptor searches for the shape of David inside the marble by taking away all the stone that is non-David. This chipping away necessitates movement. The sensorimotor system operates on the body "moving" through the flux of stimuli that is the external world: Afferent signals are ceaselessly passed from the sensory organs to the spinal cord and brain, while efferent signals are return to the motor system in an indivisible process (Riemann & Lephart, 2002, p. 72). According to Bergson, movement—the act of biological processes interacting indeterminately to sustain this thing called life—is a prerequisite to life and experiencing the world around us:

> I know that external objects make in the afferent nerves a disturbance which passes onward to the centers, that the centers are the theater of very varied molecular movements, and that these movements depend on the nature and position of the objects. Change the objects, or modify their relation to my body, and everything is changed in the interior movements of my perceptive centers. But everything is also changed in "my perception." My perception is, then, a function of these molecular movements; it depends upon them. But how does it depend upon them? It will perhaps be said that it translates them, and that, in the main, I represent to myself nothing but the molecular movements of cerebral substance. (Bergson, 1988, p. 22)

For Bergson, it is *bodily movement*—the sensorimotor system continually acting and reacting to these "disturbances" via "molecular movements"—that fuels the biological processes of perception; for Hansen, this bodily movement is the "*the framing function* of the human body *qua* center of indetermination" (Hansen, 2006b, p. 8). The human body, not the technical image Hansen argues, is that which gives form to the formless via a continuous act of isolating the relevant stimuli from a field of images according to whatever is susceptible to the body's desires, needs, and emotions.

3.2.2 Affectivity's Role in Embodied Perception

As the affective body contorts and travels through the "information flux" (Hansen, 2006b, p. xx) of the external world, the somatosensory system comes into contact with stimuli, which in turn prompts afferent responses to the brain and central nervous system (Flanders, 2011) to help construct a perceptual model of circumambient space. Perceptual models take shape through a subtractive process: Aspects irrelevant to a perceptual form are discarded, passing through the body and short-term memory in only a few milliseconds (Massumi, 2002, p. 196-197). Perception is a product of inference: We do not perceive the world as it is, but rather how it ought to be based on our memory of previous experiences (Bruner, 1973). The biological underpinning of perception surfaces when we encounter an impossible object, such as the devil's tuning fork (see Figure 3.1. below) (Masterton & Kennedy, 1975).

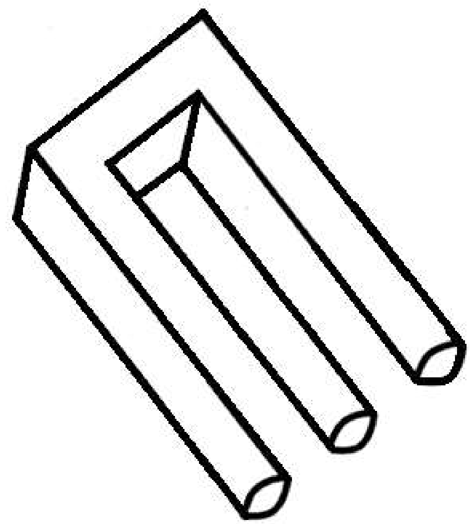


Fig. 3.1. The devil's tuning fork.

The devil's tuning fork aptly demonstrates the processes of embodied perception. This optical illusion disrupts our normally nonconscious neural processes by triggering conflicting affective registers. The ligaments connected to the lens and the orbital muscles of the eyes responsible for saccadic movements flex, effectively discarding any stimulus (i.e., that which is not in our perceptive field of focus) and brings attention to stimulus that adheres to recognizable forms based on memories of previous experiences of perceiving these shapes (i.e., the Gestalt principles, as in Wade & Tavris, 2014, p. 193-195): the elliptical shapes at the end of the parallel lines suggest that the object is cylindrical, but as the eyes follow the middle "rod," what had been perceived as a solid object transforms into the empty space between the prongs of a tuning fork. The eyes travel back and forth on the center axis of the impossible object (i.e., perceiving via proprioception), straining muscles and possibly inducing asthenopia or even nausea as muscles fatigue (Kooi & Toet, 2004).

The affective body *insists* on reconciling these two conflicting forms. Despite the number of micromovements made by our eyes and head, both forms cannot be perceived simultaneously. So powerful are the form-giving mechanisms of the human mind that we cannot see it for what the devil's tuning for what it really is: a two-dimensional drawing. Affectivity has an unquenchable desire for form that defines the affective body; affectivity is the body's capacity to affect and be affected upon. The affective body craves stimuli that can satiate its perceptual appetites, so it isolates the relevant aspects of a *desired* form from the information flux.

Thus, the capacity to insert "specific constraints on what can constitute relevant aspects of an image," thus conditioning its own process of filtering stimuli from the external world, acts as the framing mechanism of perception in the affective body (Hansen, 2006b, p. 5), thus subordinating perception and elevating affect to mode par excellence for engaging the digital (Hansen, 2006b, p. 66). The affective body is referred to as *affective* because it is *affect* that has the more significant interaction with digital information. New media art has the potential to "catalyze" an "affective process of embodied form-giving" (Hansen, 2006b, p. 203) within the body, exposing the normally nonconscious operations driving perception. To build this theoretical model, Hansen updates Bergson's theories of embodiment with neuroscience and puts forth his argument that the affective body is the framing mechanism of not just perception, but lived experience (Hansen, 2006b, p. 245). The entire impetus of Hansen's thesis is to advocate for a new aesthetic experience by turning away from "a model dominated by the perception of a self-sufficient object to one focused on the intensities of embodied affectivity" (Hansen, 2006b, p. 12-13). For Hansen, the affective body is the ideal framing mechanism to engage the inhuman information in a culture caught in the "process of digitalization":

> [F]or if the digital image foregrounds the processural framing of data by the body, what it ultimately yields is less a framed object than an embodied, subjective experience that can

> only be felt. When the body acts to enframe digital information…what it frames is in effect itself: its own affectively experienced sensation of coming into contact with the digital. In this way, the act of enframing information can be said to "give body" to digital data—to transform something that is unframed, disembodied, and formless into concrete embodied information intrinsically imbued with (human) meaning. (Hansen, 2006b, p. 13)

As virtual reality technologies, such as head-mounted displays and motion tracking systems, are firmly planted in the realm of new media, their potential to catalyze targeted affective registers opens new avenues of scholarly investigation. Head-mounted displays, for example, not only supply the eyes with mediated stimuli, but also excludes any other light from penetrating the user's eyes. Stimuli, therefore, "bottlenecks" into the user's retinas, and is the *only* available stimuli for the user's visual affective appetites. The research explores the potential for designing virtual reality experiences that capitalize on our capacity to feel our own affective registers as a means to creating powerful experiences of presence. The next section investigates the primary modalities of the affective body and how operate in concert to create our perception of space.

3.3 The Three Modalities of the Affective Body in the Perception of Space

When the spindles located in muscles, tendons, ligaments, and capsules are stretched, these mechanoreceptors register muscle length and the rate of change and pass this neural information along afferent nerve endings to the spinal cord (Riemann & Lephart, 2002, p. 73-4). This input is then interpreted proprioceptively as lifting one's foot to take a step or reaching out for a glass. The sensorimotor system has evolved specialized sensory receptors to detect a range of "information" about the external world that is then interpreted through three distinct yet deeply intertwined modalities: proprioception, tactility, and temporality. As the framing mechanism of perception, the affective body operates through these bodily modalities to give meaning to stimuli in order to form the perceptual field (Hansen, 2006b, p. 105). Adapted from the work of French media critic Paul

Virilio (1994), Hansen's theory on the affective body positions proprioception, tactility, and temporality as the primary determiners of perception, the means by which the sensorimotor system interprets the stimuli it detects via a multitude of specialized sensors necessary to create a perceptual model of the external world and the organism's place within that model. The proposed theoretical framework for presence extrapolates upon Hansen's notion of bodily modalities to construct a fuller paradigm that conceptualize the interplay among these modes of perception and their role in shaping the experience of presence (see Figure 3.2. below). As a site of indetermination (Bergson, 1988; Hansen, 2006b), the affective body interprets stimuli according to these bodily modalities: Proprioception (i.e., our sense of balance and bodily positioning), for example, is a dominant perceptual modality of which vision is subordinated (i.e., sight situated in the somatosensory system). Proprioception, tactility, and temporality are the means with which our affective bodies "see" space.

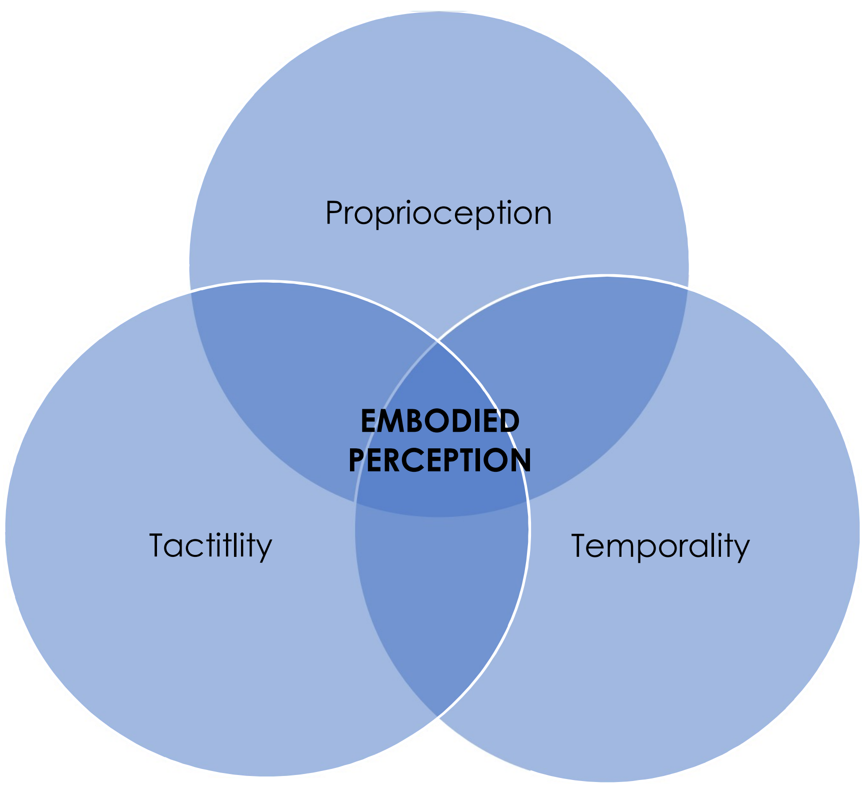


Fig. 3.2. The affective body's three modalities for embodied perception.

3.3.1 Proprioception's Role in the Perception of Space

Proprioception denotes the multitude of neural processes responsible for collecting and interpreting information about the body's position relative to the external world (Clayman, 1989, p. 824). Proprioceptors are sensory receptors, such as the muscle spindles in ligaments and cilia in the inner ear, responsible for detecting a range of stimuli required to maintain a sense of joint position and posture, respectively (Clayman, 1989, p. 156), which constitute a "proprioceptive field" around the body (Sherrington, 1906, p. 114). Even in a dark quiet room, most people are able to touch their noses with their fingertips, evidence to proprioception's hierarchal role in perception over the somatosensory system (e.g., vision, audition, olfaction, and gustation). Massumi (2002) argues for the primacy of proprioception over our other bodily modalities because it utilizes all of them, whether we perceive it or not, and in the process, gives itself a sense of embodiment.

> [Proprioception] draws out the subject's reactions to the qualities of the objects it perceives through all five senses, bringing them into the motor realm of externalizable response…[proprioception] can be said to be the mode of perception proper to the spatiality of the body without an image because it opens exclusively onto that space and registers qualities directly and continuously as movement. (Massumi, 2002, p. 59)

Massumi's conceptual model for perception is a three-strata paradigm that sandwiches proprioception between the "epidermis" (i.e., tactility) and "viscera" (i.e., visceroception) (Massumi, 2002, p. 58). Proprioception is a "dimension of the flesh," where "the body is only body, having nothing of the putative profundity of the self nor of the superficiality of external encounter" (Massumi, 2002, p. 59). This primacy of proprioception is encapsulated in Massumi's notion of *movement-vision*, a concept that aims to underscore the role of change or transformation in perception, and the *body-without-an-image*, an "infra-empirical space" the body occupies as it passes from one "image" (i.e., perspective) to another (Massumi, 2002, p. 57). Massumi is concerned about change and temporality, and like Bergson (1988) and Deleuze (1987), positions bodily action as the framer of perception. Movement-vision—as opposed to *mirror-vision*, which is the ordinary "single axis of sight" we perceive as ourselves distinct and apart from the external world (Massumi, 2002, p. 48) — is our self-conscious experience of moving from one axis of sight to another: a fleeting "disjunction" between the "symmetry" of the subject-object of mirror-vision that we feel as our bodies affectively settle into a new subject (Massumi, 2002, p. 50)[13]. Movement-vision's "elementary unit is the singularity of a movement that includes perspective which occludes the actual functioning of both the subject and the object…a *multiply* partial other-perspective included in a fractured movement-in-itself: change…that which includes rupture but is nevertheless continuous" (Massumi, 2002, p. 50-51). It is *change*, Massumi postulates, that is fundamental to experiencing a type of "vision" that "passes into the body and through it to another space" (Massumi, 2002, p. 57). At that moment we become neither subject nor object, but a body-without-an-image:

> an accumulation of relative perspectives and the passage between them, an additive space of utter receptivity retaining and combining past movements, in intensity, extracted from their actual terms. It is less a space in the empirical sense than a gap in space that is also a suspension of the normal unfolding of time. (Massumi, 2002, p. 57).

What the body-without-an-image is experiencing is an interval between subject and object. It is a disjunction we experience only as movement, for it cannot be arrested. Movement, Massumi argues, that makes change possible, and it is change i*tself* that makes perception possible. For Hansen's new philosophy on new media, he connects Massumi's notion of change back to proprioception as the "underside" of "bodily vision" (Hansen, 2006b, p. 228).

---

[13] Massumi (2002, p. 46-57) points to Ronald Reagan's performance in *Kings Row* (1942) and autobiography, *Where Is the Rest of Me?* (Regan & Hubler, 1981, p. 78-79) to illustrate movement-vision. In the film, Reagan's character wakes after an accident to discover his legs had been amputated. "Where's the rest of me?!" the character screams upon seeing his changed body. It is at this moment, Massumi argues, the moment character wakes to discover himself as a new subject, that Massumi focuses on as movement-vision and the experiencing of the body-without-an-image.

As with the devil's tuning fork, movement-vision can be demonstrated with the Necker-cube phenomenon (Hansen, 2006b, p. 250). This optical illusion (see Figure 3.3. below) consists of a wire-frame cube that can be viewed from two irreconcilable perspectives: the two-dimensional drawing is perceived as a three-dimensional construct that can be "entered" from two incompatible directions. Because the mind can only occupy one of these perspectives at a time, one can consciously experience the saccadic eye movement disrupting the neural processes of perception as the cube becomes oriented along one axis and then another. The important observation here is that interval between the perspectival shifts. This anatomical phenomenon is exploited in Lazzarini's *Skulls* (2000) to elevate an *optical* illusion to a *spatial* illusion as affective bodies, no matter how much their owners move or contort, cannot reconcile the contrasting multiple perspectives (Hansen, 2006b, p. 228-229). Hansen argues that such phenomena bring attention to the distinction between Massumi's mirror-vision and proprioception:

> Here, the emphasis is less on the limitations of vision per se, than on the embeddedness of vision within proprioception…there is a specific attempt being made to short-circuit ordinary perception *by interrupting vision*…the experience of disorientation in [*S]kulls*…is not a local instance or perceptual disarray…but rather a protracted failure of our double-valanced orientational system. (Hansen, 2006b, p. 228-229)

Both the Necker cube and *Skulls* bring attention to role of proprioception in perceiving form. While our senses of vision, audition, olfaction, and gustation are housed in the sensorimotor system, it is proprioception that interprets afferent and efferent signals through the body to maintain homeostasis and at times responds to *anticipated* external phenomena before they are perceived: The impulsive ducking one's head from a flying object is an act of nonconscious proprioception, which can be employed for "reflexive, automatic, and voluntary activities" (Riemann & Lephart, 2002, p.

75)[14]. Proprioception defines our capacity to distinguish ourselves from the external world and governs the bodily movement that facilitates perception. Optical illusions may target vision, but they still necessitate bodily movement to operate; likewise, auditory illusions, such as the glissando illusion[15], also operate on the principle of a moving body with binaural hearing and slight movements of the head (Deutsch, Hamaoui, & Henthorn, 2007). These illusions operate on a principle of ambiguity that gives them their power (Kandel, 2012, p. 207). Our movements deliver conflicting or paradoxical information, and our nonconscious mechanisms work pragmatically to form a perceptual model. Thus, movement—a fundamental act for perception—finds meaning in our proprioception. Hansen argues that proprioception "allows us to orient ourselves in the absence of fixed points or external orienting schema" (Hansen, 2006b, p. 195). When ambiguity arises in our perceptual field, it is our proprioception that tries to explain them.

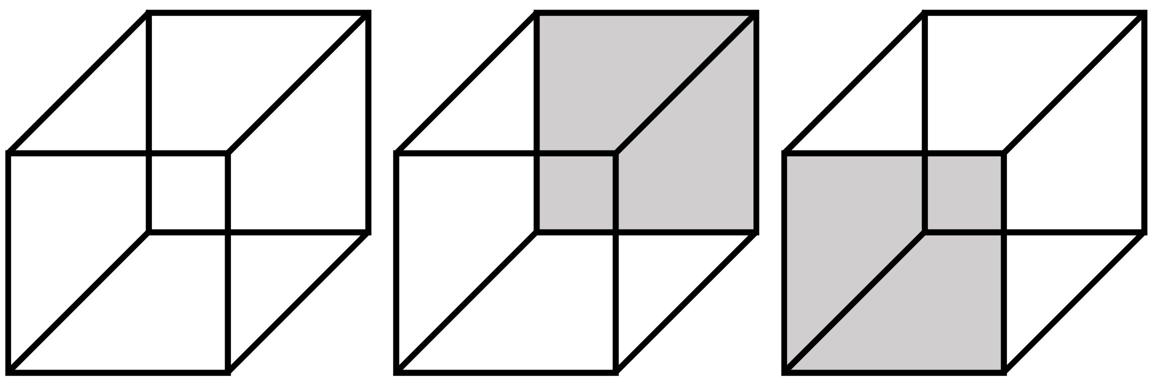


Fig. 3.3. Necker cube phenomenon. On the left, a wire-frame cube with no perspectival indicators; the cube in the middle can be entered via the gray hole from right to left; on the right, the gray opening signals a movement from left to right.

Proprioception serves as one of the three interdependent modalities employed by the affective body. Operation of afferent and efferent signals as well as the muscles needed to perform

[14] Because our sensorimotor system can be governed both consciously and nonconsciously, we can control our diaphragm to regulate breathing or hold or breath but also experience hyperventilation in which we are unable to regulate our own breathing, for example.

[15] The glissando illusion is a type of endless scale illusion, an auditory illusion in which a constant pitch or tone is misperceived as falling or rising (Vernooij, Orcalli, Fabbro, & Crescentini, 2016).

movement serve to help the affective body frame stimulus into meaningful forms, a subtractive process of discarding irrelevant aspects and reconciling ambiguity in order to create perceptual models. Thus, vision, audition, olfaction, and gustation are the result of our embodied capacity to perceive ourselves within the world. (Hansen, 2006b, p. 101). To complete this theoretical framework, however, proprioception must be situated within the other two embodied dimensions of perception: *tactility* and *temporality*.

3.3.2 Tactility's Role in the Perception of Space

Situated in Hansen's theoretical framework for the affective body, tactility complements proprioception by providing the affective body with an "internal perception" (Hansen, 2006b, p. 230), an awareness of touching and being touched from within. Hansen's notion of tactility is distinct from the somatosensory sense of touch, which is concerned with sensation and detecting changes in temperature, pressure, and friction. Tactility is the medium of empirical feelings and emotions: the triggering of affective registers (Hansen, 2006b, p. 230) that we experience corporeally. Massumi (2002) defines affect as an "intensity" that follows "different logics and pertain to different orders [than emotions]. An emotion is a subjective content, the sociolinguistic fixing of the quality of an experience which is from that point onward defined as personal. Emotion is qualified intensity…it is intensity owned and recognized" (Massumi, 2002, p. 25-26). One example that illustrates the affect-emotion dichotomy regards the experience of nociception, since one can experience pain (i.e., affect), yet through discipline one can learn to ignore it (i.e., emotion) (Buchanan, 2010, p. 5). *Tactility* is Hansen's term for *interoception*, which is "an umbrella term for the phenomenological experience of the body state, an experience which is ultimately a product of the central nervous system…regardless of what information the brain uses and does not use to construct this experience" (Ceunen, Vlaeyen, & Van Diest, 2016, p. 1). As a second dimension of the "flesh" (Massumi, 2002, p. 59), tactility is a medium for experiencing "physical disturbance and bodily activity," such as crying, laughing, arousal, snarling (Wetherell, 2012, p. 2) and is influenced by both internal *and* external stimuli: laughing, for example, may be triggered by an external stimulus. Tactility is the modality that allows us to experience—that is, perceive—the world both quantitatively (i.e., affect intensity) and qualitatively (i.e., kinds of emotions).

Hansen (2006b) is primarily concerned with new media's potential—especially virtual reality technologies—to instantiate a conscious awareness of experiencing the space *within* our bodies, to turn attention inward: "an intuition of the space of the body takes the place of the body itself" (p. 177). Lazzarini's *Skulls* (2000), Hansen (2006b) argues, catalyzes our affective registers by technically supplying an impossible image: Our affective bodies cannot reconcile the distorted skulls, resulting in a

> haptic mode of vision that cannot anchor itself in anything *pictorial* or *sculptural* and that consequently requires us to transform the haptic *from a modality of vision (perception) into an* [sic] *modality of bodily sense (affection)*. Rather than yielding in a mode of visuality consistent with sculptural form, the complex folds and hollows of these warped skulls generates a total short-circuiting of vision and a violent feeling of spatial construction that manifests, literally, as a haptic experience of the space of the body. (Hansen, 2006b, p. 229)

In short, new media art like *Skulls* allow the body to experience its own capacity for affectivity via tactility. According to Hansen, *Skulls* triggers an "affective place" inside our bodies that is "completely self-referential, self-generated, and 'tactile' in Deleuze's sense: purely intensive and without geometric coordinates" (Hansen, 2006b, p. 229). Spectators *feel* the paradoxical image rather than see it and become aware of an affective place within them "from which movement is radically excluded" (Hansen, 2006b, p. 229), a way of experiencing space readily distinct from proprioception. To experience new media art like *Skulls*, Hansen argues, is to become aware of the normally nonconscious processes of the internal spatialization of the body. *Skulls* is designed to be "seen" with bodies. Hansen details the disjunction between proprioception and tactility, resulting in feeling the space within our own affective bodies.

> First, what *Skulls* offers as a haptic mode of vision must be converted into tactility through response. Because actual bodily movement is foreclosed as a means of experiencing the work…tactility must be generated by the movement that takes place *within* the body (affectivity as action of the body on itself) as it responds to this impossible solicitation…it is precisely the suspension of movement-vision that triggers the ensuing, self-generated—we might say self-affecting—tactility. (Hansen, 2006b, p. 230)

This internal movement becomes "self-affecting" as perception is turned inward, and the body becomes aware of its own perceptual mechanisms at work. The result, Hansen argues, is an internal spatiality divorced from external spatiality.

> Second, what *Skulls* offers as tactility—an intense and internal experience of being touched (through, remarkably, in the absence of any *physical* contact)—must subsequently be folded into the body in a way that "registers" it…as [movement]…the in-folding of tactility by the body serves not to realign the forces that disturbed perception…but rather to create a bodily spatiality that is without correlation to an externally projected (and perceived) space. (Hansen, 2006b, p. 230)

Tactility and proprioception become discernable, yet simultaneously interdependent, from one another. These two modalities—or dimensions of the flesh (Massumi, 2002, p. 59)—provide a means to perceive external and internal space via proprioception and tactility, respectively, and in our everyday experience are not consciously distinct.

This capacity to experience the world through tactility allows for the creation of a perceptual model of the space inside our bodies. Tactility goes hand-in-hand with proprioception and helps give form to the virtualization of the body, a phenomenon that new media art can exploit digitally:

> In the process of catalyzing a shift from *perception* via concrete media interfaces to the *affectively tinged* exposure of their origin in the (human) framing function, these [new media art] reconfigure the virtual, transforming it from an abstract, disembodied dimension of any dynamic process into a creative dimension of human embodiment itself—an excess of the body over itself. (Hansen, 2006b, p. 90).

This virtualization, which is normally imperceptible, rises to the forefront of perception via the triggering of affective registers catalyzed by the artwork. It is precisely the capacity for new media art to wedge itself between these two bodily modalities of perception—proprioception and tactility—that compels Hansen to advocate for embodied perception as the sine qua non of digital media. Digital information, Hansen argues, is inherently formless and "nonhuman," and mew media artworks, such as *Skulls*, can provide a technical catalyst for the affective body to experience unprecedent spaces:

> [T]hus, in *Skulls*, what causes the installation space to become visually impenetrable is precisely the digital transformational process to which Lazzarini submits the original nondeformed skull. The projected installation space does not simply happen to be uninhabited at a certain moment; it is *uninhabitable in principle*. Moreover, affect cannot be extracted from this projected space for the precise reason that it was never there in the first place; this space is a radically nonhuman one, one without any analogical correlation to human movement and perception, and one into which affection can be introduced only from the outside, as a supplement that originates in the embodied response of the view spectator…what the digital modeling of space both introduces and solicits—as an activity necessary for its own constitution—is the virtuality of the body itself. (Hansen, 2006b, p. 215)

This is to say that the bodily modality of tactility—our capacity to perceive (i.e., interpret) the visceral sensations of the body—gives us the capacity to perceive the nonhuman nature of digital media and, consequently, can be leveraged to catalyze our affective triggers to enact new kinds of experiences. According to Hansen, virtual reality is new media par excellence for its capacity to "accord the body new functionalities—including the extension of [the body's] capacity for self-intuition of spacing—precisely by putting it into sensorimotor correlation with new environments…with unprecedented configurations of information" (Hansen, 2006b, p. 195). This, for Hansen, is the "Bergsonist vocation" (Hansen, 2006b, p. 11) to which new media artists must answer. Hansen's thesis advocates that new media artists should steer away from the ocularcentric Western tradition in art and toward an interface better suited for digital information: the human body.

To summarize, Hansen's affective body frames stimuli for our perceptual understanding. Proprioception and tactility give us the capacity to "see" space, both externally and internally: Through proprioception, we can construct perceptual models of the world beyond the borders of the skin; through tactility, we can perceive the internal space via our own affective registers at work. Yet this model of perception is incomplete, for we must still account for the role of memory and duration, the mechanism responsible for the sensation of change supplied by the sensorimotor system.

3.3.3 Temporality's Role in the Perception of Space

For affect to register fluctuations in intensity, the affective body must be able to retain forms and images of the immediate past long enough to detect these changes, thus affectivity also operates within a temporal dimension. The theoretical framework introduced here amends Hansen's theories of affective temporality (Hansen, 2006b, p. 235) and asserts temporality as the third major modality employed by the affective body to perceive space and a fundamental dimension in experiencing presence. Temporality, along with proprioception and tactility, serves the affective body to detect changes in its affective intensity and helps maintain the homeostasis of the sensorimotor system, allowing the body to prioritize actions and behaviors, such as those required in developmental learning (Varela, 1999, p. 272). To experience the world temporarily means more than remembering past events. Temporality is an experiencing of time, the body's awareness of the perceived now, a duration that lasts approximately 0.3 seconds (Massumi, 2002, p. 29). Building on Husserl's notion of time-consciousness (1991), Varela's theories in neurophenomenology (1999), and Hansen's work on the affective body (Hansen, 2006b), the design study investigates the mechanisms driving presence that operate below these 0.3 seconds—that is, the "temporal unit" of presence—and how the affective body perceives by sensing and interpreting these temporal changes, as well as the imperceptible intervals that separate one "now" from the next. Thus, a new theoretical framework for presence as a perceptual phenomenon that is intrinsically temporal in nature is proposed.

Husserl's three-part retentional structure of time-consciousness provides a theoretical framework for how the affective body perceives space temporally, and the forms that occupy it. Under this model, time is experienced in phases or episodes of consciousness in which some part of the immediate past is "retained" in the immediate present, thus enabling us to perceive change and succession: Using Husserl's classic example of listening to a melody, we do not perceive a series of disconnected sounds, but rather retain an awareness of the notes that immediately preceded them to constitute a temporal object. Figure 3.4. below metaphorically illustrates the standard retentional mode of time consciousness in which the horizontal x-axis represents the duration of time-consciousness and the vertical y-axis represents external stimuli's initial contact with the sensorimotor system. The dotted oblique lines represent relevant sensorium that have been retained in the time-consciousness to give the perception of duration (i.e., change and succession).

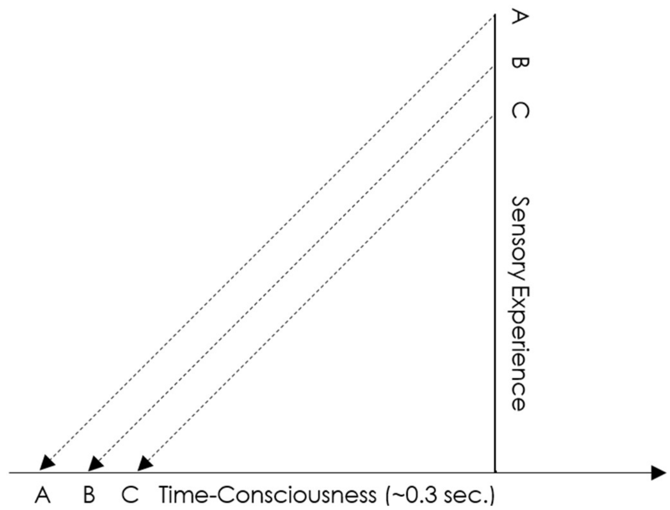


Fig. 3.4. Retentional model of time-consciousness (Dainton, 2017).

(In actuality, there would be a near infinite number of oblique lines need to properly represent the capturing of these earlier experiences.) It is important to state that these retentions are aspects of perception, not memory. Remembering a melody is not analogous to listening to a melody, for the former is a representation of past events evoked into the consciousness and operate under different neurological systems than those that govern the "presentation" (i.e., perception) of the immediate now: In fact, neurobiology indicates that measuring event-related potentials[16] reveals a 200-400 millisecond shift from perceiving something than cognitively recalling that thing (Wilding & Rugg, 1996, p. 892; Varela, 1999, p. 277). One of the key features of Husserl's retention is its ability to retain "phases of the same perceptual act in a way this is distinguishable from the experiences of the present…that show up temporally extended" (Varela, 1999, p. 278). This thickening of the present gives temporality its durational structure. In Williams' terms, the "specious present" is not a

> knife-edge, but a saddle-back, with a certain breadth of its own on which we sit perched…We do not first feel one end and then feel the other after it, and from the

[16] Event-related potentials are measurable changes in voltage during brain activity and are generated as sensory response to stimuli. They are comprised of neurological structures that are elicited by sensory, motor, or cognitive events (Sur & Sinha, 2009, p. 70).

perception of the succession infer an interval of time between, but we seem to feel the interval of time as a whole, with its two ends embedded in it. (James, 1890, p. 609-610)

In other words, the present is experienced as duration: the now—initial contact with sensory stimuli (Husserl, 1991, p. 337) and the retention of selected sensorium working together in a way to form the perception of change and succession (Varela, 1999, p. 278). Retention is not an after image or representation of anything; retention is a "kind of holding on to the now by its edge" where percepts, forms, objects, etc. drift from the metaphorical center to peripheral of time consciousness (Varela, 1999, p 279). Yet, retention and the now are just two aspects of Husserl's three-part structure for temporality. The affective body also has the capacity to anticipate temporal events before they happen. According to Brough, *protention* is Husserl's term for the affective body's "openness" to anticipating change and differs from the now and retention of temporality in that the object in focus (i.e., the future) has not yet encountered the sensorimotor system (Husserl, 1991, Translator's introduction, p. xl). Husserl argues that this intentionality toward "what is to come" (Husserl, 1991, p. 240) constitutes a "prefiguration" that *something* is about to happen (Varela, 1999, p. 89). Importantly, protention is not a symmetrical counterpart to retention: The retention phase "sets the stage" for the protention phase, but the protention phase cannot alter the "retentional threads" ex post facto (Varela, 1999, p. 290). Husserl's three-part structure of time consciousness aims to overcome a major philosophical paradox that faces retentional theory of temporality: Namely, how does the retentional phase of perception select which sensorium to sequence in order to perceive change, rather than overwhelming us with all the sensorium simultaneously[17] (Kelly, 2005, p. 210)?

[17] Kelly (2005) argues, in fact, that Husserl's retention theory names the phenomenon but come short in fully explaining the experience of time (p. 226).

Husserl's answer is that the protention phase extends the consciousness beyond the now in a way that circumnavigates this philosophical conundrum by allowing the consciousness to focus on the temporal phases of perception (Husserl, 1991, p. 169). This is made possible by the double-intentionality that Husserl ascribes to the living present: the affective body operates not only within an "object-intentionality" capacity (i.e., being conscious of object-events), but also through an intentionality of the flow itself (i.e., being conscious that we experience the world temporally) (Hansen, 2006b, p. 252). The retention phase intends to retain relevant aspects of the object, form, or image along with *the temporal phase itself* as it passes out of perception (Hansen, 2006b, p. 252). For Hansen, Husserl's double-intentionality is really the work of affectivity:

> Unlike retention, protention intend the new *prior to any impression or perceptual present*…This correlation with affect underscores the embodied dimensions of time-consciousness, since in order to intend the new prior to the constitution of an impression [i.e., contact with external stimuli], protentional consciousness must, as it were, draw on itself. Affect, accordingly, must lie at the very origin of time. (Hansen, 2006b, p. 252-3)

Thus, perception is subordinate to temporality, and temporality is subordinate to affectivity. Varela further grounds the role of affect in temporality via neurophenomenology and underscores the role of movement in perception as well:

> [T]he emergence of the living present is rooted in and arises from *a germ or source* of motion-disposition, a *primordial fluctuation*. That this has to do with a primordial fluctuation motivates our notion here that affect precedes temporality: affect implicates as its very nature the tendency, a 'pulsion' and a motion that, as such, can only deploy itself in time and thus as time. (Varela & Depraz, 2005 p. 69)

This can only be achieved, according to Varela, by multiple, yet distinct regions of the brain and the sensorimotor system functioning interdependently yet operating under a single frame of reference—

simultaneity—that corresponds to this temporal unit of the living present: A ceaseless stream of external stimuli captured by the sensorimotor system that feeds into the temporal dynamics theoretical framework (Varela, 1999, p. 272), selected and arranged by affectivity.

Varela further sutures temporality into neurobiology via his three-tiered theoretical framework for duration: (1) elementary durations that occur on the 1/10 scale; (2) the conscious duration of the now on the 1/1 scale; and (3) the "descriptive-narrative assessments" on the 10/1 scale (Varela, 1999, p. 272). The integration of the sensorimotor system occurs on the 1/10 scale, which in clock time is approximately 10-100 milliseconds, the "shortest" duration that two stimuli can be distinguished neurologically as nonsimultaneous (Varela, 1999, p. 272). These nonperceptible micro-registrations occur within these sensory thresholds and are "grounded in the intrinsic cellular rhythms of neural discharges and in the temporal summation capacities of synaptic interneurons" and manifest as "micro-cognitive phenomena," such as iconic memory and neural oscillations (Varela, 1999, p. 272). The aggregation of neuronal events that operate on the 1/10 duration scale comprise neuronal assemblies that demonstrate a strong interdependency and occur in large and distinct regions of the brain and sensorimotor system, which we experience as conscious, perceptual events of the 1/1 duration scale (Varela, 1999, p. 272-5). This 1/1 scale of duration is "the now," a duration of approximately 300 milliseconds (Hansen, 2006b, p. xxiv). These vast neuronal assemblies are able to commit to specific micro-cognitive phenomena via a "phase-lock" that synchronizes and unifies the cell assemblies and transmit information on the 10/1 duration scale (Varela, 1999, p. 272-5). Interestingly, the now of the living present may occur at approximately 0.3 seconds, but that duration (i.e., the holding together of a neuronal assemblage) can be extended to as long as 3 seconds in some subjects but usually is accompanied by brief, intention proprioceptive acts rooted within the 1/1 duration (Varela, 1999, p. 275). Together, the durations of the 10/1 and 1/1 scale constitute a "temporal horizon" in which neurobiological processes give rise to the experiencing of time independent of "an external or internally ticking clock" (Varela, 1999, p. 276-277). Yet, Varela argues, we also experience a third scale of duration on the 10/1 scale. These "endogenous, dynamic horizons" can be assembled into larger networks that expand the temporal horizon and intrinsically integrated into linguistic operations (Varela, 1999, p. 275). This temporality experienced on the 10/1 scale is more deeply connected to our sense of identity and can become disrupted, as in the case of intoxication or schizophrenia (Varela, 1999, p. 275). These descriptive-narrative assessments are integrated "moments of newness" that inform our imagination and recollection (Varela, 1999, p. 275) and are discussed more fully in the succeeding chapter regarding the implementation of this new theoretical framework for presence.

Varela's work on the immediate present as a space rather than a point (i.e., a horizon) frames temporal objects as in transit from the perceptual center to the perceptual periphery (Varela, 1999, p. 275-6). It is here that we reach the significance of Varela's hypotheses for a neurophenomenological basis for temporality: that the dynamic synchronization of a multitude of distinct yet mutual neuronal assemblies are intrinsically "*unstable*" and "constantly and successively give rise to new assemblies…each emergence bifurcates from the previous ones given its initial and boundary conditions…each emergence is still present in its successor" (Varela, 1999, p. 280). The affective body is able to experience change precisely because perception has a temporal dimension that is incessantly continuing itself, self-organizing with an emphasis on *phases* rather than networks. The affective body's capacity to lengthen these phases is demonstrated aptly in Varela's analysis of Fisher's series of ambiguous images. The series of images allow for two interpretations depending on whether the viewer begins with the first panel (i.e., Panel 1, an image of the man's face), or if the viewer starts at the final panel (i.e., Panel 2, an image of the woman holding the mirror) and reverses the sequence. Whereas the first and final panels are unambiguous, the panels in the middle (i.e., Panels 7, 8, and 9) are ambiguous enough that interpretations can be intentionally switched between the two competing images (O'Dea, 2018, p. 67). More interestingly are the fifth and eleventh panels, which exercise *unsymmetrical* ambiguity: Although one can see the image of a man's face in Panel 5, she can with some effort perceive the woman holding the mirror (and vice versa for Panel 11); however, this maneuver is only temporary and takes more effort to sustain as Gestalt principles draw perception to the more stable form (O'Dea, 2018, p. 66). When an observer begins the series with the first panel, her eyes follow the sequential panels as the image of the man's face until it collapses into the image of the woman holding the mirror in the tenth panel. Yet, when the sequence is reversed, the observer may not perceive the man's face until the sixth panel, rather than the ninth panel. Her eyes pass over the seventh, eight, and ninth panels retaining the initial interpretation, demonstrating the intentionality of affectivity: As the sensorimotor system encounters stimuli (e.g., the black lines on the white background) in the now, a combination of Gestalt principles (e.g., the laws of closure, similarity, proximity, symmetry, and continuity) infers relationships among these stimuli; in doing so, some percepts, such as the shape of a nose, the outline of an ear, are retained within the temporal unit *while simultaneously* the consciousness anticipates stimuli that feed these retained percepts in order to constitute some image (e.g., the face of a man). As in both the devil's tuning fork and the Necker cube, affectivity's appetite for form precedes the act of perception, and the observer's eyes "retain" whichever interpretation she began with as the cross the ambiguous overlap in the seventh, eighth, and ninth panels.

3.4 The Sensorimotor Interval of the Affective Body

Regarding perception, if proprioception is the method, if tactility is the medium, if temporality is the measure, then affectivity is the motive that drives the organism toward maintaining the most accurate, up-to-date, and cohesive perceptual model of space in order to meet the organism's most basic survival needs, such as finding food and procreating. As the affective body moves through the information flux of the external world (i.e., the stimuli supplied by the environment), most of the sensory stimuli that can be captured within the human sensorimotor system's narrow threshold is never actualized into conscious perception and retained only for a few moments before falling into oblivion (Massumi, 2002, p. 16). As discussed previously, the duration of the lived presence is approximately 0.3 seconds: experiments in neuroscience reveal that significant brain activity occurs 300 milliseconds *prior* to conscious awareness (e.g. the subject deciding to flex their finger) and an additional 200 milliseconds to execute a given motor function (e.g., the flexing of the flexor digitorum superficialis and the flexor digitorum profundus muscles of the finger) (Massumi, 2002, p. 29; Seeley, VanPutte, Regan, & Russo, 2011, p. 348-349). Thus, from sensory receptors' first contact with stimuli to the moment an awareness arises in the conscious mind comprises a 0.3 second nonconscious duration in which the affective body subtracts from a multifarious plethora of sensory stimuli that which is readily reducible to an expressible percept. This *sensorimotor interval* (Hansen, 2006b, p. 121) is a duration of selection, anticipation, and tendency toward form, which also infers a kind of asymmetrical, nonconscious perception of space subjected to recursive contextualization by the form-giving properties of the affective body (Massumi, 2002, p. 31). Affectivity serves to bridge this nonconscious perception to conscious perception (Massumi, 2002, p. 29), selecting the order of presentation to the time-consciousness through a recursive process prior to its actualization into conscious perception. To understand the operational mechanisms of presence, the research explores this 0.3 second, nonconscious duration in which nonconscious perception of space is manifested into conscious perception of space by the innate from-giving properties of the affective body. As we see in Hansen (2006b), the affective body is not only the instrument of perception but also the ought-deserved subject of new media art as it is more properly equipped to encounter and respond to the inhuman information of the digital. The next chapter turns to situating the phenomenon of presence into Hansen's theoretical framework for the affective body and posits that affectivity—our capacity to affect and be affected upon—is the principle operating mechanism of presence.

4. PRESENCE AS A MEDIATED PERCEPTUAL EVENT

Adapting Hansen's work on the affective body (Hansen, 2006b), we now have a theoretical framework that not only offers affectivity as the operational mechanism for presence, but also recasts the phenomenon as a *mediated perceptual event*: Presence is the experiencing of one's own normally imperceptible neurological processes that govern the perception of circumambient space at work. Presence is not a perceptual illusion; there is little perceptual reckoning of the self "being there" when one perceives the devil's tuning fork, the Necker cube, or Fisher's series of ambiguous images. Rather, presence is the outcome of the catalyzing of specific neurological processes responsible for the creation of distal attribution, the externalization of the world beyond the borders of the organism's body (Hartcher-O'Brien & Auvray, 2014, p. 422). The inability of an organism to distinguish itself apart from its environment would certainly mean doom, as it would not be able to properly respond to external (or internal) stimuli, having no mechanisms for addressing homeostasis; thus, distal attribution is even a higher-order function than perception itself. Presence is the outcome of these convoluted neural processes responsible for distal attribution being catalyzed by stimuli that has been technologically designed to be more desirable, more appealing, either through novelty or the exclusion of other, more naturally occurring stimuli, to feed the affective body's appetite for the enaction of circumambient space. Operationally, presence is better understood as a mediated, perceptual event:

- Presence is mediated because it is predicated on stimulating the sensorimotor system via the technical subordination or exclusion of natural stimuli.
- Presence is perceptual because it is predicated on evoking distal attribution.
- Presence is best characterized as an event because it temporally dispositioned to be sensitive to change.

This theoretical framework argues that presence is not simply the substitution of a mediated space over the physical space occupied by the flesh and blood body, but the experiencing of one's own affective body enacting circumambient space despite the gaps and intervals the sensorimotor system is confronted with in its encounter with the technological apparatus.

4.1 Affectivity as the Operational Mechanism for Presence

But *how* exactly does affectivity select which stimuli will take form in perceptual space in a way that shapes the intensity and kind of presence experienced? As discussed, Hansen's theories on the affective body as the framing mechanism for embodied perception supply the groundwork for theorizing how both external space (i.e., distal attribution) and internal space (i.e., interoception) are perceived, or more accurately, *enacted* through the sensorimotor system's contact with sensory stimuli. To better articulate the vast, complex interdependent neural process responsible for the perception of space, the term *enaction* is adopted to underscore the function of movement in Hansen's more active notion of affectivity: the "capacity to experience [the affective body's] own intensity, its own margin of indeterminacy…a power of the body that cannot be assimilated to the habit-driven, associational logic governing perception" (Hansen, 2006b, p. 7-8). We enact the perception of space via movement. The theoretical framework proposed here situates presence as a phenomenon achieved primarily through the confluence of three modalities—proprioception, tactility, and temporality—that "interpret" digital stimuli supplied by a technological apparatus in order to enact space and create a feeling of "being there" in a mediated, virtual environment. These three modalities provide the means by which the affective body enacts space and therefore experience presence (see Figure 4.1. below).

- The affective body enacts space via a sense of body positioning (i.e., proprioception),
- The affective body enacts space via the triggering of affective registers (i.e., tactility)

- The affective body enacts space via a sensitivity to changes in intensity of any given qualities (i.e., temporality).

This theoretical framework for presence assumes that the sensorimotor system does not differentiate between naturally occurring and mediated stimuli (Bradley, 2007; Reeves & Nass, 1996; Riva, Waterworth, & Waterworth, 2004),[18] a phenomenon that form the basis for much research centered on virtual reality technologies applied in clinical settings (Wilson, & Soranzo, 2015): PTSD treatment (Gerardi, Rothbaum, Ressler, Heekin, & Rizzo, 2008; Nelson, 2013), social psychology (Messinger, Stroulia, Lyons, Bone, Niu, Smirnov, & Perelgut, 2009), sports psychology (Zinchenko, Menshikova, Chernorizov, & Voyskunskiy, 2011), and psychotherapy (Suied, Drettakis, Warusfel, & Viaud-Delmon, 2013; Villani, Riva, & Riva, 2007). As discussed above, the affective body's desire for form is so strong that ambiguous or vague stimuli are *inferred* into form for perception form one moment to the next, continually anticipating these yet to be images. Precisely because the affective body overcomes conflicting stimuli or gaps in sensory information, design strategies that capitalize on this biological phenomenon in order to create compelling, immersive experiences with presence.

[18] Studies have measured the subjects' reflexive responses to both pictures (Bradley, Codispoti, Cuthbert, & Lang, 2001; Bradley, Codispoti, Sabatinelli, & Lang, 2001) and television (Lang, Dhillon, & Dong, 1995; Lang, Newhagen, Reeves, 1996) as well.

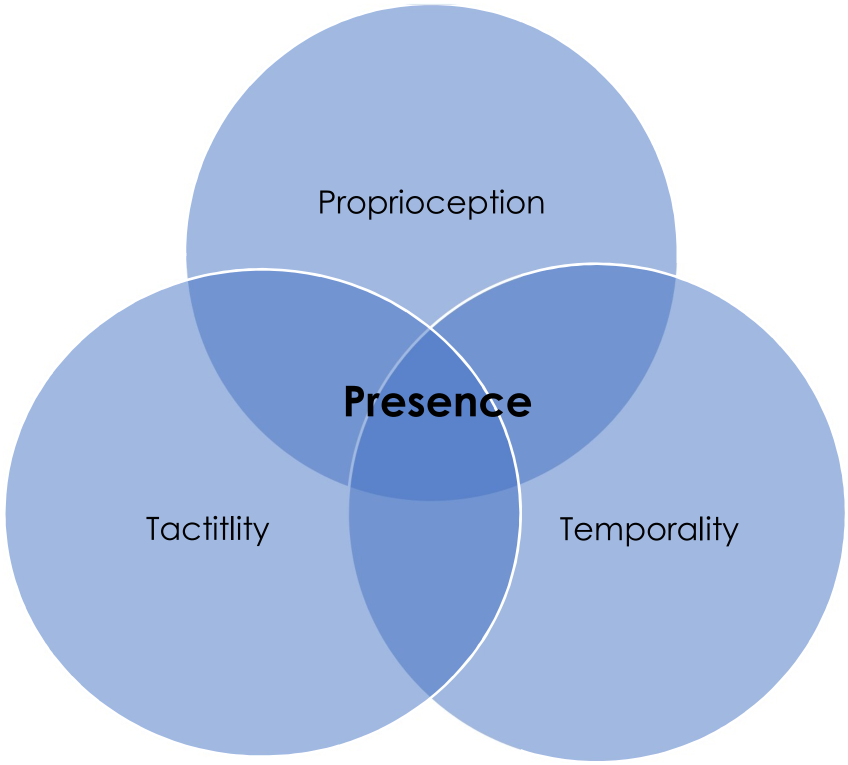


Fig. 4.1. Presence as achieved via the three modalities of the affective body.

4.1.1 Affectivity Originates in the Body, Not the Technical Frame

To complete our understanding of affectivity as the operational mechanism for presence, we turn towards Deleuze's concept of the *movement image*, which refers to how the fundamental image (i.e., perceptual form) in cinema is not a compile of successive images, but rather motion itself, as illustrated in Deleuze's analysis of the cartoon:

> [The cartoon] no longer constitutes a pose or a complete figure, but the description of a figure which is always in the process of being formed or dissolving through movement of lines and points taken at -any-instant-whatevers of their course…[The cartoon] does not give us a figure described in a unique moment, but the continuity of the movement which describes the figure. (Deleuze, 1986, p. 5)

For Deleuze, and like Bergson, all things are in a state of constant flow, and the movement-image, as it is analogous to human perception, simply means spatial slice of motion (Deleuze, 1986, p. 59).

This movement is "interrupted" via the intervals that exist between "frames"—that is the sensorimotor interval—a gap from which, according to Deleuze, affection arises. Deleuze classifies three types of movement-images: perception-image, action-image, and affect-image (Deleuze, 1986, p. 61-66). The *perception-image* is concerned with perspective (i.e., form) and is always less than the material thing:

> We perceive the thing, minus that which does not interest us as a function of our needs. By need or interest we mean the lines and points that we retain from the thing as a function of our receptive facet, and the actions that we select as a function of the delayed reactions of which we are capable. Which is a way of defining the first material moment of subjectivity: it is subtractive. It subtracts from the thing whatever does not interest it. (Deleuze, 1986, p. 63).

Viewing objects from different perspectives reveals different images—that is, forms—of the object. When we encounter the sensorimotor interval, the perception-image stalls. These "perceptions of things" become "prehensions" as we anticipate the next perspective-image on the *other side* of that gap (Deleuze, 1986, p. 64). From this prolonged interruption arises the counterpart of the perception-image, the *action-image*, which, according to Deleuze, is the "delayed reaction of the centre of indetermination" (Deleuze, 1986, p. 64). As objects cross our periphery and into the center of our perceptual field, we grasp "the 'virtual action' that they have on [us], and simultaneously the 'possible action' that [we] have on them, in order to associate [us] with them or to avoid them, by diminishing or increasing the distance [between us]" (Deleuze, 1986, p. 65). The action-image refers to the interaction among objects relative to their positions in the perceptual field. Whereas the perception-image emphasizes space, the action-image is concerned with time. The action-image, therefore, is the "material aspect of our subjectivity": "One passes imperceptibly from perception to action. The operation under consideration is no longer elimination, selection or framing, but the incurving of the universe, which simultaneously causes the virtual action of things on us and our possible action on things" (Deleuze, 1986, p. 65). It is the interval, the gap between the perception-image (i.e., the sensorimotor's system contact with stimuli) and the action-image (i.e., the response to that stimuli), that supplies the missing piece: the *affect-image*. Affect, according to Deleuze, "occupies the interval…without filling it in or filling it up" and allows for the "subject perceive itself, or rather experiences itself 'from the inside'…relates movement to a 'quality' as lived state" (Deleuze, 1986, p. 65). The affect-image is concerned with objects in the process of experiencing some quality (e.g., pain, beauty, fear, etc.). Affect "reestablishes the relation" caused by the interruption of the interval that "allocates on the one hand the received movement, and on the other the executed movement, and which might make them in a sense incommensurable" (Deleuze, 1986, p. 66). Deleuze's canonical example of an affection-image is the use of the montage and the close-up of the human face best demonstrated by Dreyer's *The Passion of Joan of Arc* (1928), in which we witness passion—and anger and fear—pass through the actress' face, acting upon and causing action in the subject (Deleuze, 1986, p. 106).

Here arises a problem with Deleuze's cinematic metaphor for affect and the affect-image. Hansen poses a course correction for affect, one that positions affect as a quality of the framing body rather than the technical apparatus as proposed by Deleuze (Hansen, 2006b, p. 7). Although Hansen agrees with both Bergson (1988) and Deleuze (1986; 1989) that the body is the site of affection and memory, he targets Deleuze's claim that images (i.e., perceptual forms) exist prior to their human encounter; more to the point, Hansen criticizes Deleuze for placing affectivity autonomously outside the human body, introduced via the technical frame (Hansen, 2006b, p. 137). Deleuze (1986), like Bergson, understands all matter, and therefore all images, to be in a state of ceaseless movement, of action and reaction. However, where Deleuze diverges from Bergson is regard to the function of affect in the theory of embodied perception. For Bergson, affection is an "impurity" (Bergson 1988, p. 58) caused by the flesh of the human body, much like a small crack in a camera case that exposes a bit of film to light. Deleuze inverts this argument and theorizes that affection is actually a permutation of the movement-image. Hansen aptly summarizes Deleuze's point well: "Affection as a phenomenological modality of bodily life gives way to affection as a concrete type of [movement-] image—the affection-image—defined exclusively by the protracted *interruption* [author's emphasis] of the sensorimotor circuit, the interruption, that is, of the form of the movement-image" (Hansen, 2006b, p. 6). As in the montage, the interruption or interval of the process is what gives meaning to these distinct units and perception. For Deleuze, the images are the result of the cinematic frame (i.e., the frame, shot, and cuts employed) before they come into contact with the passive body.

4.1.2 The Autopoiesis of Affectivity

Hansen challenges the Deleuzian notion that affect is a product of the technical, and, along with Massumi (Massumi, 2002, p. 227), grants affection with far more agency than previously afforded. Affectivity—active affection, as opposed to Deleuze's passive affection—comes to stand for the body's capacity to "experience itself as 'more than itself' and thus to deploy its sensorimotor power to create the unpredictable, the experimental, the new" (Hansen, 2006b, p. 7). Hansen aims to resituate perception as the result of a sensorimotor function of the human body as opposed to Deleuze's arguments that perception is an extension of the human mind: "By rendering cinema homologous with the universal flux of images as such, Deleuze effectively imposes a purely formal understanding of cinematic framing and thus suspends the crucial function accorded the living body on Bergson's account" (Hansen, 2006b, p. 7). Hansen presents affectivity not only as autopoietic but also the modality of lived experience: Affect is neither a contamination of our perception as Bergson suggests (1988), nor ever subordinate to perception as Deleuze argues (Hansen, 2006b, p. 134-135), but rather our capacity to experience affect is the very modality by which we experience the world at every moment. Returning to Robert Lazzarini's *Skulls* (2000), Hansen points out that it is the technical framing of the impossible sculptures themselves (i.e., the distortion of the skulls) that *catalyze*s the affective registers with paradoxical stimuli that resists biologically grounded Gestalt principles:

> The projected installations pace does not simply happen to be uninhabited at a certain moment; it is *uninhabitable in principle*. Moreover, affect cannot be extracted from this projected space for the precise reason that it was never there in the first place; this space is a radically nonhuman one, one without any analogical correlation to human movement and perception, and one into which affection can be introduced only from the outside, as a supplement that originates in the embodied response of the viewer-spectator. (Hansen, 2006b, p. 215)

Lazzarini's *Skulls* succeeds because it demonstrates the primacy of the body's investment of affect over perception, that when confronted with inhuman digital information, the body experiences its own "virtuality"—the affective body's awareness of its own potential for actualization, the "collapse" of its own sensorimotor interval between contact and response to stimuli (Hansen, 2006b, p. 170; 225). Unlike Deleuze's movement-image in which affect occupies the sensorimotor interval from outside the body, Hansen's affectivity enacts a space within the body, a space occupied by the sensorimotor system and constituted by the actions of bodily sensations (Hansen, 2006b, p. 225). Thus, the affective body is autopoietic because it can create the conditions in which to shape its own affective experiences: the affective body's encounter with *Skulls* (2006) is the affective body confronting its own inability to perceive imperceptible digital information. Affectivity *is* the sensorimotor interval, the experiencing of the body's own virtuality, of one's own susceptibility to change (Hansen, 2006b, p. 227). In Hansen's words, "Affectivity…names the body's agency over itself: the capacity of a sensitive element to isolate itself and to act on the whole body as a *force*, or rather, to catalyze the body's action on itself" (Hansen, 2006b, p. 227). In order for sense organs to isolate themselves, affectivity must not only possess autonomy, but also enacts a sort of affective space within the body (Hansen, 2006b, p. 227). The observer becomes aware of her own bodily movements (i.e., proprioception) failing to give form to the incorrigibly distorted skulls, an action which catalyzes her own affective registers (i.e., tactility), and inherently anticipates changes within itself (i.e., temporality). As the framing mechanism of perception, the affective body is self-organizing, self-regulating, and self-creating. As the mechanism for presence, affectivity operates to sustain form, to perceive images, to enact circumambient space and the time consciousness—processes that are catalyzed with contact with the mediated stimuli supplied by the technical apparatus. Hansen's theory of affectivity and embodied perception as a similar explanation for how the affective body experiences space and time in virtual environments is adapted: how and what the affective body *desires* frames experiences of presence both quantitatively and qualitatively. The theoretical framework for presence introduced here postulates that the same mechanisms that enact perceptual form from the affective body's encounter with stimuli beyond the borders of its skin are responsible for creating the sensation of presence by via the embodied perception of space.

4.1.3 Presence and the Enlargement of the Margins of Indeterminacy

Hansen's driving thesis in *New Philosophy for New Media* (2006b) is that the affective body is the best interface to render the inhumaneness of digital information into the digital image—Hansen's term for the very process in which the body actualizes formless, digital stimuli into perception (Hansen, 2006b, p. 11). It is precisely this inhuman, formless nature of digital information that gives power to new media artists who understand the capacity for technology to expand the affective body's center of indetermination (Hansen 2006b, p. 11). The *center of indetermination* is Bergson's term for the gap between the virtual and the actual (Bergson, 1988, p. 17-19; Hansen, 2006b, p. 5). Hansen updates this notion to the sensorimotor interval, the interstice between detection and response to stimuli, and is the neurobiological basis for affectivity (Hansen, 2006b, p. 5-8). Theses intervals are characterized as indeterminate because they inherently unstable and lack distinct boundaries, and therefore are irreducible. Nonetheless, these centers of indetermination empower the body with the capacity to *experience its own indeterminacy*, to open itself to its own intensifying affective excess, and create the conditions by which it can trigger its own affective registers (Hansen, 2006b, p. 7-8). This indeterminacy powers affectivity and serves as the source of its autopoiesis. When this indeterminacy encounters digital information, Hansen argues, the affective body is capable of refining its own sensorimotor interval by enlarging the margins of its own centers of indetermination in anticipation of the digital image (Hansen, 2006b, p. 252). Hansen's theoretical framework for this expansion of indeterminacy provides the best procedural explanation for how the vast network of neural processes responsible for enacting distal attribution in a digital environment converge to create the mediated, perceptual event known as presence. Hansen argues that the affective body can extend the duration of the protention phase of time consciousness as the affective body readies itself for the digital image. The underlying mechanisms of presence can be best understood as a *conscious extension of the protention phase* in which the body is self-aware of its own proto presence in an act of self-affection. The protention phase is extended to anticipate that the digital image is in fact operating in the same manner as the physical, real-world that our evolutionary psychology has been adapting to for millions of years.

Returning to Varela's work on neurobiology, Hansen connects affectivity to the protentional dimension of time consciousness, underscoring the fact that the essential function of protention is to open itself to new stimuli before it is encountered in the perceptional present (Hansen, 2006b, p. 252-253). This opening to anticipation results in a thickening of the living duration, the "enlargement of the threshold of the 'now' of phenomenological experience and to catalyze an aesthetic experience of this enlargement in the form of an intensification of affectivity…the potential for [digital information] to expand the experiential grasp of the embodied human being" (Hansen, 2006b, p. 16). Hansen illustrates this affective extension in his phenomenological analysis of Bill Viola's *Quintet of the Astonished* (2000). Viola's new media work is a video installation of five actors whose dramatic emotional expressions unfold in slow motion through the duration of the video, revealing the normally imperceptible microexpressions of affect passing through the actor's faces (Hansen, 2006b, p. 260). Shot at 384 frames per second on film, then played at normal speed of 24 frames per second, the video unpacks an "oversaturated temporal object" and reveals microexpressions that normally operate on Husserl's 1/10 scale of duration and comprise the most elementary components of temporality, confronting the affective body with

> what it cannot properly perceive yet what constitutes the very condition out of which the perceivable emerges, undergoes profound self-affection. In this incredibly intense experience, consciousness is made to live through (affectively, not perceptually) the very process through which it continually emerges, from moment to moment…. (Hansen, 2006b, p. 264-265)

Watching the normally, imperceptible microexpressions pass across the actors' faces expands the protentional phase of time consciousness of the viewer, an expansion significant enough to disrupt or collapse the sensorimotor interval: Metaphorically, the sensorimotor system could not "process" the digital stimuli quickly or sufficiently within this gap between sensory stimuli reception and form-giving perception. Viola's work supplies the affective body with stimuli that resists these processes (i.e., Hansen's digital image), which then catalyzes affective registers as the body becomes more invested in creating a more cohesive perceptual model. As the sensorimotor interval collapses, the margins of indeterminacy expand across the immediate now and retention phases of time consciousness and is experienced consciously. The observers become aware of these feelings of intensity passing through their affective bodies. This phenomenon may be unique to digital information, as by its malleable nature, can be technically modulated form one moment to the next and therefore endowed with a greater potential for catalyze the affective registers connected to perception.

When the affective body is confronted with stimuli that resists the neurological processes responsible for creating a perceptual model of the body centered in circumambient space, the affective body responds by becoming more invested in the construction of a spatial model, which we can consciously experience as intensities of affective registers within our bodies. Presence is better understood as a mediated, perceptual event in which the primary operating mechanism is affectivity. Rather than framing presence as the user "forgetting" that she is in a physical space wearing a VR headset, presence is the exposure to the affective body's own framing mechanisms at work selecting images for a perceptual model of space, an act which extends the consciousness into a domain normally occupied by the nonconscious (Hansen, 2006b, p. 266-7). No amount of photorealistic information, no matter the totality of the simulation for the everyday physical space, no advances in technology will likely ever compensate every single one of the billions of sensory receptors attuned to the reception of natural stimuli, and thus, in the service of form-making, the affective body exposes its own selection process to the conscious to overcomes the sensory anomalies or gaps encountered from the technical apparatus. The affective body does not "unsee" stimuli supplied outside the technical frame, or "forget" its normally wider field of view being restricted by a head-mounted display. The affective body ceaselessly seeks stimuli of every lived moment of the organism and never ignores the fact that it is standing on a hard, cool wooden floor in an apartment building, but instead constructs that "virtual environment" and presents it to the conscious as a higher order perceptual model of space. Presence is that moment when the affective body has constructed a perceptual model of space cohesive enough to sustain distal attribution *despite* sensory anomalies or gaps. Presence is not a sensation of being there, but rather a sensation of space itself pressing upon the affective body.

4.1.4 Affectivity's Commitment to Distal Attribution

This theoretical framework that posits affectivity as the framing mechanism of presence finds support in the Riva, Waterworth, and Waterworth's three-layered paradigm that explains presence as an evolved psychological mechanism (2004) first discussed in Chapter 2. To review, Riva, Waterworth, and Waterworth's biocultural theory defines presence as not only intrinsic to distal attribution but also fundamental to our conception of space beyond the reaches of our sensory experiences (Riva, Waterworth, and Waterworth, 2004, p. 409). Their theoretical framework for presence, aligning with Damasio's model of the three-levels of the self (1999) (see Table 2.2), posits that each layer of presence serves a specific function in maintaining an internal/external world divide and possesses distinguishing operational properties (Riva, Waterworth, and Waterworth, 2004, p. 405). Because much of this their theoretical framework is built upon evolutionary psychology, they make certain assumptions about presence relevant to this research:

- Presence is evolution's response to some problem that threatened individual survival or reproduction.
- Presence is an adaptive solution determined by the organism's ability to detect some stimuli but not others, both actively and passively, as well as stimuli internally and externally.
- Presence is the output of neurological processes that oversee physiological activity, communicate to other psychological mechanisms, and trigger actions in the organism. (Riva, Waterworth, and Waterworth, 2004, p. 406)

Researchers who overlook the underlying biological-serving functions of presence run the risk of reducing presence to characterizations of the technical apparatus (Riva, Waterworth, and Waterworth, 2004, p. 406) rather than understanding presence as an evolutionary mechanism catalyzed or excited by information (i.e., stimuli) supplied by the technical apparatus. These same evolutionary mechanisms responsible for our sense of "presence" in everyday reality, according to Riva, Waterworth, and Waterworth, are also responsible for the experience of presence in virtual reality (2004, p. 406).

However, affectivity operates these mechanisms *differentially* according to (1) the nature of the stimulus and (2) constraints placed on the sensory receptors. Presence in a virtual environment is not analogous to feeling present in everyday reality for the simple fact that the affective body never forgets, ignores, or divides itself in the construction of perceptual space, but rather infers these perceptual models via selecting from all possible stimuli: Distal attribution is achieved *despite* that (1) stimuli supplied by the technological apparatus is not analogues to their real-life counterparts (e.g., the images and the photons that constitute them on the HMD display cannot completely replicate human vision) or (2) the inability of the technical frame to address the entire body in the act of perception (e.g., the narrow field of view in a VR headset or over-the-ear headphones are designed to occlude or prevent outside stimuli form reaching sensory receptors). Affectivity's commitment to a cohesive, perceptual model of circumambient space is so strong that it resists any perceptual incongruencies or sensory gaps that interfere with distal attribution, arguably the single most important function of the affective body. To meet this commitment, the affective body's centers of indeterminacy swell, expanding the duration of the now as more than the normal neurological resources are called in order to engage with the mediated stimuli and overcome any conflicting or missing sensory inputs at every single moment. Distal attribution, thus, is in intrinsic property of presence and one of the primary functions of the affective body.

4.1.5 Mediation and Presence

As mentioned previously, there is a significant distinction between Riva, Waterworth, and Waterworth's three-layered model (Riva, Waterworth, and Waterworth, 2004) and the theoretical framework proposed here regarding the role of mediation in the experience of presence. Riva, Waterworth, and Waterworth's three-layered model understands presence as an evolutionary-derived, biological phenomenon arisen to address some adaptive challenge, and is the natural condition of the organism independent of any technology (Riva, Waterworth, and Waterworth, 2004). Under their theoretical framework, mediation is the application of technology that serves one or more of the three layers of self in creating an internal/external divide in the organism and requires more technological capabilities to engage the deepest levels of presence (Riva, Waterworth, and Waterworth, 2004, p. 414). In their model, there exists three phylogenetic strata of presence: *proto presence* (first layer), *core-presence* (second layer), and *extended-presence* (third layer) (Riva, Waterworth, and Waterworth, 2004, p. 409-412). Beginning with the outermost layer, extended presence can be understood as the highest level of conscious evolving meaning-as-significance and the least technologically demanding to engage. Extended presence situates the extended self within a larger, unexperienced world, and rooted in self-identify, personality, goals, and behavior; the meaning-as-significance property of extended presence and allows us to determine the value of an event in terms of our goals, which increases one's survivability (Riva, Waterworth, and Waterworth, 2004, p. 411). Reading a book, for example, can engage the extended self by capturing the *focus* of the extended consciousness, which describes the nature of the reader's attention on a continuum: in this case, the reader's thoughts are directed toward her imagination rather than external events in real life (Waterworth & Waterworth, 2001, p. 204; Riva, Waterworth, and Waterworth, 2004, p. 413). This *absence of mind* describes an engagement of the extended consciousness with internally-generated schema (i.e., extended presence) while the two remaining layers of presence remain focused on real-life events, that is, minimally engaged with the thoughts of the imagination (Riva, Waterworth, and Waterworth, 2004, p. 413). Under this three-layered model, reading a novel can evoke extended presence, even though the body is aware it is sitting comfortably in a chair and turning the pages of a book.

There is a higher technological demand required in order to engage the second- and first-levels, core presence and proto presence, respectively. While literature may engage the extended presence, traditionally painting, sculpturing, and drama were more effective at engaging core presence, a quality that Waterworth & Waterworth describe as the *locus* dimension of presence (Waterworth & Waterworth, 2001): the degree to which one is focused on either real-world events or mediated events, which is often a flux between the two: "Any mediated presence is in competition with presence in the real world" (Riva, Waterworth, and Waterworth, 2004, p. 413). Core presence is the experience of the here and now happening to *me*, while proto presence, according to Riva, Waterworth, and Waterworth, is the oldest and most fundamental function of presence, and primarily concern with maintaining a "nonconscious mapping" of the physical, internal state of the organism (Riva, Waterworth, and Waterworth, 2004, p. 409). The *sensus* dimension of presence in this theoretical model describes the level of attentional arousal captured by the organism and may affect other layers of presence, such as activity or emotion (Riva, Waterworth, and Waterworth, 2004, p. 413). Mediating both core presence and proto presence seem to occupy a special place in Riva, Waterworth, and Waterworth's three-layered model, for they require much more bodily investment in order to achieve than mediated extended presence (see Table 4.1. below).

Table 4.1. Riva, Waterworth, and Waterworth's model for mediated presence (2004).

Layer	Mediation of Presence
Proto Presence (1st Layer)	*Experiencing a VR headset with subperceptual tracking*. The user may find the content boring (failure to achieve extended presence) and the vividness of the virtual environment lacking, resulting in an awareness that one is experiencing a mediated event (failure of core presence).
Core Presence (2nd Layer)	*Viewing a large portrait*. A viewer's attention may be captivated by a powerful image, but that does not necessarily dictate that the viewer will feel "inside" the image (failure of proto presence) or contemplate any significance of the image (failure of extended presence).
Extended Presence (3rd Layer)	*Reading a novel*. A reader may become engrossed in her imagination while reading, but neither the sensorimotor system nor affective registers are triggered (failure of proto and core presence, respectively).

Squaring Riva, Waterworth, and Waterworth's three-layered model of presence (Riva, Waterworth, and Waterworth, 2004) with the affective body requires two conditions. First, presence proposed here is by definition a mediated, perceptual event and characterizes a relationship between the affective body and technological artifacts. The term *presence* is not a substitution for *consciousness*, for it would also burden the term with explanations for hallucinations, dreams, and pathologies; presence is more a *sensation*, a biological adaption for feeling space. Second, Riva, Waterworth, and Waterworth's third layer of presence is phenomenologically distinct than the two inner layers of presence, as achieving extended presence does not engage the sensorimotor system significantly to achieve pure distal attribution. Perception is never separated from the affective body, thus any definition of presence predicated on the principle that can be experienced in a space without any sensory input is fallacious: Reading an engrossing novel is not an experience of presence, for no matter how descriptive the written word may be, it simply is technologically inadequate to address the multitude of sensory needs that the affective body creates. Imagining a space is not analogous to experiencing space. One may experience terror while reading her or his favorite horror author, but to experience affect is not synonymous with experience of perceptual space, for in the former at no time did the affective body never stopped listening, touching, and smelling the world around it, even if the reader did.

4.2 The Two Domains of Presence Explicated

The theoretical framework posits that affectivity is the primary operating mechanism for creating experiences of presence in mediated or virtual environments, and that presence is a biological adaptation for accommodating mediation. Affective bodies are so invested in distal attribution that, given the sensory anomalies and gaps supplied or denied by the technological apparatus, insist on the placing of the self within perceptual models of circumambient space. As argued previously, the theoretical framework proposed here posits that presence cannot occur unless the technological apparatus can sufficiently trigger the neurological processes responsible for distal attribution within the sensorimotor system; thus, imagining another place is more an engagement of attention rather than a dimension of presence. With affectivity's role in forming distal attribution as the central organizing principle for the experience of presence, the theoretical framework for the two domains of presence must be reconsidered. As described preciously, the scholarship reveals that presence can be experienced quantitatively in degrees of intensity (Regenbrecht, Schubert, & Friedmann, 1998; International Society for Presence Research, 2000b; Juan & Perez, 2009; Steed, Friston, Lopez, Drummond, Pan, & Swapp, 2016; Hvass, Larsen, Vendelbo, Nilsson, Nordahl, & Serafin, 2017; Cooper, Milella, Pinto, Cant, White, & Meyer, 2018) as well as qualitatively in types or kinds (Steuer, 1992; International Society for Presence Research, 2000b; Ijsselsteijn, 2002; Ijsselsteijn and Riva, 2003; Lee, 2004; Riva, Waterworth, & Waterworth, 2004; Lombard & Ditton, 2006; Mennecke, Triplett, Hassall, and Conde, 2010). In regard to the former, intensities of presence correlate to the expansion of the margins of indeterminacy when the affective body encounters digital information; in regard to the latter, dimensions of presence reflect different manifestations of distal attribution, and therefore are predicated on *spatial presence exclusively*. This theoretical alignment of the two domains of presence is supported by Hansen's work on the affective body's special relation to digital media and underscores the nature of presence as an adaption of the affective body to the catalyzing effects of immersive technologies.

4.2.1 Fluctuations of the Margins of Indeterminacy

Experiences of presence can be described quantitatively as more or less intense and reflects the degree to which the sensorimotor system is privileging mediated stimuli, which occurs moment-by-moment and may result in intermittent "breaks" in presence (International Society for Presence Research, 2000b; Riva, Waterworth, & Waterworth, 2004; Slater, 2002; Slater & Steed, 2000). Under the theoretical framework of Hansen's affective body, intensities of presence can be understood as sensations of distal attribution in oscillation: Low-intensity experiences of presence indicate that the sensorimotor system is barely engaged (i.e., the triggering of affective registers) with the mediated stimuli, resulting in the self-conscious experiencing of partial, incomplete, or conflicting distal attribution properties; high-intensity experiences of presence correlate to a high engagement of the sensorimotor system and the creation of a predictable, coherent perceptual model of circumambient space. This engagement of the sensorimotor system with the mediated or digital stimuli correlates to the growth of the affective body's boundaries of indeterminacy. Low-intensity experiences of presence indicate that the stimuli provided by the technological apparatus was insufficient to maintain any perceptual model for the consciousness to use reliably, thus the inaccuracies of the simulation and technological constraints become perceptual. On the other hand, high-intensity experiences, or optimal presence, reveal more than reliable models of distal attribution; they also correlate to expansion of the affective body's center of indeterminacy, that irreducible interval between sensory detection and response that can extend our perception of temporality. Experiencing optimal presence in a VR headset is not simply the affective body replacing the stimuli of the everyday world with mediated stimuli and creating a virtual environment, but rather the affective body's adaption to technological artifacts via a *selective*, not substitutive, framing mechanism. No matter how immersive or vivid the virtual environment, sooner or later the user becomes self-ware of the inadequacies or paradoxes of the mediation: the weight of the headset on the face after prolong use, the technical limitations of the application's physic engine, nausea from artificial locomotion. Over time, the affective body brings to the conscious' attention these mediation shortcomings, and the intensity or presence decreases, leading to the margins of indeterminacy constricting to their "normal" size.

4.2.2 Distal Attribution of the Phenomenal Body

The second domain of presence outlined in the scholarship frames the phenomenon into qualitatively distinct, yet often overlapping, experiences, as taxonomized in Lombard and Ditton's seminal six conceptualizations of presence (Lombard and Ditton, 2006). Despite the lack of a shared theoretical framework, under this taxonomy speaking to another person on a telephone, watching a theater performance, playing video games, yelling at actors on a television screen, chatting with voice-assisted technologies, and reading a novel are expressions of the same phenomenon (Bracken, 2005; Green, Brock, & Kaufman, 2004; Hartmann et al, 2016; International Society for Presence Research, 2000b; Lee, 2004; Lombard & Ditton, 2006; Schubert & Crusius, 2002; Tamborini & Skalski, 2006): an experience of externalization evoked during mediation between the user and the technological apparatus. The central organizing principle of these disparate conceptualizations is the nature of the relationship between the user and the technology, a characterization more of the mediation with the technology rather than the user's perception of circumambient space. This is a significant distinction, as the original notion of the term *presence* was truncated from *telepresence*, which characterizes the feelings a teleoperator experiences while remote piloting a submersible (Sheridan, 1992): Conceptually, presence originally described the feelings associated to spatial experiences and mediating role of technology, which is predicated on that technology's capacity to provide useful feedback to the operator (Sheridan, 1992, p. 3). The efficacy of this mediation then is dependent on many factors, such as responsiveness, speed, and display of the technological apparatus, but the ergonomics, haptic feedback, and kinesthetics of the interface underscore the crucial role of the body in the user interaction. The original conception of presence then is predicated on (1) the feelings associated with being physically present at a remote location and (2) the kinematic and dynamic qualities of the interface (Sheridan, 1992, p. 1), of which the former is highly dependent upon the latter. Regarding telepresence specifically, piloting a vehicle remotely successfully is highly determined on the responsiveness of the feedback and feedforward (Sheridan, 1992, p. 3) and that experiences of presence impact the operator's performance in commanding a remote device to task completion. Sheridan (1992) describes the assemblage of afferent sensory information from the technology and efferent responses from the sensorimotor system as a closed information-control loop (Sheridan, 1992, p. 6), which in moments of intense experiences of presence correlates to a successful mapping of the remote environment with the operator's spatial awareness, a phenomenon that can be measured objectively with task completion studies (Gaetz et al, 2018; Gallagher, Allen, & Maclachlan, 2001; Kawashima & Mita, 2009; Ramachandran & Blakeslee, 1998; Ramachandran & Rogers-Ramachandran, 2000; Richardson, Olleveant, Crawford, & Kulkarni, 2018). The original conceptualization of presence then is derivative of a feeling of being physically present at the remote location of the slave device (Loomis, 1992, p. 113) and underscores a kind of distal attribution grounded in the sensorimotor system highly dependent on the technical interface.

As discussed previously, the affective body's form-giving properties govern perception via the sensorimotor system and places primacy on coherent spatial models despite anomalies or gaps in sensory stimuli. Perception is constituted of the phenomenal world, the conscious experiencing of perceiving the physical world that is inferred to exist prior to the sensorimotor's contact with it (Loomis, 1992, p. 114); as such, we can also perceive ourselves as possessing phenomenal bodies—our experiential conceptions of the bodies we occupy—as juxtaposed to our physical bodies, which in most everyday experience functions imperceptibly (Loomis, 1992, p. 114). The phenomenal body, in other words, is the *conscious* experiential form of the affective body and subordinated, as with perception, to affectivity[19]. The affective body's commitment to distal attribution is so

[19] The distinction between the phenomenal body and Massumi's virtual body is not only a matter of consciousness and nonconsciousness, respectively, but also the latter is more concerned with potential and conceptualizes "a form of

fundamental that persons who have suffered traumatic amputations may still experience sensations of pain, itching, and tickling in their missing limbs, a phenomenon known as phantom limb syndrome (Bailey & Moersch, 1941, p. 37). Ramachandran and Blakeslee's work on phantom limb syndrome (Ramachandran and Blakeslee, 1998) reveals insight into how the body retains or remaps the phenomenal self when it experiences the sudden loss of a limb. For most people in their everyday experience, there is no perceptual discrepancy between their phenomenal bodies (i.e., the body they perceive, understand, and experience) and their physical bodies (i.e., the flesh-and-bone body of the real world), but patients with phantom limb syndrome have reported painful sensations of squeezing cold iron bars (Kawashima & Mita, 2009) or digging their nails into their palms (Ramachandran & Blakeslee, 1998, p. 22), or being unable to uncurl their twisted, frozen phantom fingers, as if locked in their final position prior to amputation: even patients who suffered paralysis in an arm for weeks before its amputation reported feeling a phantom arm that had been immobilized in "cement" or a "block of ice" (Ramachandran & Blakeslee, 1998, p. 43-44). For many patients, these phantom limb sensations may pass after a few weeks or months; however, other patients experience these symptoms for years (Gallagher, Allen, & Maclachlan, 2001). Even more perplexing are reports of phantom limb syndrome from people born without complete appendages: One patient, born without arms below her shoulders, reported that she used her phantom arms while gesticulating, such as pointing out objects; however, her phantom arms were six-eight inches *shorter* than their flesh-and-blood counterpart, a fact the patient became aware of once she was fitted with prosthetic arms (Ramachandran & Blakeslee, 1998, p. 41). Furthermore, the patient reported that she felt her phantom arms gesticulating only while she was talking, and when she walked, those same phantom arms would "stay frozen" on her side, which reflects that

superlinear abstraction" and "organized differently but is inseparable from the concrete activity of the body" (Massumi, 2002, p. 30-31).

fact different neural processes are responsible for gesticulation and locomotion (Ramachandran & Blakeslee, 1998, p. 41-42).

The phenomenal body has the capacity to not only retain phenomenal vestiges of itself, but also remap the sensory input of those phantom limbs to other parts of the body, a response known as cortical reorganization that may occur when there is a decrease or loss of sensory input due to deafferentation either by paralysis or amputation (Bailey & Moersch, 1941; Richardson, Olleveant, Crawford, & Kulkarni, 2018). Patients experiencing phantom limb syndrome have reported that an amputated index finger can be stimulated by tickling a cotton swab on the patient's upper lift (Ramachandran & Blakeslee, 1998, p. 25) or experiencing an orgasm in a phantom foot during sexual intercourse (Ramachandran & Blakeslee, 1998, p. 36). In such cases, the loss of sensory information creates a "gap" in the phenomenal body that is cortically sutured to other body surfaces. Although grossly simplified in its depiction, the Penfield map represents a thin vertical strip of the cerebral cortex that maps cortical functions to their corresponding sensory and motor operations, which are commonly referred to as the cortical *sensory* homunculus and cortical *motor* homunculus[20], respectively. The larger the representation, the more cortical mass devoted to that operation: The lips are enlarged on the sensory model to reflect the complex and extensive neural network of sensory receptors, whereas in the motor model the hands are designated as the most invested organs for motor functions. Additionally, the Penfield homunculi maps the proximity of corresponding sensorimotor neural operations in the cerebral cortex, which suggests that patients with amputations may experience these sensations in apparently disparate parts of their bodies. A patient suffering from a phantom itch in his index finger may find relief in scratching his upper lip, for example (Ramachandran and Blakeslee, 1998, p. 29), as the cortical centers are relatively close, suggesting the

[20]Penfield's homunculi have their own fascinating history in cartography. Despite its inaccuracy, the Penfield homunculi have nonetheless caught the public's imagination (Schott, 1993).

creation or use of existing neural pathways. Regarding one patient who had lost his left hand, Ramachandran and Blakeslee (1998) were able to map the phantom limb on both the patient's left cheek as well as his left shoulder, so that when these patches of skin were stimulated, the patient reported sensations in the phantom hand (Ramachandran and Blakeslee, 1998, p. 30). This neural plasticity is also evident in bilateral hand transplant patients who, after experiencing deafferentation from amputation and experienced phantom limb sensations in the face, reported a partial restoration of their original phenomenal hands, although partial sensation of the phantom fingers could still be felt in the face (Gaetz, 2018, p. 92)[21].

4.2.2.1 The Phenomenal Body's Commitment to Form

The phenomenal body is essentially one's awareness of the sensorimotor system mapping the physical body, and phantom limb syndrome is a condition brought about by an abnormal or pathological process resulting from a massive "rewiring" of neurological pathways (Ramachandran & Blakeslee, 1998, p. 51) as the sensorimotor system confronts anomalies or gaps in the sensory field while the affective body grapples to maintain distal attribution—a commitment so strong that it is at least partially maintained on a genetic level since individuals can be born with phantom limbs (Ramachandran & Blakeslee, 1998, p. 40-41). The sensorimotor system may also remap the phenomenal body unnaturally to the physical body, such as phantom fingers "dangling" from an amputated shoulder (Ramachandran & Blakeslee, 1998, p. 49) or a "telescopic" phantom hand that extends from an amputation when reaching for something (Ramachandran & Blakeslee, 1998, p. 43). Nonetheless, the sensorimotor system remains committed to distal attribution: The edges of the phantom body may be contradictory, they may be unstable, but they are *not* formless. The patient can still "feel" the circumambient space of the phantom hand *proprioceptively*. This demonstrates that

[21] Neural connections in the cerebral cortex can be modified in distances that up to one centimeter (Ramachandran & Blakeslee, 1998, p. 28).

there is a strong, possibly genetic connection between experiencing consciousness and the mapping of the sensorimotor system (Ramachandran & Rogers-Ramachandran, 2000, p. 317). Pain, tickling, and other phantom sensations are still modality-specific, so that sensations of heat or pressure still follow thermoreceptor or mechanoreceptor pathways, respectively (Ramachandran & Blakeslee, 1998, p. 50), and indicate the sensorimotor system's need for sensory-specific stimuli to maintain homeostasis. Where the patient sees empty space at the end of an amputated wrist, the affective body remains *tactilely* invested in an "inaccurate" model of distal attribution: This investment cannot merely be the irritation of neuromas—benign tumors that form from the scar tissue of damaged nerve cells similar to those found in the amputation of a limb (Clayman, 1989, p. 723)—since the scar tissue can be surgically removed and patients still experience phantom pain, sometimes even more intensely then before (Ramachandran & Blakeslee, 1998, p. 50). Affectively, phantom limb syndrome is the affective body's way of telling the conscious mind to not trust what it is perceiving by supplying sensory information that cannot be ignored, leading to the patient's awareness of the decoupling between the organic sensorimotor system and the perception of that system. More important is the fact that the boundaries of the phantom limb are *tactilely* distinct: With their eyes closed, patients can feel with great concision the tips of their phantom fingers touching each other as well as other parts of their body (Ramachandran & Blakeslee, 1998, p. 43, 49-50, 54). The most significant aspect of remapping of the phenomenal body is not its plasticity, but rather its commitment to discernable borders that demark internality and externality: Sensation is experienced either internally (e.g., the intense squeezing associated with mechanoreceptors) or externally (e.g., the feeling of cold associated with thermoreceptors) (Iggo, 1982, p. 382-383) and reflects the binary nature of distal attribution and the affective body's discomfort with vague or ambiguous forms. In other words, to the sensorimotor system, form is more important than accuracy or verisimilitude.

4.2.2.2 The Role of Mediation in Reshaping the Phenomenal Body

The treatment of phantom pain in the hand, such as the sensation of intense squeezing, has found partial success with mirror boxes. Patients insert their arms into the box but can only see the reflection of their physical hand superimposed over the phantom hand. Over a series of exercises, patients learned to unclench their phantom hands by focusing on the overlaying reflection as if it were a physical manifestation of their missing hand (Ramachandran & Blakeslee, 1998, p. 46-7). Interestingly, the perceptual illusion of the missing hand created by this low-tech mediation approach can take effect *immediately*; however, as soon as patients close their eyes or remove their phantom hands from the mirror box, the phantom pain returns (Ramachandran & Blakeslee, 1998, p. 47), which suggests that the sensorimotor system has a predilection for that sensory input which sutures the phenomenal body to the physical body. What phantom limb syndrome and the treatment of it reveals is the relationship between technology and distal attribution: Mediation of the sensorimotor system can result in not only a remapping of the phenomenal body but also a reshaping of the "phenomenal" space surrounding the phantom limb. In terms of presence, the mirror box is triggering the affective registers responsible for distal attribution with a reflection (i.e.., mediated stimuli) that allows the affective body to unclench the phantom fist (i.e., proprioceptively feel space) and the extinguishing of the phantom pain (i.e., tactilely sensing phantom fingers wiggling, rubbing, and squeezing) as the affective body self-organizes its own distal attribution boundaries that are incongruent with the IRL space[22]. The mirror box represents perhaps the lowest technological threshold required to enact the sensation of presence: a strategically placed mirror[23].

---

[22] Even con-joined twins who have been separated can experience a "phantom person": "When Dao woke up from surgery it was like…there was a phantom person. She woke up and was screaming and flailing her arms—that was where Duan was—and she was pounding on the bed with her arms, screaming, and turning in circles looking for Duan" (Murray, 2001, p. 124).

[23] While the mirror box catalyzes a type of hand presence localized in the phantom limb, other efforts have aimed at expanding the phenomenal body via robotics and cybernetic implants. Performance artist Stelarc's work on body modification are attempts at reshaping his phenomenal body, and his current project is focusing on engineering an ear

Nonetheless, the important take away is that the mirror box is mediating stimuli to the sensorimotor system, not the extended consciousness, as evident in patients' initial shock at how "real" their phantom hands felt without the material flesh and bone.

Thus, presence can be characterized according to dimensions of distal attribution: head presence, hand presence, eye-tracking, etc. in which the affective body's encounter with the technology results in a remapping of the phenomenal body through mediation. Dimensions of presence reflect the proportional attention that the affective body devotes to the homeostatic functions of the sensorimotor system while engaged with immersive technologies and can be described in anatomical terms since the technology is usually designed to directly target specific sensory receptors. The affective body's commitment to maintaining a coherent model of distal attribution is an intrinsic property of presence. No literary novel, despite how artfully written to engage the affective registers, has ever been reported to cause a reader to duck, dodge, recoil, or perform any reflexive action in the nonconscious[24]: How could it? For written words are neither designed to engage distal attribution in the sensorimotor system nor capable of triggering a reflexive action, unlike cinema and music, that can engage the sensorimotor system more directly and instigates a reflexive, rather than conscious, responses. Distal attribution is a property of the phenomenal body and helps the sensorimotor system maintain homeostasis of the organism; the saccadic movement of the eyes and lifting of the hand to turn the page are, for the most part, the only proprioceptive acts the body performs to "perceive" the mediated space of the novel, acts that may fall from conscious perception, but not the sensorimotor system. The affective body can respond intensely to a well-written story. The reader's attention may be devotedly entirely to the

---

and microphone on his forearm, which will also be Internet-connected to permit people all over the world to listen in. He refers to his work as an exploration into phantom flesh. ("Ear on the Arm," 2019)

[24] Although a sacred text may provoke such genuflection or other proprioceptive acts, such cases are testaments to the power of material artifacts, not the stories within them: Such intense bodily responses are noticeably absent in reports of reading religious in an e-book (Mrozowski, 1993).

imaginary events manifested from the reader's capacity to interpret lines and dots on a page as external spaces, but the affective body is not in service of the mind's eye, and the sensorimotor system does not forget that a book is being held in the hands or a chair is supporting the weight of the body. Perception and imagination are both subordinate to affectivity; furthermore, the sensorimotor system is not triggered by imagination alone. The very fact that a reader can turn pages *unconsciously* clearly indicates that the *sensorimotor system is operating in a spatial dimension distinct and apart from that of the conscious mind*. Has any reader ever become so engrossed in the written word that she has forgotten to turn the page? The technology of the mediation is simply not able to engage the sensorimotor system enough to trigger the neurological processes necessary to enact distal attribution; thus, not all mediation results in experiences of presence in its original conception. Distal attribution is indicative of presence, and the separation of the mind's eye from the sensorimotor system is, by definition, not presence, no matter how intensely affective registers are triggered. The theoretical framework for presence asserts that presence is fundamentally connected to the technically mediated distal attribution of the sensorimotor system, and without this engagement, the experience cannot be characterized as presence. This understanding of presence circles back to the original conception of telepresence: The experience of feeing inside a mediated environment.

4.3 Presence and Virtual Reality

The unending commitment to distal attribution is an evolutionary adaption that allows the sensorimotor system to create an afferent model of the organism in order to maintain homeostasis. Other evolutionary adaptations, such as opposable thumbs, bipedalism, and enlarged brain structures, have given *Homo sapiens* the ability to craft material and symbolic artifacts that not only greatly facilitate social leaning, but also symbolically refer to the internal space within their bodies as well as those spaces they cannot perceive directly (Riva, Waterworth, and Waterworth, 2004, p. 406).

Immersive media are artifacts designed to engage specific neurological processes, and in the case of virtual reality technologies, have the technological potential to deeply engage the sensorimotor system and impact distal attribution. Because virtual reality technologies have the capacity to (1) supply digital stimuli subjective to modulation at a sub-perceptual speed and (2) isolate or deprive targeted sensory receptors with or from sensory stimuli, they are illustrative in drawing attention to how the body constructs perceptual models of space. Virtual reality technologies refer to the three popular types platforms for VR (Wilson & Soranzo, 2015, p. 1): head-mounted displays computer automatic virtual environments CAVE, and virtual environments presented on screens (Cruz-Neira, Sandin, & DeFanti, 1993; Taylor et al, 2010).

New media artist Julius Horsthuis' work on 3D fractal art demonstrates how virtual reality technologies can expose the normally nonconscious catalyzation of the affective registers responsible for distal attribution and the sensation of presence by confronting the affective body with non-Euclidean spaces. Just as the devil's tuning fork and Necker cube are impossible objects that exist in perception but have no real-world counterpart, so to impossible spaces confront the affective body with stimuli that defy the everyday Cartesian experience of space. Analogous to the Penrose stairs in M.C. Escher's *Relativity* (1953), impossible spaces are designed to resist the nonconscious form-giving properties of perception but maintain the perspective of being *inside* that non-Euclidean[25] space. Horsthuis' 3D fractal artwork, such as *The Cryogenian*, *The Machine*, and *Emergence VR*, present the VR user with an algorithmic landscape constituted of Menger cubes, Mandelbulb sets, and other three-dimensional fractals that befuddle the Gestalt principles of convergence, interposition, linear perspective, parallax, and perceptual consistency, which help the

[25] Non-Euclidean geometry is two-dimensional plane geometry on a three-dimensional curvature. The most distinguishing property of non-Euclidian geometry from the everyday Euclidean geometry used in architecture regards parallel lines. In Euclidian geometry, parallel lines are characterized as a single line that intersect at a single point, but given the nature of the curved plane, such lines may not remain parallel, such as those drawn on the surface of a sphere (Coxeter, 1998).

affective body perceive distance and size (Wade & Tavris, 2014, p. 193-195). Fractal art, by its mathematical nature, is symmetrically recursive *ad infinitum*, exhibiting the same geometrical patterns no matter how much "closer" the viewer approaches the object. Consequently, one of fractal art's greatest contributions is that is challenges the hegemony of the linear perspective in art and science (Garousi & Kowsari, 2011, p. 222).

Unlike the human topographical experience of traversing space toward faraway objects and landscapes reveals more perceptual details about their distances and sizes, the human encounter with the inhuman fractal terrain like that of Horsthuis' fractal artwork can be characterized as a confrontation with mathematical infinity. Horsthuis' *The Cryogenian* takes the spectator through a computer-generated, abstracted landscape of enormous stone-like Mandelbulb sets in which space itself becomes unstable as distances and sizes appear to evade assessment, as if one were observing a distant mountain range on a horizon that grew bigger and farther away simultaneously. "Fractal pieces depict a restricted area of a fractal with a degree of magnification the amount of which would not be clear to the observer. The spectator cannot understand where he or she is with regard to what he or she sees" (Garousi & Kowsari, 2011, p. 224). Coupled with virtual reality technologies, fractal art resists the affective body's usually reliable application of Gestalt principles in its attempt to form a cohesive circumambient spatial model. The sensorimotor system has evolved to detect certain patterns as fundamental elements for constructing a perceptual model of space, such as determining distance by the apparent convergence of parallel lines and the understanding that faraway objects may be obscured by atmospheric effects (Wade & Tavris, 2014, p. 195-6). For the VR participant of *The Cryogenian*, the edges of the Mandelbulb sets converge on a vanishing point infinitely far away and without any stable frame of reference. The observer's perspective is situated on a perspectival plane so that as the observer travels across the symmetrical yet fragmented landscape, the magnification of the three-dimensional fractals increases but their distances and sizes cannot be assessed confidently.

Just as the affective body is unable to reconcile itself perspectivally with Lazzarini's distorted skulls, the affective body insists on the modalities of embodied perception to make sense of the impossible space of Horsthuis' *The Cryogenian*. Movement necessitates any assessment of the distance and size of the Mandelbulb sets, and since the retinal disparity is slight between the left and right eyes' overlapping field of views (i.e., convergence), these fractals appear at enormous scales to the participant's frame of reference. The rendered atmospheric effects—the texture of the smaller Mandelbulb sets appears hazy and more uniform—suggest that these objects must be miles away and therefore huge, yet the affective body cannot discern if this is a scale of miles, leagues, or even astronomical units. In most virtual reality headsets, these fractal objects appear the scale of mountains; however, in a dome theater, such as La Société des Arts Technologiques' 42-foot high Satosphere capable housing 350 spectators under a 360-degree spherical projection powered by eight video projectors and 157 speakers ("Satosphère," n.d.), the Mandelbulb sets in *The Cryogenian* appear celestial in distance and size[26] to the spectators lying on their backs: This significant difference of scale in the Mandelbulb sets is predicate on the only available point of reference to measure distance and size for the observers, which is roughly the interpupillary distance of the spectator in the former (i.e., the stereoscopic display of the VR headset) and the nearly 60-foot diameter of the dome theater floor in the latter. The participant's encounter with the colossal three-dimensional structures floating in space is akin to hallucinations or dreams, but with more lucidity. Abstractions like infinity, immensity, and complexity stir corporeal responses as the affective body responds to *The*

[26] In fact, Horsthuis' title suggested that the fractals may be glacial in nature, as the Cryogenian Period marks the age of the most extensive ice age in Earth's geological history, circa 720-635 million years ago when glaciers may have reached the equator (Shields-Zhou, Hill, & Macgabhann, 2012).

Cryogenian by devoting more neurological resources to overcome this uncertainty, resulting in the participant's reckoning of her own affective registers being triggered.

In addition to perceiving the non-Euclidean space of *The Cryogenian* via proprioception and tactility, the affective body struggles with the impossible space temporally as each moment approaching a three-dimensional fractal seems to defy the usually spatial logic of magnification, resulting in the affective body devoting more neural resources to "figuring out" distance and size in the perceptual model. In the natural world, discerning distance and size can be a sequential phenomenon as the affective body awaits and anticipates each sensory update gained from moving closer or obtaining a different perspective, having more light being cast on an object, or the accompanying sensory information—or the lack thereof: Perspectival cues, such as miniscule retinal disparity, the inability to discern finer details in the object's texture, and the fact that an observer cannot hear anything from the object's movement, allows her to deduce that a car speeding across the horizon is faraway rather than tiny and near. She may not be able to assess distance and size upon initial glance; she may need a moment or two to mentally map trajectory and speed, for example. Horsthuis' *The Cryogenian*, however, undermines the affective body's temporality by prolonging this expectation that additional sensory information will help complete the perceptual model. The Mandelbulb sets are infinitely recursive, so they will always appear farther and larger than previously discerned a moment ago. Despite the Mandelbulb sets' complex appearance, the human observer eventually feels as if they have been trapped temporally on a Möbius strip[27]: bounded to an infinite loop of one dimension with each lap seeming to undermine the preceding model of scale.

Horsthuis' *The Cryogenian* succeeds at highlighting how new media experiences with virtual reality technologies have the potential to expose the operational mechanisms of presence when the

[27] Incidentally, the symbol for infinity is the lemniscate, which is the same figure-8-shape as the Möbius strip.

affective body struggles to ascertain this paradoxical spatial model, thus providing opportunities for further researcher that will hopefully lead to a better understanding of how designers and developers can create more compelling experiences of presence. However, intense experiences of presence are not confined to contemporary virtual reality technologies, as there is a long history in art and media that have adapted immersive strategies for inducing presence in the creation of mediated space. The power of mediating spaces lie in great part on the ability of the participant to "carve out" these spaces through technologically mediated gestures, postures, and locomotions: Space is experienced differently whether one is standing or lying down, walking forward or backward, swinging arms widely or curled in a fetal position, beckoning with open palms or warning with fists. Although their cultural meanings may be widely different, spatial schemas carry symbolic meaning for the affective body because of human beings' shared anatomy (Birdwhistell, 1970; Tuan, 2011) and reveal a kind of metaphoric axis or orbit that the affective body follows to instantiate circumambient space. In addition to experiencing degrees of affective intensity and dimensions of distal attribution, presence as a mediated perceptual event must also possess a third property that is characterized by *directionality*, affective trajectories determined by biology and culture, in which the affective body can travel along to evoke sensations of presence by giving space its "materiality" via the human body. With the affectivity as the operational mechanism driving presence, the movement makes the space. The role of spatial schemas and their connection to the human body as an instrument and survey tool for space is taken up in the next chapter.

5. AN AFFECTIVE SPATIAL SCHEMA FOR THE AFFECTIVE BODY

This chapter concludes the theoretical framework for the affective body and presence introduced and explicated within the two preceding chapters with an investigation into the role of spatial schemas in shaping experiences of virtual space within an affective dimension. The affective body organizes space according to a set of schemas centered on the anatomical positioning and relativity of human bodies in shared spaces. The aim of this chapter is to synthesize these spatial schemas into a single, referential schematic—introduced as the Affective Spatial Schema—that provides the theoretical support for the research by identifying several schemas popularized in virtual reality applications that influence the gestures, postures, and locomotions bodies perform while enacting virtual space, which is explicated in the final chapter with a discussion of the study's findings. The spatial schemas identified here are greatly informed by Yi-Fu Tuan's work in humanistic geography in which he identifies the two primary factors that influence the human organization of space: the anatomical structure of the human body and the distance between these human bodies (Tuan, 2011, p. 34). Tuan (2011) points out that although cultures around the globe "differ in how they divide up their world, assign values to its parts, and measure them," the shared anatomy of the human body seems to be a principle organizer of "humanly construed space" and the instrument by which we measure direction, location, and distance (Tuan, 2011, p. 34-35; 44). The final task in outlining a theoretical framework for presence begins with investigating how the affective body categorizes space and time according to anatomical, physiological, and biological processes that govern the living body, and the impact these processes have on presence. Although studies demonstrate that spatial representation and spatial codes are employed by animals, such as ants and rats for path integration (Roberts, 2001, p. 24-25), in humans such spatial schemas can provide structure to memory, communication, and reasoning—a significant cognitive aid for abstract thinking (Gattis, 2001b, p. 2). From da Vinci's *Vitruvian Man* (1490) to *Ayurvedic Man*

(1800), the presentation of an erect human body with face and palms facing forward, feet planted shoulder-width apart, has been a popularized anatomical position for depicting the thinking, bipedal human, at least in the tradition of Western art (Gylys & Wedding, 2017, p. 47; Snyder, Conner, & Lorenz, 2007, p. 4; Tuan, 2011, p. 37). Tuan's schema (Tuan, 2011) underscores the self-referential properties of the body to act not only as a ruler and compass in the organization of space but also as a theodolite by which the body surveys space, making for an ideal baseline for this investigation into affectivity, movement, and presence. Analogously, most humans possess the faculty to contract the zygomaticus major and minor muscles of the upper lip (Seeley, VanPutte, Regan, & Russo, 2011, p. 326, Table 10.2) into an expression commonly interpreted as a smile, but the reading of the smile is through the lenses of an irreducible amalgam of cultural values, personal experience, and context; likewise, these schematics for the affective body are anatomically possible for many human beings[28], but their readings can be highly individualize. The following sections identify common, but by no means universal, values assigned to these spatial schemas and is intended as a primer, not a comprehensive list, of commonly associated assigned values. The significance in these spatial schemas lies not in the fact that they are expressed so diversely across the species, but rather that they exist with any congruity at all, indicating that these spatial schemas are not simply spatial metaphors but possible mechanisms for abstract thought itself (Gattis, 2001b, p. 7). Disclaimers aside, the values identified here can further assist efforts to reach a better understanding of how affective spatial schemas can shape perception of virtual space by proposing a third dimension to presence that characterizes the "routes" the affective body travels in the enaction of space, names here as *directionality*.

[28] The author recognizes that the human body comes in many shapes and sizes and, perhaps with the arguable exception of many identical twins, each body is unique and valued in its own right. Although the human body conceptualized in this framework is that of a body with two arms, two legs, and full faculty of its senses, this abstract schematic should not be inferred as a value statement: whether a body has fewer or more than four appendages is not so much the point as that all bodies are endowed with these affective spatial schemas by virtue of being living, breathing bodies.

5.1 Spatial Schemas as Structures for Abstract Thought

Until the need for more accurate measuring devices, the human body fulfilled a primary role in qualitative measurement. Traditional folk measurements for length, capacity, and time were inspired by parts of the body (Tuan, 2011, p. 45-50) and reflect the central role of the body as a shared point of reference for many every-day measurements before standardization. Folk units of length, width, height, depth, and distance are measured with the spans of hands or the reach of limbs for measurements shorter or smaller than the human body, but larger or farther measurements are made with the time or distance of a walking human (Tuan, 2011, p. 45). English alone is filled with terms denoting informal units of measurement, evidence of the deep linguistical and cultural associations between the human body and spatial awareness. Mass, volume, and weight, while certainly referenced against natural objects (e.g., eggs, stones, and horses) (Tuan, 2011, p. 45), have corresponding bodily folk units regarding capacity, a useful measurement for calculating food storage or labor, as evident in language, such as *mouthfuls*, *handfuls*, and *armfuls*. *Shoulder-height* is the distance from ground to shoulder, but *shoulder-length* is the length from the crown to the shoulders. Some folk units for measuring length, for example, remained in circulation long enough to be given more formal units of measurements, as evident by a small sample of folk measurements appearing in Table 5.1. below from the *Oxford English Dictionary* (2019). Such subjective, yet shared, spatial demarcations give some credence to Protagoras' declaration[29] that "man is the measure of all things" (Aristotle & Kennedy, 1991, p. 210). However, as Tuan hypothesizes, there is a noticeable lack of bodily measurements for the calculation of area, likely due to its more abstract nature than length, capacity, or time (Tuan, 2011, p. 46), and so other standards were created, not surprisingly, with references to agriculture: one unit of *cow's grass* equals the amount of land required to support one

[29] Protagoras' declaration essentially placed humans in the center of the universe, which was a direct challenge to Socrates and Plato's notion of absolutism (Craig, 2005, p. 802-803).

cow in Ireland (Kelly, 2012, p. 16); an *acre* is the area of land that can be tilled in one day with an ox in England ("Acre," 2019, Def. 2.a.); a *morgen*—literally German for "morning"—denotes the amount of land one person can till with a single horse or ox dragging a plough during daylight ("Morgen," 2019, etymology). Although these folk measurements are intended to estimate plots of land, they connate a temporal dimension as well, namely, the duration from sunrise to sunset.

Spatial structures are also applied to temporal reasoning. Most life on Earth has evolved circadian rhythms to the day-and-night cycle and will maintain these rhythms even if exposed to conditions of everlasting light or darkness (Bhadra, Thakkar, Das, & Bhadra, 2017), underscoring the role of internal biological clocks in the experience of time. The affective quantifying of time, therefore, reflects these natural, rhythmic biological processes of the human body. Like folk units for measuring space, the body provides a shared reference point among human beings. Short intervals can be measured in heartbeats and breathes, while the longest stretches of time can be measured by the lives of children or death by old age; menstruation cycles, the length of human gestation, and even all of childhood (i.e., a generation) can stand for informal units of measure. Temporal reasoning can be metaphorized as *ego-moving* schema in which the speaker moves through time; contrarily, time can also be expressed as a river in which time moves, rather than the observer, from the future to the past, known as a *time-moving* schema (Gentner, 2001, p. 203). Both schemas can be reflected in language, such as "I am approaching the deadline" for the former and "The deadline is approaching" for the latter, and are oriented along a front-back axis, which suggests that these spatial schemas allow for a "mapping" that organizes temporal reasoning (Gentner, 2001, p. 205).

Table 5.1. A sample list of standardized folk units. All *Oxford English Dictionary* (2019) references point to each unit's entry in the dictionary.

Unit	Measurement	Description	OED Reference
Thumb	Length	Breadth of a finger ~ I inch	Def. 4.
Finger	Length	Breadth of a finger ~ 3/4 of an inch	Def. 2.a.
Hand	Length	Breadth of a hand ~ 3 inches	Def. 9.
Foot	Length	Breadth of the middle toe to the heel ~ 12 inches	Def. III.6.a.
Cubit	Length	Breadth of the tip of middle finger to the elbow ~ 18-22 inches	Def. 2.
Fathom	Length	Span between two outstretched arms ~ 72 inches	Etymology (Old Saxon, Old High German, Old Norse); Def. 2.a.

This implementation of the human body as an instrument of measurement for space and time reflects the importance of the human body as an organize of space. This segmentation of space according to human anatomy is more than a convenient ruler; it is the manifestation of the spatial structures employed by the affective body that organize abstract thought. The affective body experiences the world according to spatial schemas, anatomical references that orientate the affective body and imbues value and meaning to spatial properties. To better identify the values that are associated with these spatial schemas, and to reach a better understanding of presence, the theoretical framework for presence is heavily influenced by the work of developmental psychologist and cognitive scientist Merideth Gattis who has written extensively on the adaptation of spatial schemas for structuring abstract thoughts, which help organize cognitive acts according to spatial properties (e.g., sequence, opposition, spatial arrays, and proximity) not inherent in the abstraction itself (Kita, Danziger, & Stolz, 2001, p. 118; Tversky, 2001). Although it has been well established that animals construct cognitive maps of their spatial environments[30] (Roberts, 2001), Gattis proposes that *Homo sapiens* have evolved mechanisms that map spatial structures onto non-spatial concepts (Gattis, 2001b, p. 6-7), which aid the organization of abstract thought and evolutionarily

[30] Roberts outlines multiple studies involving birds, dogs, and rodents that infer animas use multiple landmarks for navigation and can intuit shortcuts between points, but not all animals (e.g., rats) appear to form topological maps of their environments (Roberts, 2001, p. 16-23).

beneficial to three specific cognitive acts: the spatial structuring of memory, communication, and reasoning (Gattis, 2001b, p. 2).

5.1.1 Spatial Schemas to Structure Memory

Memory can be deeply intertwined with place, as evident in the trigger of memories when we visit a childhood neighborhood, and spatial schemas are even used as memory aids, such as the method of the loci used since the ancient Greeks (Gattis, 2001b, p. 3; Legge, Madan, Ng, & Caplan, 2012, p. 3; p. 380). Items arranged in a linear array, for example, can be better recalled than those without spatial configurations (Gattis, 2001b, p. 3-4), and items organized isotropically in a directional relation (e.g., X > Y, Y > Z) are easier to remember than those same items sequenced heterotropically (e.g., Y > Z, X > Y) (McGonigle & Chalmers, 2001, p. 248). The *symbolic distance effect*, which states that the reaction time to assess the magnitude of two symbols is inversely proportionate to the differences between the symbols' relative sizes (Moyer & Bayer, 1976), is also reflected in working memory[31] as a spatial schema to organize non-spatial abstract ideas along a one-dimensional continuum that accounts for qualitative differences in terms or "more" or "less" (McGonigle & Chalmers, 2001, p. 249). In other words, abstract thoughts are subject to a linear ordering organized on "comparative size judgements" that "are derived from core design primitives which are neither spatial or linguistic in nature," which McGonigle and Chalmers argue is the foundation for an "effective inductive mechanism" that aids working memory in recalling multiple items in sequence (McGonigle & Chalmers, 2001, p. 251). This relational, serial coding found in the symbolic distance effect allows for quick reaction times in recalling items by establishing a linear, asymmetrical organization[32] (McGonigle & Chalmers, 2001, p. 254, 260).

[31] In cognitive psychology, working memory refers to a type of short-term memory in which transitory information is retained for manipulation ("Working Memory," 2019).
[32] Interestingly, by the age of four, children appear to privilege spatial vectors (i.e., verticality) in spatial search performances, suggesting that children younger than this age had yet developed spatial schemas to aid them in systematic spatial searching (McGonigle & Chalmers, 2001, p. 271).

5.1.2 Spatial Schemas to Structure Communication

In addition to memory, spatial schemas have also provided structures that permit the communication of more complicated relations between thoughts, often organized in a binary or duality that positions two ideas, characteristics, or qualities in opposition (Gattis, 2001b, p. 4). As Campbell noted (Campbell, 1973, p. 281), a reoccurring theme in many creation myths begin with the One breaking into "contradictory planes of being," often subdivide into more elemental segments (Tuan, 1990, p. 16, 20-23). These creation myths signal an ancient, deep spatial relationship with spoken language, symbols, and writing and the spatial structuring of communication and social values: good v. evil, light v. darkness, sacred v. profane (Gattis, 2001b, p. 4; Tuan, 2011, p. 34-44). These value-laden dichotomies are expressed symbolically through social behaviors that privilege one side of the dichotomy over the other. For example, the asymmetry of the body along the right-left axis is recognized in many cultures as a binary between good (the right side) and evil (the left side), thus the right-side of the body becomes associated with the sacred, the powerful, the legitimate, while the left-side signifies the profane, the weak, and the illegitimate, and reflected symbolically in practices, such as reserving the right side of the host for the guest of honor[33] (Tuan, 2011, p. 43). These spatial schemas are reflected in language as well. Gentner and others observe that notions of time are widely metaphorized spatially in which the future and past are expressed with one-dimensional modifiers exempli gratia *front/back* for *before/after*, respectively, rather than *narrow/wide* or *shallow/deep*, which infers a two- or three-dimensional conceptualization of time (Gentner, 2001, p. 203). The spatialization of time is further evident in the use of prepositions, Gentner continues, as in "*at* the store" and "*at* sunset"; "*from* here *to* there" and "*from* tomorrow *to*

[33] As a reminder that although the major spatial schemas discussed in this chapter appear in nearly all cultures, they are in fact not universal or necessarily imbued with the same values. Tuan points out that in traditional Chinese culture, the honorable and masculine is the left side, an exception likely originating in a unique cosmology that orientates a divine ruler southward and consequently orients the sunrise to his left (Tuan, 2011, p. 44). Moreover, the Mopan, a Mayan community in Belize, do not express the usual distinction between the right and left axis, despite their linguistical similarity to the Yucatec, who do express these common spatial demarcations (Kita, Danziger, & Stolz, 2001).

the day after"; "*through* the hallway" and "*through* the month" (Gentner, 2001, p. 203). In American Sign Language, signers can express the future as existing "ahead" or "in front," the present as occupying the same location as the signer, and the past as "behind" the signer: For example, the lexical sign for *tomorrow* and *yesterday* are morphological variants differentiated by anteriorly or posteriorly gestures (i.e., the future and the past, respectively), while *today* is an emphatic downward motion (i.e., the present as the co-location of the signer) (Emmorey, 2001, p. 156-158). Further studies support the *system-mapping hypothesis*, which postulates that there exists in part an analogous structure to time as found in space in which "representational structures of the domains of space and time are aligned, and further relations connected to the base system are projected as candidate inferences from the base domain (*space*) to the target domain (*time*)" (Gentner & Markman, 1997; Gentner, 2001, p. 216-217). Under this hypothesis, this mapping can be expanded incrementally to introduce new structures to "existing systems of correspondences"[34] (Gentner, 2001, p. 217). However, the structuring of time is not solely a spatial domain, and more likely that this structural mapping began as analogies between perceived relational similarities between normally unlike ideas, which led to a gradual expansion of the mapping via inference (Gentner, 2001, p. 218).

5.1.3 Spatial Schemas to Structure Reasoning

This incremental mapping, Gattis posits, greatly benefited the cognitive act of reasoning "because the structure provided by a spatial schema, combined with partial knowledge of a set of elements and relations between them, allows us to infer the elements or relations that are unknown" (Gattis, 2001b, p. 5). This spatial structuring of cognition is capitalized in graphical displays, such as menus, tables, and line graphs, to organize information nominally, ordinally, and sequentially to aid in memory, provoke interest, and, perhaps more importantly, encourage inference and

[34] Evidence suggests that there is an asymmetry to the space-time system mapping hypothesis, as subjects were able to comprehend time with spatial metaphors but not space with temporal metaphors (Boroditsky in Gentner, 2001, p. 218).

discover new relationships (Tversky, 2001, p. 79, 109**)**. Proximity, a spatial property, is applied as an organizing principle to displaying information in an array or matrix to help in making spatial inferences (Tversky, 2001, p. 109) to those things which have no spatial properties. This incremental scaffolding of inference, over time, allowed for even vaster mapping structures of other abstract thoughts that had no inherent spatial properties but nonetheless found utility in the Gestalt principles of proximity, grouping, and similarity in the inferences of non-spatial properties, such as spatial representations of data (Tversky, 2001, p. 89, 92-93). New inferences, and therefore new meanings, could be made.

However, the establishment of meaning between abstract thoughts and their representational spatial schemas, as Gattis argues, is governed by four cognitive constraints: iconicity, associations, polarity, and structural similarity (Gattis, 2001a, 224-235). These constraints reflect "an identifiable category of mapping patterns defined by a certain type of similarity between the represented concept and the spatial representation in which it is communicated" (Gattis, 2001a, 224). Icons are symbols or pictograms that have some semblance to the objects that they represent; this resemblance, therefore, constrains the interpretations of those spatial relations (Gattis, 2001a, 224). *Iconicity* is prevalent in the understanding of maps, as lines, colors, and shapes become representations for roads, water, and cities (Gattis, 2001a, 225; Liben, 2001). This iconicity-constraint, as Gattis notes, aids reasoning with the capacity to compare qualities and relations between objects, but is less effective in representing abstract ideas, such as luminosity and temperature (Gattis, 2001a, p. 225). As the relationship between icons and their objects grew more complex, pictographs evolved as well, developing *associations* between representations with more abstract attributes rather than the objects themselves (Gattis, 2001a, p. 225-226). In spatial representations, often an increase in quantity is associated with an increase in size or occupies a higher position on the vertical axis than "smaller" quantities, spatial associations formed from previous experiences (Gattis, 2001a, p. 226-227). A third constraint to these spatial mappings does not rely on the perspectival resemblance of icons or the meaning-by-experience of associations, but rather a "organizational structure underlying many perceptual and conceptual dimensions" (Gattis, 2001a, p. 227). *Polarity* organizes concepts in opposing, *asymmetrical* binaries, a continuum reflected semantically in many parts of speech: Unmarked terms are usually etymologically older and carry positive connotations compared to their younger marked terms, which have negative connotations (e.g., *bound/unbound*, *correct/incorrect*, *understand/misunderstand*, *interested/disinterested*, *regular/irregular*, *pure/impure*, etc.) (Gattis, 2001a, p. 228). This polarity is further evident in studies that reveal that young children organize achromatic color and loudness according to size (i.e., darker grays and louder tones were organized as "bigger" than lighter grays and quieter tones), but as they grow older and acquire language, they employ less perceptual organization and more linguistical organization (i.e., *light* and *dark* move away from polar organizations of *big* and *small*), which suggests the existence of perceptual and linguistic polar structures that facilitated cross-dimensional mapping based on likenesses in grammatical valence and directionality (Gattis, 2001a, p. 228-230, 231). The final constraint, *structural similarity*, maps representations to relational structures rather than perceptual semblance (iconicity), attributes or properties (associations), or comparative values (polarity) and allows for the "pairing of elements to elements, relations to relations, and higher-order relations to higher-order relations" (Gattis, 2001a, p. 231). This structural mapping is revealed in Gattis' experiments in which participants were first taught the meaning of a few simple gestures (via diagrams) of artificial signs and then asked to infer meaning from new gestures (Gattis, 2004; Gattis, 2001a, p. 232). Results revealed that participants followed similar organizational structures for object-mapping and relational-mapping in the acquisition of this artificial sign language: Inference privileged ipsilateral gestures for objects (e.g., body parts maintained their signifiers on the same axis or plane in the interpretation of new gestures) but maintained contralateral gestures for relations (e.g., verbs preserved their signifiers in relation to the body parts) (Gattis, 2001a, p. 235-236). These experiments suggest that participants assign conceptual elements to physical objects and conceptual relations to physical relations when introduced to new spatial schemas (Gattis, 2001a, p. 238), a structural similarity-constraint that allows the mapping of abstract thoughts hierarchically via spatial schemas (Gattis, 2001a, p. 242). Thus, space itself is a "ready-made tool for reasoning, using that tool involves going beyond the information given" (Gattis, 2001b, p. 9), as evident in the fact that we can infer meaning from symbols, pictograms, and other spatial representations "without specific instruction…by establishing correspondences, or mappings, between concepts and space. These correspondences are based on similarity between aspects of the spatial representation and aspects of the concept being represented" (Gattis, 2001a, p. 244). Studies further suggests that children map spatial schemas to reasoning as well, specifically inferring first-order relations from the height of a line and second-order relations from the slope of a line (Gattis, 2001a, p. 245).

Taken together, iconicity, associations, polarity, and structural similarity constrain the incremental mapping of abstract thought as we draw meaning from inference gained from spatial organization. The adaptation of spatial schemas to structure abstract thought brought a significant cognitive advantage, succinctly summarized by McGonigle and Chalmers:

> "Placing of logical/linguistical objects along an imagined spatial dimension, for example can provide a convenient spatial bridge between logical arguments, and allow for a variety of relative judgements to be made without requiring retention or co-ordination of the logical arguments which informed the subject in the first place." (McGonigle & Chalmers, 2001, p. 275)

As mentioned previously, the application of spatial schemas to abstract thought is perhaps best exemplified with seriation, as Gestalt-like principles aid in the conceptualizing of time, number, and order (Gattis, 2001b, p. 9, referring to Roberts, same edition), suggesting a deep structural conceptualization that goes beyond a metaphor and closer to an operational mechanism that enables the development of new concepts (Gattis, 2001a, p. 275). Spatial schemas facilitate abstract thought by providing an organizational structure based on spatial properties, such as proximity, continuity, symmetry, and similarity, which themselves are grounded in the conceptualization of the human body as a surveyor of space: The human body becomes the means by which space is segmented, ordered, and arranged according to asymmetrical, binary orientations. As such, these spatial relations became laden with values that we map onto other cognitive acts and influences the very experience of space itself. The next section investigates spatial schemas that have wide cultural purchase, providing the theoretical framework necessary to reach a better understanding the intersection of presence, directionality, and the affective body.

5.2 Mapping Meaning to Spatial Schemas

Marcel Jousse, French anthropologist and Jesuit whose ideas on gestural communication have become seminal for oral studies (Sienaert, 1990, p. 91-92), noted that the bilateral structure of the human body is the primary determiner for how we divide space along three primary spatial schemas[35]: front-back, above-below, and right-left (Sienaert, 1990, p. 96), a division also recognized by Tuan (Tuan, 2011, p. 37-44) and echoed by Lecoq (Lecoq, 2006, p. 5). Obviously, the human body has not evolved symmetrically. Our primary methods of locomotion propel us forward; consumption is carried out in the upper half, but bodily fluids are expulsed in the bottom half; and most people are right-handed (Llaurens, Raymond, & Faurie, 2009, p. 881-2). Our own anatomical structures prevent us from experiencing space symmetrically, a disequilibrium that influences the value we assigned to these spatial divisions. To reiterate, as Tuan (2011, p. 34) reminds the reader

[35] These spatial schemas correspond to the three anatomical planes, which perpendicularly intersect one another as the body assumes the anatomical position: the *frontal* or *coronal plane* (i.e., the x-plane), the *transverse* or *horizontal plane* (i.e., the y-plane), and the *sagittal plane* (i.e., the z-plane) (Gylys & Wedding, 2017, p. 47-48; Snyder, Conner, & Lorenz, 2007, p. 9-10).

that although many cultures organize space along these schemas, the values and meaning they assign to them are shape by an individual's culture and personal experiences, and that no two people see the same space (Tuan, 1990, p. 5). Birdwhistell, the anthropologist who pioneered the field of kinesics, is more full-throated in his warnings to researchers interpreting the social meaning of gestures and body motions:

> There is no body motion or gesture that can be regarded as a universal symbol…not only can we dispense with so-called "natural" gestures as being single-culture bound, but we can be prepared to discover that the methods of organizing body motion into communication behavior by various societies may be as variable as the structures of the languages of the societies. (Birdwhistell, 1970, p. 81)

Even though languages may differ widely in syntax, phonemes, and grammar, human bodies share anatomical structures, such as the morphology of the pharynx and larynx (Conroy, 1997, p. 180-181) as well as the Broca's region of the brain (Conroy, 1997, p. 261), specifically for speaking (Conroy, 1997; Holloway, 1967), which governs communication practices—even if the values and meaning of that communication is culturally and individually based. Like the isolated emergence of sign languages in different cultures around the world, gestures and motions are deeply intertwined with communication and demonstrate "the same kinds of grammatical machinery found worldwide in spoken languages" even if the linguistic and kinesic systems are different from their mother tongue, as in the case of American Sign Language, which uses number and gender systems more akin to Bantu and Navajo than British or American English (Birdwhistell, 1970, p. 113; Pinker, 1994, p. 36). Spatial schemas provide structures in which non-spatial concepts (e.g., social class, sacredness, and profanity), are organized according to spatial properties (e.g., size, shape, balance, constancy, spatial relations, and population) that imbue the experience of space with meaning. This section identifies six popular spatial schemas and their connotated values in hopes to reach a better understanding of how spatial schemas influence the affective body's perception of space. As these spatial schemas are referents to the anatomy of the human body, it is important that an investigation into directionality and presence begins with the anatomy of the human body demarcates divisions of space and their associated meanings. The first three spatial schemas are termed the *primary spatial schemas* as they are more fundamentally rooted into the anatomical divisions of the body and have the widest cultural currency, reflecting primarily values spatialized in size, shape, and balance; the remaining schemas are termed the *secondary spatial schemas*, as they are organized primarily according to the body's relation to a second external reference point in space. This analysis of the human body spatial schema also addresses spatial properties that transcend all schemas and greatly influence the values and symbolic meaning attributed to the spatial schemas.

5.2.1 Three Primary Spatial Schemas

The three widely adopted spatial schemas are adapted from the three primary axes of the upright human body assuming the anatomical position: a *front-back schema*, an *above-below schema*, and a *right-left schema* based on the coronal (frontal) orientation, the transverse (horizontal) orientation, and the midsagittal (median) orientation, respectively (Gylys & Wedding, 2017, p. 47-48). These spatial schemas and their spatial properties, rooted in the orientation of the body as it stands upright in three-dimensional space, impregnate meaning and structure to the experience of space itself. It is worth repeating that these schemas, although evident in many cultures (Birdwhistell, 1970; Gattis, 2001a; Gattis, 2001b; Iliev, 2014, p. 128-135; Lecoq, 2006, p. 5; Sienaert, 1990, p. 96; Kita, Danziger, & Stolz, 2001; Tuan, 1990; & Tuan, 2011), are not universal, and that they merely provide a starting point into further investigations on the intersection of presence and directionality.

5.2.1.1 Front-Back Schema

The human body clearly places primacy on forward-facing, as is evident in morphology of bipedalism[36] (Conroy, 1997, p. 205-227) and the orientation of the eyes, nose, and mouth. Recognition of the human face is likely perceived according to Gestalt principles (Homa, Haver, & Schwartz, 1976; Sagan, 1977, p. 72-73) and etymologically associated with the word *front* ("Front," 2019, Def. I.1.a.). Unlike the ears that can detect stimuli in all directions, the eyes have evolved to operate within a restricted field of view approximately 190 degrees for stationary eyes and around 290 degrees if the eyes move (Howard & Rogers, 1995, p. 32), as binocular vision plays an important role in judging distance, size, and speed in three-dimensional space (Braddick, 1982, p. 192; Tuan, 1990, p. 7). In contrast, this 70-degree gap in our visual field creates a dark side of vulnerability. To walk backwards is unnatural—to run backwards anatomically impossible—and a maneuver commonly executed when we do not want to turn away from something. Thus, the space experienced before the body is distinguished from the space experienced behind the body (Tuan, 2011, p. 40). The body privileges sight[37] and a forward-facing orientation, as it can perceive far more information about its environment (Tuan, 1990, p. 6). Afterall, as Tuan observes, the reach of human vision[38] is greater than of the other senses, as humans can see distant objects on a horizon

[36] There are two basic biomechanical principles that govern the morphology of bipedalism: the body's center of gravity must be low enough to balance the body when standing erect and in mid-stride, and the lower appendages must be able to move swiftly through a wide arc in order to provide the necessary propulsion to maintain locomotion (Conroy, 1997, p. 206). Fossil evidence for bipedalism is found in early australopithecines dating 3.5 million years old (Mithen, 1999, p. 204), which predates the appearance of human fossils and reminder that walking is not an evolutionary mechanism exclusive to *Homo sapiens*. Although there are several behavioral theories for the evolution of bipedalism (Conroy, 1997, p. 227), a likely theory lies in australopithecines' exposure to more thermal heat as their East African environments transformed from forests to savannahs: An upright posture exposed less skin to solar radiation, and walking was more energy efficient than quadrupedalism, both evolutionary adaptations that likely benefited from australopithecines' upright posture, itself an adaptation from moving through an aboral environment (Peter Wheeler in Mithen, 1999, p. 204).

[37] Humans' dependence on vision as one of the primary senses is probably a legacy of our arboreal heritage, as it is more important to see in the dense foliage of the rain forest than to possess a keen sense of smell; additionally, among mammals, humans and primates are particularly adept at discerning static objects and see in color, adaptations useful for finding the colorful fruit of the rain forest (Tuan, 1990, p. 6-7).

[38] Tuan warns that even though humans possess similar sense organs, their development and attitudes about their environment begin at an early age, such as a sensitivity to wind direction (Tuan, 1990, p. 12).

that escape detection from the other senses (Tuan, 1990, p. 10). This spatial schema is reflected further in customs, symbols, and language: Individuals with greater social status are often places or situated in the front of a queue or assembly, while those with lesser social status follow or are in the rear; homes, Tuan points out, are often asymmetrical with distinguished fronts and backs (Tuan 1990, p. 27). To face someone can be an act of defiance; to bare one's bottom at someone can be act of profanity. The etymology of the word *front* traces it to an anatomical reference, the *forehead* ("Front," 2018), and the idioms "face your fears" and "turning your face away" both carry connotations of courage and shame, respectively. Our egocentric nature is "directionally biased": In many cultures this predisposition to facing forward takes on a temporal metaphoric value, as that which lies ahead of us is the future, and that which lies behind us is the past[39] (Gentner, 2001, p. 203; Tuan, 1990, p. 30; Tuan, 2011, p. 35).

5.2.1.2 Above-Below Schema

This attitude toward temporality is also structuralized in the vertical axis of the body in the anatomical position, as that which is above is privileged as the future while the past is conceptualized as below (Tuan, 2011, p. 35). This dichotomy is not surprising. As with the front-back orientation schema, the human body privileges one polarity over the other for the simple anatomical fact that a living, breathing human cannot survive without the upper half of a human body. Tuan finds that in many languages, "high" and "low" carry conations of *superior* and *inferior*, respectively, structurally reflected in cosmological myths (i.e., eternal salvation lies above, eternal damnation lies below), and further materialized in architecture (i.e., the height of monuments, temples, and pyramids reflects prestige) (Tuan, 2011, p. 37-38). Before our modern understanding of astronomical distances that place celestial objects as "out there," the stars, planets, and comets were conceptualized as "up

[39] In American Sign Language, lexical temporal signs contain morphological variants to signal the present, future, and past, such as forward-motion gestures to metaphorically refer to the future and rear-motion gestures to indicate an action in the past (Emmorey, 2001, p. 156-157).

there" to the Medieval mind (Tuan, 1990, p. 134). Tversky observes that this vertical asymmetry structurally parallels the fact that gravity dominates all things and therefore a fundamental organizing property of perception (Tversky, 2001, p. 99). Conceptualizations of quantity, Tversky points out, are associated with verticality because larger piles are perceived to be "higher," a structure also replicated in visual aids, such as bar charts, in which increase or addition is displayed as along a y-axis (Tversky, 2001, p. 99-100). Verticality, according to Tuan, becomes a symbolic stratification for transcendence and connected to an eternal cyclical conception of time (Tuan, 1990, p. 129). The structure conceptualizes that which is above us as sacred, powerful, supreme; the profane, dark, and fear situated spatially "below" us. Social status, progress, and power become conceptualized as a stratification from which one can "fall."

5.2.1.3 Right-Left Schema

Although less dramatic, the asymmetry of the right and left sides of the human body can be found in anatomical structures of the brain's two hemispheres as well as the asymmetrical displacement of the heart and the liver of the left and right sides, respectively (Tuan, 2011, p. 43). Most people are right-handed[40] (Tuan, 2011, p. 43). This asymmetry, as with the front-back and above-below orientation schemas, is further conceptualized as a binary between two opposing values: In many cultures, the right side is the privileged side for power and sacredness and the left side is associated with the weak and profane (Tuan, 2011, p. 43). Psychomachia in Christian iconography often depicts an angel on the right shoulder and a devil on the left; spilled salt, after all, is tossed over the left shoulder to blind the Devil (Hall, 2008, p. 42). The right hand is favorable to the left hand, as the former is active and holds the sword, and the latter is passive and bears the shield; for magicians in both Europe and Africa, the right hand was the way to "white" magic and

---

[40] The earliest evidence for righthandedness in the fossil record is found in the labial striations on the anterior teeth, dating to approximately 1.8 million years ago (Frayer, Clarke, Fiore, Blumenschine, Pérez-Pérez, Martinez,…Bondioli, 2016, p. 65), which obviously greatly predates the rise of modern humans.

other sacred actions, while the left is reserved for "black" magic and poison crafting (Biedermann, 1992, p. 283). However, here, a disclaimer is in order. Of the three major schemas, the right-left schema is easily the most unstable, as not only are there cultures that do not recognize such distinction, as in the case of the Mopan indigenous people of Belize (Kita, Danziger, & Stolz, 2001), but also many cultures do not or have not subscribed continuously to the conventional "right is good, left is bad" dichotomy, as in the case of traditional Chinese culture that equates the left side to positivity (Tuan, 2011, p. 44) or Hall's argument for a "turn to the left" during the Renaissance in which the left symbolized divinity (Hall, 2008). Nonetheless, the important matter is not so much the cultural values symbolized in the right or left sides, but rather the widespread utilization of the asymmetrical dichotomy as a symbolic spatial schema.

5.2.2 Three Secondary Spatial Schemas

In addition to spatial schemas organized according to the three major anatomical axes or planes of the human body, Tuan (Tuan, 1990; Tuan, 2011) recognizes three spatial schemas organized according to the human body's relative position to another object or place in space: *standing-lying schema*, *centrism-periphery schema*, and the *solitarity-solidarity schema*. The primary and secondary schemas can be classified as "spatial schemas" because they both can be organized in Cartesian space (i.e., the six spatial schemas can be mapped via coordinates); moreover, theoretical framework classifies the latter three spatial schemas as "secondary" not for any lesser quality or influence than the three primary spatial schemas, but because their organizing principles are predicated on an external reference to the body that may or may not be present—as juxtaposed with the three primary spatial schemas, which egocentrically references only the body itself. Like the primary spatial schemas, these secondary spatial schemas carry symbolic meaning and structure the experience of space along an asymmetrical continuum imbued with positive and negative values according to context; however, the secondary spatial schemas are organized according to the human body's spatial relation to the ground, the center, and other bodies, external reference points that possess widespread cultural significance. To repeat the disclaimer, the values of these spatial properties should be approached with the same caution as the previously mentioned spatial schemas regarding practice and corresponding values and are intended as first steps into exploring the underlying structure that influences the affective body's experience of space, and therefore the phenomenon of presence as well.

5.2.2.1 Standing-Lying Schema

If there is a hierarchy to the influence of the three secondary spatial schemas, the erect human being is probably at the apex. As few creatures are capable of bipedalism, the posture of a standing human being distinguishes *Homo sapiens* from most other animals in their environments. Here, the point of reference is the ground and resistance of gravity under the human body. A human can see farther and evade faster when standing, a posture associated with good health and a defiance against gravity, commonly characterized as "assertive, solemn, and aloof"; inversely, a human body lying prone is "submissive" (Tuan, 2011, p. 37), a sign of fatigue or illness and therefore defenseless. The supine human may reflect these qualities as well but can also be an indication of relaxation, and to some extent, a reflection of trust or an attitude of safety. These values are echoed metaphorically in English with the lexicon "stand": "take a stand" or "stand your ground" (i.e., remain steadfast); to stand "back," "aside," "down," (i.e., not interfere); "to let stand" (i.e., not disturb something); to "stand guard" or "stand watch" (i.e., vigilance)—in fact, idioms consisting of "stand" with a preposition or adverb are far too numerous to list here ("Stand," 2019), an indication that, at least in English, there strong connotations between vitality and a standing human being. Conversely, "to lie in prison" connotes captivity and misery and "to lie under" is to be disadvantaged ("Lie," 2019). Even one of the most abstract depictions of a human being, the stick figure, appear in the Lascaux Cave dating to 15,000 BCE and often is interpreted as lying down rather than standing (Stokstad & Cothren, 2011, p. 11).

5.2.2.2 Centrism-Periphery Schema

Tuan further identifies another spatial schema in which the structure itself is interpreted with meaning, which he calls "the prestige of the center" (Tuan, 2011, p. 38). Tuan argues that many cultures have or had organized space around a central point "with concentric zones (more or less well defined) of decreasing value beyond," geographically and cosmologically (Tuan, 1990, p. 27). Proximity influences attitudes and behaviors. The World Navel, Campbell tells us, lies at the center of the universe from which all other things spring forth, the point at which the dualities of Heaven and Earth touch and revolve around (Campbell, 1973, p. 40-42). The peripheral edges of the world are mysterious and dangerous—foreboding to some, a call to adventure for others—and resistant to being mapped and spatially organized[41]. Tuan recognizes two references points in the centrism-periphery schema that correspond to two deep-seated human traits, egocentrism (i.e., the individual as the center) and ethnocentrism (i.e., the tribe or homeland as the center) (Tuan, 1990, p. 30). "Egocentrism is the habit of ordering the world so that its components diminish rapidly in value away from self," but, as Tuan points out, rarely fully achieve as human beings depend on the help of each other to survive (Tuan, 1990, p. 30). More importantly for Tuan, ethnocentrism—a "collective egocentrism"—is the more prevalent trait and "probably necessary to the sustenance of culture," as many cultures historically have perceived themselves as the center of the Universe (Tuan, 1990, p. 30-32). Conceptually, the center is often a metaphorical structure that is predicated around a baseline, a common reference, or a point of origin, implying that the debasement of a non-spatial quality can be perceived as occupying a space "farther away" from the center: Proximity and

[41] "Here be dragons" is an anachronistic phrase referring to the common practice of populating the edges of the Medieval maps with monstrosities representing the unknown world (Ruitenberg, 2007, p. 8).

distance transcend their structure to become symbolic dichotomies of good and evil, normal and strange, and home and exile (Tuan, 1990, p. 16). The notion of a center also infers the notion of an edge or border, something that is enclosed with clearly demarcated boundary, and represented symbolically with the circle, perhaps the most popular and recognizable of all geometric symbols, as they are readily found in the Sun and Moon (Biedermann, 1992, p. 69). Geometrically, the center of a circle is equidistance from all points on the edge, a property that lends the circle to be associated with perfection, a value so attractive in its simplicity that it resists other conceptual models despite their undeniability, as exemplified in the belief of a geocentric model of the heavens and the refutation of the Copernicus' heliocentric model of the Universe (Sagan, 1980, p. 53); Galileo's rejection of Kepler's elliptical heliocentric model over the notion that the orbits of the planets *had to be* perfectly circular (Arnheim, 1969, p. 277); and the skepticism Hubble faced when his discoveries proved that the Universe not only stretched far beyond the Milky Way but also is expanding despite his thoughtful presentation of empirical evidence and theory[42] (Bartusiak, 2009; Hetherington, 1982, p. 43). On the quantum level, the circle is in the Rutherford-Bohr atomic model used to depict the relative "orbits" of electrons around a nucleus, an outdated model that still finds purchase in many high school textbooks (Weinberger, 2014, p. 3086). The affinity for centralism defines a spatial schema with a nearly universal reference point infused with vales that correlate to the proximity or distance from the center and profoundly shapes the experience of space.

5.2.2.3 Solitarity-Solidarity Schema

The third minor spatial schema introduced here is organized according to the relative proximity of human bodies sharing a given space and commonly reflects values of freedom and intimacy (Tuan, 2011, p. 59). Solitarity is a spatial property that symbolizes the values bestowed on a

[42] Ironically, Hubble's discovery of an expanding implies that every point in the cosmos is, astronomically speaking, the center of the Universe (Sagan, 1980, p. 262-264, 318).

single human body in a given space; on the other end of the continuum, solidarity denotes the values that are symbolized when many people occupy a given space. As with the standing-lying and centrism-periphery spatial schemas, context greatly determines which end of the spectrum is bestowed with positive or negative values with greater fluidity than the three primary spatial schemas. When one seeks meditation, a space devoid of other people may be preferred, but alienating a human being is sometimes a punitive act; when one is afraid, the safety of others may be reassuring, but too many people confined to a single space can generate feelings of captivity. Personal space, of course, is culturally determined, but the more important fact is that all cultures have spatial schemas that organize personal space and assign meaning and value to circumambient space according to anatomical orientations and positions (Birdwhistell, 1970; Gattis, 2001a; Gattis, 2001b; Iliev, 2014, p. 128-135; Kita, Danziger, & Stolz, 2001; Lecoq, 2006, p. 5; Sienaert, 1990, p. 96; Tuan, 1990; & Tuan, 2011). Other factors influence this schema, such as the volume of the space, the distance between people, and the social relationship between one human body and another, that determine whether behavior is deemed as etiquette or rudeness (Tuan, 2011, p. 59-60), but the higher-order determiner is the spatial schema itself, for it provides notions of proximity and distance as valued-laden spatial properties. A discussion of anthropologist Edward T. Hall's work on proxemics is relevant here. *Proxemics* is Hall's term for "the study of how man unconsciously structures microspace—the distance between men in conduct of daily transactions, the organization of space in his house and buildings, and ultimately the layout of his towns" (Hall, 1963, p. 1003). Hall has even identified eight factors that represent a "closed behavioral system" that determines the meaning of the distance between two bodies in any given culture (see Table 5.2.) to help anthropologists to record notations for observational fieldwork and analysis (Hall, 1963, p. 1006-1007). These factors are informative in that provide a systematic approach to observing human behavior responding to the distance between two people, but Hall reminds us that not all factors function simultaneously or share the same complexity (Hall, 1963, p. 1006-1007). More importantly for the discussion here is that these proxemic factors point to conditions that influence the values bestowed in the solitarity-solidarity spatial schema and dictate what is "too close" or "too far." Although Tuan pairs spaciousness with crowding, he recognizes that there is a significant distinction between a room full of things and a room full of people, as the "inanimate objects" of the former possess a sense of presence "only to the degree that people endow them with animate or human characteristics. Human beings possess this power naturally"[43] (Tuan, 2011, p. 59).

Table 5.2. Hall's eight proxemic factors. Each factor gives meaning to the distance between human bodies (Hall, 1963, p. 1006-1007; 1007-1017).

Proxemic Factor	Description of Factors Influencing Proximity & Distance Among People
Body Positions	The relative body positioning between two people gives meaning to the space between them. Although there are numerable different postures, Hall is concerned with parsimony, so he limits to this factor to three classes: standing, sitting or squatting, and prone. Interestingly, he also identifies gender as a fourth class that determines the values brought to the proxemic relationship. (Hall, 1963, p. 1007-1008)
Sociofugal-Sociopetal Orientation	These terms refer to how spatial arrangements can encourage or discourage social interaction, as in the arrangement of chairs. Sociofugal refers to orientations that discourage social interaction, while sociopetal encourages social interaction, which Hall records according to an eight-point compass demarking the degree to which two subjects are facing. (Hall, 1963, p. 1008-1009)
Kinesthetics	For Hall, kinesthetics concerns potentiality, as in the ability to strike or caress another person, and he identifies four "inventories of potential actions" that imbued value on the proximity of two bodies: (1.) touching with the head or trunk, (2.) touching with the forearms, elbows, or knees, (3.) touching with fully extended arms, and (4.) touching with the stretching of the whole body. (Hall, 1963, p. 1009-1010)
Touching	Hall identifies seven classes of touching that can occur between bodies, ranging from mutual touching to no contact and classified according to the duration of the touching, with longer durations associated with greater intimacy. (Hall, 1963, p. 1011, 1012)
Eye Contact	Hall reminds us that culture determines "at what, at whom, and how one looks," and naturally it plays a role in the association of values in proxemics. Eye contact is measure, like touching, according to degree to which a person sees another person directly or from the periphery or even not at all. (Hall, 1963, p. 1012-1014)
Body Heat	Usually only applicable for short distances, sensing another's body heat can draw or repulse another body. The type of clothing, if any, may affect body heat as well as the fact that the body does not warm uniformly. Hall's scale for body heat ranges from the conductive hear felt in skin-to-skin contact to no discernable detection of body heat. (Hall, 1963, p. 1014-1015)
Olfaction	Despite each individual's olfactory acuity, to smell another's body odor can be valued as intimacy or disgust, and different odors are acceptable in given circumstances. Hall points out that perception, not necessarily the detection, of

[43]Tuan concedes that people can be objectified into things rather than human beings, as in the case of servants or slaves, who become "invisible" to society (Tuan, 2011, p. 59).

	odors greatly varies from culture to culture, and influences how people behave in close spaces. As Hall's notation system is derived on observed behavior, so he reductively classifies behavior changes to smell to five classifications: (1) detection of differentiated body odor, (2) detection of undifferentiated body odor, (3) detection of another's breath, and (4) detection of smell likely, and (5) no detection of smell. (Hall, 1963, p. 1015-1016)
Loudness of Voices	Hall readily identifies three culture conditions that give meaning to the loudness of a human voice between two people in a given space: situation, relation, and distance. His notation scale consists of seven tiers from silent to very loud. This is Hall's attempt to objectively measure the loudness or quietness of a voice and avoid a subjective approach that measures such quality according to one own's ethnocentric baseline. He cautions the use of "the investigator as a measuring device" and encourages researchers to record the same observations separately and compare afterwards in order to calibrate the scale. (Hall, 1963, p. 1016-1017)

5.2.3 Common Affective Spatial Properties

For human body schemas, spatial properties become structures of meaning and can be characterized broadly according to classes of size, form, symmetry, and spatial relation. As nonspatial concepts become organized according to their "shape" or "proximity" within a spatial schema, values and meaning are inferred according to these structural elements. Larger sizes, for example, are often associated with larger quantities, an association capitalized in charts and graphs (Gattis, 2001a, p. 226), and are generally more desirable than that which is smaller. Whether a spatial property is assessed positively or negatively is determined by culture and context: A body positioned low to the ground (e.g., crouching) may be interpreted as subjugation or genuflection in different spaces (e.g., prison or church). Understanding how spatial properties become organizing structures for abstract ideas values is imperative to constructing a theoretical framework for presence and the affective body, as the experience of space is not value-free, but rather charged with affectivity. These four classes of spatial properties are inherent in the spatial schematics for the affective body and likewise should be approached with similar caution regarding the currency of their meanings; nonetheless, they are spatial properties imbued with widely recognized cultural significance and are directly relevant to this discussion on the role of spatial schematics in shaping experiences of presence (see Table 5.3. below).

Table 5.3. Four classes of spatial properties and their corresponding terms.

Four Spatial Classes	Related Terms & Concepts
Size	Magnitude, length, area, volume, mass, capacity
Shape	Configuration, form, compactness, attenuation (elongation), proruption (indention), fragmentation, segmentation, perforation (punctuated-ness), closed, open, geometric, nongeometric
Symmetry	Similarity, dissimilarity, continuity, discontinuity, balance, imbalance, constancy, inconstancy, asymmetry
Spatial Relation	Directionality, dimensionality, array, matrix, orientation, topology, metric, contains, inside, outside, covers, overlaps, interposition, disjoint, touching, proximity, distance, sequence, order

5.3 An Affective Spatial Schema for the Affective Body

Together, these affective spatial schemas and the values that are bestowed upon corresponding spatial properties constitute a set of schematics for the body's affective organization of space. Like the previously mentioned analogy with facial expressions, the value in these schemas lies in the fact that most cultures differentiate space according to the shared anatomical structures: segmented, binary, and asymmetrical spatial schemas become imbued qualitatively with symbolism, meaning, and values fundamental to the experiencing of that space, even if those values are unstable when viewed in the long arc of history[44]. Spatial properties and structures, such as proximity and stratification, are fundamental not just to perception, but to thinking itself, as Gestalt principles inform not only what is seen but also what is conceptualized; as Gattis (2001b) theorizes, spatial schemas provide organization to aid memory, communication, and reasoning by mapping spatial properties onto non-spatial qualities to operate not simply as metaphors but as cognitive mechanisms for abstract thought (Gattis, 2001b, p. 2). From cognition to perception to movement, spatial schemas provide operational structures for affective mapping of space and the meaning and values that are inferred onto that space: Thus, the self-referential affective body comes to be the organizing structure for its own affectivity. The affective body, by virtue of movement via the three

[44] James Hall attests to this instability in his analysis of the left-right spatial schema in Renaissance art in which he argues that, for a short time, artists embraced a "left-turn" that symbolically liberated femininity and emotion as positive, human qualities (Hall, 2008).

bodily modalities, enacts—or perhaps more accurately, *performs*—space inseparable from meaning, an affective space resistant to Lefebvre's notion of the abstract space of globalism[45] (Lefebvre, 2011). The *Affective Spatial Schema* is a conceptual model for the investigation of the affective body's organization of space, and, like the de facto anatomical position used in medicine, provides a referential structure by which researchers and developers can investigate the affective body's mapping of meaning to spatial properties.

Although these meanings are greatly informed by cultural and contextual determiners, the more important point is that the Affective Spatial Schema operates on mechanisms that enact certain types of spaces, such as the sacred or the mythical, to satisfy an affective appetite. These mechanisms, in a word, are movement. Movement is the observable, measurable, and qualifiable material component of force. Any force, whether thermal, chemical, or mechanical, both in classic physics and quantum mechanics, is defined by movement or the resistance to movement[46]. This raises the question: If the affective body is moving in response to some force, then what is that force driving the enaction of space? The answer is affect. Affect is not only an active force, but it is also inescapable to the living body. Returning to Hansen, affectivity is "the capacity of the body to experience itself as 'more than itself' and thus to deploy its sensorimotor power to create the unpredictable the experimental, the new… a capacity to experience its own intensity, its own margin of indeterminacy" (Hansen, 2006b, p. 7-8). Affectivity, the body's ability to experience and perceive

[45] Lefebvre's abstract space refers to the "objective" space of capitalism, a space that has divorced labor from the human body in order to quantify, organize, and optimize the production of goods and services for consumption; the most damning outcome of such a conception of space, according to Lefebvre, is the idolatry of quantification and the erasure of the qualitative dimensions of space: "Abstract space is measurable. Not only is it quantifiable as geometrical space, but, as a social space, it is subject to quantitative manipulations: statistics, programming, projections—all are operationally effective here. The dominant tendency, therefore, is towards the disappearance of the qualitative, towards its assimilation subsequent upon such brutal or seductive treatment." (Lefebvre, 2011, p. 352)

[46] The most likely contender for the theory of "everything" currently rests on the theoretical framework of string theory, which postulates that all matter in the universe is elementally comprised of one-dimensional "strings" that vibrate in different ways, resulting in the manifestations of subatomic particles, such as electrons or photos (Cappelli, Castellani, Colomo, & Di Vecchia, 2012).

the varying intensities and kinds of biological responses (e.g., accelerated heartrate, pulse, or breathing) associated with emotions and feelings, is the dominant force that shapes the experience of space. The affective body's appetite for affect-rich space is never satiated: like any other living organism, it makes its way through the world ceaselessly seeking those things beneficial and avoiding that which is harmful. This movement, driven by an affective appetite, materializes in the affective body via the three affective bodily modalities of proprioception, tactility, and temporality working interdependently to create a perceptual—and affectual—model of space. The following section investigates the operating principles that drive the body's affective mapping of space and the meaning and values that are inferred from it, operating mechanisms that play a central role in the experience of presence in mediated environments. Leveraging these principles that operate the Affective Spatial Schema offers further avenues of investigation in presence.

5.4 Explication of the Theoretical Framework: The Directionality of Presence

In *The Poetics of Space* (2014), Gaston Bachelard phenomenologically analyzes the poetic image of the house to explore the body's relationship between real and "felicitous space" in his efforts to outline a geometry of the imagination (Bachelard, 2014, p. 19). For Bachelard, the house provides a shelter for the dreamer to daydream, an intimate space meant for solitude, isolation, and silence and the privileged site of "thoughts, memories, and dreams of mankind" (Bachelard, 2014, p. 28). He posits that the house is more than a phenomenological object, but rather an instrument to study the "topography" of the human soul (Bachelard, 2014, p. 19-20). The "verticality" and "beingness" of the house metaphorically reflect the architecture of inner space (Bachelard, 2014, p. 39). For Bachelard, the house, phenomenologically speaking, is a place in which intimate human experience fills every nook, corner, and drawer that scaffolds the transformative actions one performs to turn a house into a home. As Bachelard points out, "We always *go down* [the stairway] that leads to the cellar, and it is this going down that we remember, that characterizes its oneirism…we always *go up* the attic stairs, which are steeper and more primitive" (Bachelard, 2014, p. 467). Corners, for example, are places where we read or mediate or indulge in silence and can be characterized as sites of immobility (Bachelard, 2014, p. 156): "every corner in a house, every angle in a room, every inch of secluded space in which we like to hide, or withdraw into ourselves, is a symbol of solitude for the imagination…the germ or a room, or of a house" (Bachelard, 2014, p. 155). We retreat to the depths of a corner to contemplate and keep secrets; children are also sent to corners as punishment by exclusion. The *dream house* is the home of the future, Bachelard observes, and is "better build, lighter and larger" than houses of the past, such as the *childhood home*[47] (Bachelard, 2014, p. 81).

Although Bachelard intended for his phenomenology to aid poets in transcending the conscious mind to "collect documentation on the subject of the *dreaming consciousness*" (Bachelard, 2014, p. 5), he also unveils a sort of nonconscious choreography the affective body performs when it inhabits an environment. Bachelard is correct in that people possess innate desire to fill space with the intimate, repetitive actions of daily living (e.g., cooking, cleaning, sleeping, resting, playing, copulating, defecating, etc.). However, the framing mechanism for the phenomenological experience of home is not the architecture of the house, but rather a repertoire of gestures, postures, and locomotions the affective body performs as it moves through the environment. One needs not the house to recognize the pantomime of opening a window, closing a door, answering a phone, or other abstracted movements that have come to symbolize these well-known actions, *even if* those gestures themselves have become anachronistic, such as the cracking of an invisible early 20th century movie camera in charades. Obviously, the actions of our daily lives move within a symbolic dimension, but as Burke asks, are we honest with how much the "symbol-using animal" called *Homo*

[47] Bachelard's poetic image of the house has been criticized for its male-centric interpretation and overlooks the fact that for many women the home remains a place of oppression in the form of housework and confinement (Olivares, 1996).

sapiens has constructed her or his reality with these symbolic actions (Burke, 1966, p. 5)? Jacques Lecoq, an influential thinker on physical theater (Bradby, 2006, p. xiii), provides avenues to explore Burke's philosophical challenge. Like a mime pushing against a transparent wall, movements can be divorced from the constraints of the material world and still express symbolic meaning: The gestures, postures, and locomotions of a mime carve out objects from space, allowing "the imagination to invent what does not really exist, to change its dimension, its weight, to overturn gravity and to play with the infinite possibilities" (Lecoq, 2006, p. 72). Returning to the image of the mime pressing against an unseen wall, the actor reaches up on her tiptoes, arms outstretched, until her hands fold at a right-angle perpendicular to the invisible wall. We then witness her pull her arms down but understand that she has just lifted herself up and now her chin rests on a "ledge." Whereas Bachelard inspires poets to open themselves to the "reverberations" of the house (Kearney, 2014, p. xx), Lecoq tells his actor-mimes to focus on the fundamental elements of these actions in terms of balance, rhythm, and motion: "The great mime attains the domain of Movement, with a capital M, and does not confuse the exercise with the style. This is how he or she touches us in our depths" (Lecoq, 2006, p. 67). Lecoq advises the mime to practice a self-minded approach to investigating how movement becomes an expression of an idea, not by playing charades but by giving form via affective movement. "If I mime the sea, it is not about drawing waves in space with my hands to make it understood that it is the sea, but about grasping the various movements into my own body"; the mime identifies these "secret" rhythms the body affectively embodies to "make the sea come to life in [the mime] and, little by little, to become the sea," repeating this introspection as the mime hones the forces compelling the movements into more concise forms (Lecoq, 2006, p. 69). This is how, to paraphrase Lecoq, the mime becomes the master of elliptic language (Lecoq, 2006, p. 72).

Understood within the theoretical framework for the affective body, both Bachelard's poetics of space and Lecoq's theater of movement and gestures draws connections between movement and the affective experience of space. Both notions advocate a phenomenological sensitivity to the "forces" or "rhythms" the body experiences with spaces and implicate that there exists an affective dimension to the experiencing of space predicated around gestures, postures, and locomotions that trigger the affective body's cravings for qualitative distinct spaces, such as the affective response one may experience while performing rituals in sacred spaces. For virtual environments, such affect-laden movements find more purchase in the enaction of circumambient space: Because the affective body directs itself toward those movements that bring about desired spaces, the Affective Spatial Schema greatly informs the meaning and value these movements embody. The theoretical framework for the affective body posits that, in addition to experiencing presence in terms of intensities and localizations of distal attribution, there exists a third domain of presence, one that considers the affective body's desire for mediated spaces via movement, termed here as *directionality*. The theoretical framework for presence proposes that the affective body is never at rest, and so movement is indicative of embodied perception and the impetus behind the proprioceptive, tactile, and temporal modalities employed to experience presence. The affective body rotates and revolves along well-worn, bio-culturally determined points of articulation and axes of freedom—trajectories that have been both constrained by anatomy and kinesthesis and yet greatly influenced by the Affective Spatial Schema proposed in the theoretical framework for presence. Directionality characterizes how movement along these directions are corporealized as gestures, postures, and locomotions that organize how users experience a sense of "being there" in a mediated or virtual environment.

The design study investigates how bodily gestures, postures, and locomotions frame the embodied perception of space, and ultimately the phenomenon of presence, with the aim of developing a topology of presence that can aid in the design of more compelling experiences of presence in virtual environments. The next chapter details the design of the study aimed to investigate the validity of the proposed theoretical framework proposed in the hopes of contributing to the advancement of immersive strategies that capitalize on the affective body's natural inclination to connect meaning and value into spatial experiences. One of the best opportunities to investigate experiences of presence is to begin at the beginning, the first moments when the affective body encounters the digital or mediated stimuli informing the body's perception of space. "Getting VR legs," the phenomenon identified here as the enaction of virtual environments, provides such an opportunity to investigate the affective body's first contact with the digital or mediated stimuli of the technological apparatus, as well as the occlusion of natural stimuli by the technology. The study's findings are discussed in the final chapter, where implications are reconciled with the theoretical framework and analyzed for meaning in order to produce a topology of presence for researches, designers, and developers can leverage for more compelling experiences of presence.

6. STUDY TO INVESTIGATE THE ENACTION OF VIRTUAL SPACES

This study aims to investigate the relationships between presence and the affective body's enaction of virtual spaces: the gradual or incremental movements the body performs to navigate and orientate itself in virtual environments while minimizing nausea, disorientation, and other symptoms of simulator sickness. Since virtual spaces are often larger than the tracking spaces of the technological apparatuses, artificial locomotion[48] allows players to perceive the illusion of movement beyond the boundaries of the play-space: The joystick on the Oculus Touch controller, for example, operates similarly as a conventional game controller, moving the virtual body through virtual landscapes much larger than the permissible play-space occupied by the player's corporeal body. However, sensory conflicts between stimuli, such as visual and aural cues that signal movement despite a stationary body, that arise with artificial locomotion can be a factor for intense symptoms of simulator sickness (McCauley & Sharkey, 1992, as cited in Kolasinski, 1995, p. 7; Palmisano, Mursic, & Kim, 2017). Essentially, simulator sickness occurs when there is a failure to induce vection in the virtual space (Hettinger, Berbaum, Kennedy, Dunlap, & Nolan, 1990). Nausea and other symptoms have been theorized as biological adaptations to the body's experiencing of conflicting sensory information, particularly involving the proprioceptive system, as a natural defense mechanism to the consumption of a poison or toxin (Treisman, 1977, p. 494, and cited in Kolasinski, 1995, p. 8).

The body's enaction of virtual space makes an ideal unit of analysis to investigate experiences of presence due to the exposure of the normally nonconscious operational mechanisms of the affective body responsible for the enaction of circumambient space. According to the theoretical framework for presence, the affective body's encounter with the incorporeal mediated

---

[48] Boletsis' review of the literature (2017) revealed four kinds of artificial locomotion techniques employed in virtual reality experiences: motion-based, room-scale based, controller-based, and teleportation-based locomotion.

stimuli of the virtual reality technology can trigger affective registers in a way that, as Hansen puts it, "expands the affective body's margins of indeterminacy" (Hansen, 2006b, p. 11, which is experienced affectively in the body's encounter with innately inhumane digital information. As the affective body moves and turns in virtual spaces, it may perceive the images from the HMD as first order (i.e., perceiving and responding to the images as having a kind of corporality and immediacy that is prioritized over the space IRL), but the affective body does not forget its bare feet on a hardwood floor or the headset pressing against the face, even if the user is no longer conscious of them. Rather, these tactile, proprioceptive, and temporal properties of the phenomenon help inform the affective body's organizing of spatial schemas, playing a role in presence and the enaction of virtual spaces. By investigating this phenomenon—the affective body's capacity to navigate virtual environments while minimizing the effects of simulator sickness toward sensations of presence—a fuller understanding of the operational mechanisms driving the experiences of presence can lead to the creation of more compelling experiences of presence. As mentioned previously, presence can be experienced not only in quantitative intensities and qualitative distal attribution but also in affective, embodied kinematics that are conducive to presence for their capacity to be imbued with affective meaning and values, which is termed here as the directionality of presence. Enaction of virtual spaces is where these affective gestures, postures, and locomotions matter the most, for they bring with them into perception the conscious the triggering of the normally nonconscious affective registers, thus opening opportunities to learn more about the nature of presence.

6.1 Methods and Procedures

This research design adopts an empirical auto-phenomenological approach to investigate the phenomenon of the enaction of virtual space, as well as its intersection with presence. Although presence can be highly subjective—an elusive quality that is problematic to measure, as mentioned in the first chapter—it can be described and catalogued due to similar shared qualities among users.

Thus, the research design adopts an empirical auto-phenomenological methodology to structure the researcher's subjective experience with varies virtual reality and immersive technologies and software applications coupled with open-ended interviewers with designers, developers, and researchers of VR and immersive experiences at selected research sites. The underlying philosophy guiding this auto-phenomenological study is derived from Mark B. N. Hansen's writing concerning the affective body and perception (Hansen, 2006b), Susan Kozel's work on affect and embodiment in virtual environments (Kozel, 2007), and Steve Swink's metrics for designing virtual mass and virtual forces in virtual spaces (Swink, 2009). Data collection takes the form of self-reporting of the experience, followed by an analysis to identify themes. The second part of this study is directed at interviewing designers, developers, and researchers regarding their approach to helping the body enact virtual spaces and sustaining experiences of presence. Some of these interviews were held on site; one interview (in two sessions) was conducted in the virtual space of the participant studio's two VR games. The aim of the interviews is to identify the cultural concepts surrounding presence: What is the nature of presence, and how are users and players encouraged to enact virtual space to sustain presence? Data collection takes the form of interviews and observations of designers and developers working/collaborating on VR projects. The data is compiled into a detailed thick description of the experience, followed by an analysis of topics and patterns that signifies how the participants approach presence and enaction, which is presented in the findings section. All participants have access to this data in efforts to maintain reciprocity. Discussions of the findings are presented at the end of this chapter, and the implications of the findings are brought forward in the next chapter along with a topological map for presence that outlines the remaining theoretical framework for the directionality of presence.

6.1.1 An Auto-Phenomenological Approach

To investigate the unit of analysis (i.e., the body's enaction of virtual spaces), the design study adopts an auto-phenomenological approach in which the researcher analyzes his experiences with a range of virtual reality and immersive technologies including a wide range of virtual reality software applications. Phenomenological methodologies are designed to investigate a lived experience in order to identify the essential qualities or properties that constitute and give significance to that experience of the phenomenon (Creswell, 2007, p. 57-58); therefore, an auto-phenomenological methodology has been applied to answer Research Question 1: In brief, how embodied movement affectively informs the experience of presence. This auto-phenomenological method is predicated on the theoretical framework for presence (proposed in Chapters 3, 4, and 5 of this dissertation) in which the affective body's capacity to affect and experience affect is presented as the primary operational mechanism responsible for experiences of presence. This theoretical framework for presence assumes the existence of a third, affective domain to these experiences that are not characterized primarily in terms of intensities or locals of distal attribution, but according to affective, embodied movements that take on significance (i.e., imbued with meaning, symbolism, values, etc.) in virtual environments. An auto-phenomenological approach provides the right analytical tools to investigate the relationship between the theoretical framework for presence to investigate the meaning of experiencing enaction of virtual spaces.

6.1.1.1. Applying Hansen's Affective Body for Phenomenology

The proposed theoretical framework for presence, which is heavily influenced by Hansen's work on the affective body and its encounter with digital information (Hansen, 2006b), privileges embodied movement. Thus, the research design is concerned with how the body utilizes movement and affect to enact virtual space. To investigate the validity of the hypothesis for a directionality of presence, the researcher has embraced an auto-phenomenological methodology to understand the essence (Husserl, 1991) of the affective body's processes of enaction of virtual spaces, the ways in which bodies wave their hands, swing their arms, or twirl to interact with virtual yet massless objects, navigate virtual environments, and sense virtual forces. The theoretical framework for presence provides an auto-phenomenological structure to help the researcher bracket the structure from the subjectivity of the experience in order to discover more insight into the phenomenon of enaction (Drummond, 2007, p. 59). The affective body's enaction of virtual environments has the potential to expose the normally imperceptible processes responsible for enacting circumambient space, and so auto-phenomenology provides the ideal methodology to describe, not explain, the researcher's conscious encounter with the normally unconscious processes of constructing perceptual models of circumambient space. The auto-phenomenological approach is guided by the driving question, "What does it feel like to experience the affective body work at constructing a perceptual model of circumambient space?" To answer these questions, it is imperative to separate the conscious feelings triggered by the phenomenon from the affective bodily responses experienced during enaction of virtual spaces. Furthermore, phenomenological experiences of enaction must account for not only the affective body's encounter with digital information (i.e., Hansen, 2006b) but also the interplay between virtual and actual bodies and forces on the affective body to set aside those aspects or qualities not essential to the structure of enaction of virtual spaces. To fulfill this task, Susan Kozel's poetics of responsivity (Kozel, 2007) and Steve Swink's metrics for virtual sensation (Swink, 2009) help inform the auto-phenomenological methodology applied to this design study, as they provide paradigms of to aid in the phenomenological bracketing required to investigate forces experienced during the enaction of virtual spaces.

6.1.1.2 Applying Kozel's Poetics of Responsivity for Phenomenology

Susan Kozel's poetics of responsivity provides an auto-phenomenological methodology for analyzing the effects of sensations in the body as it moves through mediated-spaces (Kozel, 2007, p.

183). Kozel's methodology contributes to this phenomenological investigation by suppling the necessary analytical tools to subtract and reduce the essence of the phenomenon as it relates to forces (i.e., gravity, inertia, centrifugal force, and weightlessness) acting upon the body during the body's enaction of space with the technological apparatus. Kozel embraces responsivity over interactivity citing that the latter is defined too broadly and over-emphasizes decision-making rather than multisensory bodily responses as well as the social and ethical relationships with other living bodies (Kozel, 2007, p. 182). Interactivity does not address passive responses (i.e., "acts of listening, prevaricating, meandering, stumbling, thinking, reassessing, and hesitating; the states of confusion, uncertainty, frivolity, intimacy") from soft, nebulous subjects acting and being acting on as they move among one another (Kozel, 2007, p. 186, 187). Kozel's poetics of responsivity also account for a type of agency that's exercised non-consciously through multiple bodies (Kozel, 2007, p. 187). Conceptually, her poetics of responsivity are comprised of the three groupings[49] organized around the body in concentric spheres, like Russian nesting dolls, in which each sphere is comprised of four phenomenologically discrete kinesthetic and proprioceptive qualities (see Table 6.1. below). The inner-most sphere characterizes the visceral sensations of physical forces on the body, such as gravity, while the middle sphere groups the sensations the body experiences s at the borders of its sensory receptors. The outer-most sphere comprises the types of responses to sensations the affective body experiences as responding within a network of other living bodies. This auto-phenomenological approach aids in the phenomenological analysis of the affective body's encounter with these sensations experienced during enaction of virtual space, allowing for a more effective analysis. Her poetics are grouped within three areas of focus: *dynamics of the body*, *reconstruction of physicality*, and *extrapolations of the body* onto other social constructions (Kozel, 2007, p. 183).

[49] Kozel refers to them as "logics" (Kozel, 2007, p. 183).

Dynamics of the body. Kozel's poetics identifies four dynamics that are concerned with the kinesthetic range of the living body: *torque*, *impulses*, *rhythm*, and *spirals*. These dynamics allow for a phenomenological investigation into the sensations of gravity, inertia, centrifugal force, weightlessness/resisting gravity, etc. (Kozel, 2007, p. 194-198) that the body experiences in circumambient space. Because these dynamics are sensitive to a living body, notions of fatigue, lapses in concentrations, pain, and even sweat are recognized as qualitative dimensions of this space. Torque refers to the force felt upon the body as it rotates on an axis; Kozel's poetics are concerned with the nature of the body's responses to these forces as it twists and contorts itself chasing electronic displays devices (i.e., screens, headphones, haptic feedback, etc.) of the technological apparatus (Kozel, 2007, p. 195). Head-mounted displays allow for the body to contort in ways not typically experiences in traditional screen technologies. The ability to turn around and view "behind" the user is a qualitatively distinct experience. Impulses are drives or urges, often suddenly and nonconsciously, that compel a body to action. In poetics of responsivity, these are more visceral actions/reactions the body experiences, such as the fatigue brought about by prolonged experiences of dread while playing VR horror games. Rhythm refers to how the body responds to repetitive patterns of responses temporarily and structures "delays, delays, lags, motions and speeds, and affective qualities of screen behavior and visuals" that kinesthetically qualifies the experience (Kozel, 2007, p. 193). One example points to the fact that user interfaces are typically designed around repeating patterns for the users to learn how to operate a system. For Kozel, how bodies learn to repeat an action until that movement is "deeply ingrained in physical memory" (Kozel, 2007, p. 198) highlights the cyclic nature of the living body. Whereas torque qualifies the forces felt upon the body as it rotates and bends toward the displays, spirals qualify the trajectories of these movements through mediated, volumetric space (Kozel, 2007, p. 112-113). This need not refer to literal spiral movements, but rather the freedom of movement afforded to a free-floating body as it travels through space.

Reconstruction of physicality. Living bodies feel their way through the world. The edges of the sensorimotor system (i.e., the sensory receptors) can sense stimuli of varying intensities and kinds and can even remember them; in fact, so sensitive is the flesh that it need not actually touch something to sense it: a photograph from a gruesome crime scene, a favorite song, and the smell of roasting duck can create palatable changes in the body. *Flesh, kinesthesia*, *intercorporeity*, and *metabolism* address how the living body constructs itself within the innately inhuman digital space and time of the technological apparatus. Following arguments made by Merleau-Ponty's, flesh is the "thickness between the seer and the thing" (Kozel, 2007, p. 200). Space is not simply an empty medium that allows for signals, photons, molecules, etc. to travel through, but a connective tissue that binds the living, affective body to the world around it. The responses that arise between the skin (i.e., the sensory receptors) and the screen (i.e., the electronic displays of the technological apparatus) is the *flesh*, which in the theoretical framework is the experiencing of the affectivity (the body's capacity to affect and being affected upon). It is through the flesh that "we confront memory, imagination, and intuition" (Kozel, 2007, p. 200). The affective body cannot be separate from the flesh; flesh is how the affective body knows the world. Through linear perspective, faux terrain, and other technological effects, the panoramas of the 19th century were designed to facilitate kinds of presence not by creating space, but by offering specific stimuli that lured movement along affective trajectories, resulting in an expanding the flesh around an affective body. To paraphrase Kozel, it is flesh at a distance (Kozel, 2007, p. 201). Traditionally, kinesthesia (and by extension, proprioception) is an awareness of other moving bodies that "pull" on the movements of the affective body (Kozel, 2007, p. 111). The affective body creates space and time through movement. Even when seated, the body's biological processes are circulating to unfold circumambient space around it. Kinesthesia in Kozel's poetics of responsivity is more concerned with the locomotions that grows or expands spaces around the body: Whereas the notion of spirals emphasizes bodily contortions, kinesthesia focuses on how the affective gravities between bodies influence the orbits of other affective bodies in a virtual space. Intercorporeity refers to the rhythms that play across many bodies, including non-human bodies. (Non-human bodies denote those things that are recognized as bodies/entities, whether they are made of organs or not: virtual bodies in the forms of avatars, animal bodies, etc.). Affective bodies are differential to other affective bodies; bodies—and computer technologies—respond to one another. Specifically, intercorporeity are the responses that arise between corporeal and virtual bodies. If the world is made of flesh, asks Merleau-Ponty (Merleau-Ponty, 1968, p. 138), where does the body end and the world begin (Kozel, 2007, p. 202)? Kozel's response is, surprisingly, with the Deleuzian notion of metabolism[50]. This biophysical term, which commonly refers to the chemical process that sustain life, is adapted to Kozel's poetics of responsivity to denote the unique processes, motions, and arrangements of movements that constitute the individual (Kozel, 2007, p. 202-3). Metabolism replaces agency with action and response, initiative and passivity, resulting in a much less stable subject. This puts the emphasis less on form and more on response. For studies of presence, the notion of metabolism may reveal mechanisms that facilitate experiences of presence.

Extrapolations from the body. The final and largest grouping places the affective living body within a system of relations to other affective bodies: "The intrinsic quality of the relations indicates that the elements entering into a relation are constituted in part by this relation, and that without the relation in which they participate they would no longer be the same" (Kozel, 2007, p. 204). Thus,

---

[50] "A drawing together of Deleuze and Merleau-Ponty may seem paradoxical…. Merleau-Ponty seems to hold sacred the form of the human body, while Deleuze disintegrates it into forces, planes, and directions. My kinetic corporeal expansion of Merleau-Ponty is twinned with a phenomenological twist on Deleuze: I enhance moments of vibration and disequilibrium in Merleau-Ponty's thought at the same time as I ground our encounter with Deleuzian non-bodies, even when abstracted as sounds or ideas, in a concrete moment of experiential encounter." (Kozel, 2007, p. 185)

the poetics of responsivity recognizes that the subject is changed and formed by the alterity of other bodies. Kozel identifies this aspect as an *ecosystem* in which entities are constituted by *affect* and *motion* (Kozel, 2007, p. 206). *Ethology* becomes the characterization of this combination of affect and motion. Kozel places the constructed body into a larger network of interdependent parts; to deconstruct these relations would fundamentally change the subject. Ecosystems, therefore, have "an ability to enact a kinesthetic transformation upon the states of the body and consciousness of those who inhabit it for any length of time" (Kozel, 2007, p. 210). In other words, these networks create responses that can be felt among affective bodies. Embodied dimensions, embodied values, and the freedom of movement offered by VR technologies create and ecosystem that facilitates experiences of presence. For Kozel, the term *affect* is expanded to include emotions, moods, dispositions, material impressions, and metabolisms (Kozel, 2007, p. 208). Kozel's notion of affect echoes Hansen's affectivity, that is, the ability to create affect and the capacity to be affected (Hansen, 2006b, p. 7). The phenomenon of presence parallels many of the mechanisms that trigger experiences of affect. Furthermore, living bodies are never truly at rest. They move and are moved by other bodies, much like the orbits of celestial objects. Speed and slowness, movement and rest create disruptions felt throughout the system. An affective body enacts space and time via motion. Finally, *ethology*, a term borrowed from Deleuze, in Kozel's poetics is "a way of describing the choreography in responsive systems, or ecosystems" (Kozel, 2007, p. 207). This is not a choreography in a literal sense (i.e., a determined set of moves in response to a system), but rather a behavior exhibited by bodies sharing a series of interrelated responses in which none are truly random or guaranteed to one event (Kozel, 2007, p. 207). Different motions create different affects, and vice versa, which can be read by affective bodies. Kozel's ethology can help structure aspects of the ecosystem that lend to certain experiences of presence that may result in sensations of terror or sublime, for example.

Table 6.1. Kozel's poetics of responsivity.

Logics	Responsivity	Architectures	
Inner Circle: Dynamics of the Body	Responses concerning the kinesthetic range of the body as it experiences forces	Torque	The force felt upon the body as it contorts itself following the electronic displays of the technological apparatus
		Impulses	The drives or urges that compel the body to respond
		Rhythms	The distinct, repetitive patterns of responses over time
		Spirals	The freedom of movement afforded by the technical apparatus
Middle Circle: Reconstructions of Physicality	Responses concerning the skin's encounter with digital space	Flesh	The point of contact between the body's edges and digital stimuli
		Kinesthesia	The proprioceptive awareness of sharing and responding to other bodies, both virtual and corporeal
		Intercorporeity	The rhythm of movements felt in the body over time as a response to other bodies within a mediated relationship
		Metabolism	The processes and collections of movements that constitute the living subject
Outer Circle: Extrapolations from the Body	Responses concerning the movements of other living bodies	Ecosystems	Bodies are constituted as part of a system if responses
		Affect	Kozel's umbrella term for sensation, emotions, and feelings—biological responses to sensory stimuli
		Motion	Movement necessitates all structures of responses
		Ethology	The speed or slowness and affective states the body experiences that inform its responses

6.1.1.3 Applying Swink's Metrics for Phenomenology

One of the challenges of designing for virtual worlds is due to the technological inability of the virtual reality apparatus to simulate mass and the physical forces that are exerted on it. In video games, this technical shortcoming is somewhat compensated via careful game design in which simulated objects and forces trigger the appropriate affective registers for the affective body to perceive and sense virtual mass and forces. Steve Swink's notion of game feel—his term for the experiencing of sensation from the virtual objects and virtual forces residing in video games—provides a set of quantitative and qualitative metrics to measure the effectiveness of "virtual sensation" (Swink, 2009). His metrics for virtual sensation contribute to the auto-phenomenological approach, as with Kozel's poetics of responsivity, by providing the researcher with better analytical tools required to investigate effectively units of analysis as the relate to the affective body's encounter with virtual objects and virtual forces. Understanding how, for example, a player can sense her stomach dropping as she rides down a virtual elevator despite standing an immovable concrete floor (D. DeLane, personal communication, February 16, 2018; see Appendix A.5.), may lead to a better understand of how the affective body enacts virtual spaces for virtual objects and virtual forces, as well as those effects of experiences of presence. Swink has identified six properties of game feel that can be measured in order to create specific experiences with virtual objects and forces. Three of these properties are classified as quantifiable, hard metrics; the remaining three properties are more subjective and address a player's attitude toward an aspect of a virtual world. Table 6.2. below details each of Swink's six metrics for virtual sensation.

Quantifiable metrics for virtual sensation. The physical construction of the *input* device strongly influences the feelings of control for the player (Swink, 2009, p. 101-102). The hard plastic of a joystick or the tension in a button spring shapes the aesthetic experience for the player. To slingshot a bird by holding and releasing a button rather than swiping across a touchscreen changes the aesthetic experience in Angry Birds (2009). The weight of a head-mounted display and the shape of the motion controllers phenomenologically affect experiences in virtual reality. Software interprets input signals and modulates them within a given parameter, so that pressing right on a directional pad, for example, may move the avatar slowly to the right but holding the same button down for 1.2 seconds may send the avatar into a sprint. Signals from the input device are mapped to changes of state in a given game, and even an input device with relatively few input controls can be remarkably expressive: Super Mario Bros. employs only six buttons, yet Mario can walk, run, jump, long jump, shoot fireballs, swim, slide, and change direction in mid-air, giving players a plethora of game mechanics to dance Mario through the game. How developers build *responses* can help facilitate experiences of presence, such as interpreting input signals as jumps or runs through the simulated space created by computer code, essentially the output of the player's input (Swink, 2009, p. 119). However, it is *content* that greatly characterizes the virtual forces in a game: the simulation of space through collision code and level design (Swink, 2009, p. 139). A race car's speed is determined by its relative position on a racetrack; take away the racetrack and the race car does not appear to move. If the same racetrack passes a seaside cliff, the user may experience feelings of acrophobia or tranquility depending on the confluence of effects developers are aiming to create.

Qualifiable metrics for virtual sensation. Swink's term *polish* refers to developers' use of effects to impart a sense of physical reality onto virtual objects (Swink, 2009, p. 151). These visuals, sounds, and haptic feedback characterize the physical properties of otherwise intangible objects: In some games, detonating a virtual nuke results in a visible shockwave rippling across the screen, followed by a loud boom and a shaking of the game controller. If these effects were absent, the explosion would feel literally less impactful. Presence can be greatly facilitated not only when users believe they can interact with objects in the world around them, but also that those objects have unique physical properties. *Metaphor* refers to the player's expectations based on the game's representation and treatment of game mechanics and virtual space (Swink, 2009, p. 171). Games that employ realistic graphics and marketed as simulations are expected to have complex mechanics that mirror abilities and functions in the real world: A flying simulator is expected to replicate the complex actions required to fly a plane in various weather conditions. The same simulator, however, would be greatly unsatisfying to most players if the only input to fly the plane was a single button press. Similarly, Mario's cartoonish representation lends credibility that he can make fantastically great jumps with the press of a button. This notion carries over to experiences of presence and help create a suspension of disbelief in the virtual world. *Rules* are the meanings within a game as defined by relationships within a system. "Rules…provide motivation, challenge, and meaning for motion" (Swink, 2007, p. 98). Rules include both higher-order and lower-order goals: Save a princess, leap a chasm, respectively. The rules provide for a hierarchy of values for a player's motions, allowing the player to prioritize actions and focus on long-term goals. Rules also governed health and damage systems, as well as define the physical properties of objects (e.g., an object being too heavy for a player to wield until a specific strength requirement is met). Rules can govern how an affective body is expected to behave, including but not limited to ethics.

Table 6.2. Swink's six metrics for measuring virtual sensations.

	Metric	**Explication**
Quantitative	Input	The material, construction, and design of the input device affect the phenomenological experience, such as playing with a game pad, keyboard and mouse, or hands on throttle-and-stick controller.
	Response	The game's output responds to the player's input signals, modulating the parameters of the game, such as changing the avatar's position in response to the press of a button.
	Content	The simulation of space by collision code and level design that give meaning to real-time control of the player's avatar.
Qualitative	Polish	The artificial cues that are designed to convey forces and masses, such as the sounds of crashing glass to express fragility.
	Metaphor	The player's assumptions are informed by the treatment of the representation of objects and spaces, such as Activision's Call of Duty franchise that pairs military shooter themes with realistic gunfire sounds yet ignores most themes that address the atrocities of war.
	Rules	The purposeful relationships between objects or parameters designed to influence virtual sensation, such as saving a princess or unlocking an achievement.

6.1.2 Interviews with VR Community Practitioners

To complement this study's phenomenological approach to the investigation of presence and the enaction of virtual spaces, interviews with VR community practitioners has been carried out to answer the second research question posed in Chapter 1: How do creators design for immersive experiences to optimize the user's enaction of virtual space? An analysis of open-ended interviews with the cultural-sharing group is expected yield greater insight into how embodied movement plays a significant role in maintain or intensifying experiences of presence because, as an emerging technology, virtual reality is exciting in its potential but also a mystery in many ways, as such technologies provide opportunities to investigate the body's affective encounter with digital information (Hansen, 2006b, p. 163). For the research design study, one research site visit and four sets of interviews were conducted: one set of the interviews was carried out with the development team inside its own VR games, providing a unique opportunity to discuss the strategies for presence and immersion while simultaneously demonstrating those implications in virtual reality. Participants represent researchers, developers, and entrepreneurs who are invested in creating compelling experiences of presence.

6.1.3 Research Sample

To collect the auto-phenomenological data, the researcher participated in several immersive and virtual reality technologies as well as a variety of accompanying software. In October 2017 the researcher was invited to a tour and demonstration at the Virtual Reality Lab at the Center for Computation and Visualization at Brown University by Prof. Tom Sgouros. The second research site visited occurred in February 2018 at the Toxic VR Lounge, a virtual reality and escape room arcade, in Clifton Park, New York. In addition, the researcher owns several head-mounted displays and an extensive library of virtual reality applications. Hardware includes the Samsung's Gear VR, Sony's PlayStation VR (PSVR), Facebook's Oculus Rift, and HTC and Valve's Vive Headset with over 250 hours of use collectively. Over 200 virtual reality software applications from a variety of genres and utilities were experienced: educational and training software; art and media installations; creative platforms for drawing, sculpting, and making music; health and fitness applications; real estate and tourism applications; VR social forums; and several VR games across many genres. For the interviews, the inclusion criteria for the participants are their diverse range of work with immersive experiences: Red Storm Entertainment is the studio behind VR social games Werewolves Within (2016) and Star Trek: Bridge Crew (2016); Donn DeLane, owner of an escape room and VR arcade; Sebastian Sarbora, CEO of Ilium VR, a studio for VR gun peripherals; and Prof. Tom Sgouros, manager of the Virtual Reality Lab at the Center for Computation and Visualization at Brown University. Two of the participants (Red Storm Entertainment and Mr. Donn DeLane) were solicited by email; the remaining two participants (Prof. Tom Sgouros and Mr. Sebastian Sarbora) were referrals. All of the participants agreed to the open-ended interviews.

6.1.4 Data Collection and Analysis

Data collection and analysis strategies for the auto-phenomenological data are derived from Creswell's suggestions based on his adaptation of the Stevick-Colaizzi-Keen method (Moustakas, 1994, and cited in Creswell, 2007, p. 159). Software applications were studied on multiple sessions and across multiple hardware platforms with a systematic, variable approach aimed at separating the phenomenon's content from its context. Data were collected via self-reporting the phenomena and recorded on filed notes, computer and audio files, and personal notes. The data then were analyzed to produce a list of significant statements, followed by grouping the significant statements into larger themes. From these themes, the researcher wrote thick descriptions comprised of both a textual and structural descriptions of the phenomenon: Textual descriptions report the content of the phenomenon (i.e., "what happened during the phenomenon") while structural descriptions capture the context of the phenomenon (i.e., "how did the phenomenon happen") (Creswell, 2007, p. 157). In the discussion of the findings, the two descriptions were integrated into a thick description of the phenomenon that captures the essence of the experience (Creswell, 2007, p. 159). In addition, data were collected via open-ended interviews with seven participants between October 2017 and February 2018 and recorded on audio and video equipment. These interviews averaged approximately 20-40 minutes with additional time set aside to participate in tours or demonstrations of technologies or software. A conventional approach to the analysis of the interview data was applied following Creswell's recommendations (Creswell, 2007, p. 161) adapted from Wolcott (Wolcott, 1990; Wolcott, 1994): (1) The small group of community practitioners is first described, including identifying the inclusive criteria for the study; (2) the findings are analyzed for "pattern regularities," such as reoccurring statements and connections to the group description (Creswell, 2007, p. 162); the patterns are then interpreted for meaning and addressed in the discussion of findings. For both the auto-phenomenological and interview data collections, additional data were captured in fieldnotes, audio recordings, and computer files.

6.2 Presentation and Discussion of Findings

The findings for the research study are presented below. To better reflect the subjective nature of the auto-phenomenological methodology as it pertains to the experience of a single body, I have opted to use first person voice in the discussion of the findings in this section. I first analyzed the data using the process of horizontalization in which significant statements are identified and given equal value (Moustakas, 1994, and cited in Creswell, 2007, p. 235). I present selected examples of significant statements from my auto-phenomenological self-reporting records and interviews along with their formulated meanings in Tables 6.3. and 6.4., respectively. The criteria for determining the significance of the statement regard that statement's relevancy to presence or the enaction of virtual spaces. I first formulated clusters from the significant statements from the data sets according to thematic qualities relevant to the theoretical framework for presence proposed (i.e., those that were determined to be an essence of the phenomenon); second, formulated meanings were interpreted from the thematic clusters, such as the sample seen in Table 6.5. below. My analysis of the findings reveals three themes, each presented below as a composite description, related to the essence of experiencing presence and enaction of virtual spaces. First, when engaged with virtual reality technology, my affective body encounters an assemblage of three phenomenologically distinct types of stimuli that inform experiences of my body's enaction of virtual spaces. Second, movement is identified as a fundamental activity for achieving presence and phenomenologically distinct according to qualitative, quantitative, and temporal properties. Third, my movements choreographed among multiple affective bodies greatly increases sensations of presence and my body's enaction of virtual spaces.

Table 6.3. Selected examples from self-reporting. Selected examples of significant statements from auto-phenomenological self-reporting records regarding presence and enaction of virtual spaces.

Samples of Significant Statements from Self-Reporting	Formulated Meaning
[Recorded after a session with a VR first-person shooter, War Dust] "My teammates are dead, and we are losing the checkpoint. I'm hiding in bushes at Delta. The icon above the checkpoint is flashing, indicating to the enemy troops that I am still in the area. I am crouching, not moving, careful not to breathe too heavily into the microphone so to not give my position away. I can hear the enemy players whispering in Russian; I know they are talking about me. The binaural audio reveals their approximate orientation and distance, even though I only hear three sounds from them: their voices, footsteps, and gunfire. Gunshots and explosions echo across a virtual landscape reminiscent of an unidentifiable war-torn southeast Asian country. I can feel the plush shag carpet under my elbows and belly, but all I can see is the pixelated foliage surrounding me. My movements are small, slow. I move only when they make noises. I lie prone on the shag rug on the apartment's hardwood floor and slowly crawl away from enemy voices. Random shots are fired into the bushes; sounds of whizzing bullets pass over me. The weight of the HMD strains my neck as I raise my head to get a better view. The weight of the HMD reminds me of the helmet I wore in Marine boot camp. My mind drifts between old memories and this virtual daydream."	Intense sensations of presence can be experienced during cat-and-mouse maneuvers and other highly spatialized choreographies.
[Recorded after a session with the virtual reality edition of The Elder Scrolls V: Skyrim] "I have played [The Elder Scrolls V: Skyrim, 2011] enough to have completed the main campaign, and so am familiar with the location of the towns relative to one another, the NPC's and their related quests. But I have never been to Skyrim in virtual reality [The Elder Scrolls V: Skyrim VR, 2017]. I am riding a horse I bought from a stable to circumnavigate the perimeter of the map [a feat that would take over 12 hours to complete]. I have no body in the virtual fantasy world, save for the stiff pair of gauntlets that represent my hands. I squirm on the stool I am sitting on and feel a numbness in my bottom that I first attribute to horse riding rather than the two-hour session. I press my left thumb on the controller's touchpad to move the horse forward. There are sounds of hoof steps and neighs from under me. I hear the familiar shriek of a dragon and see its outstretched shadow pass over me and the horse. I set the horse to a gallop and lift my neck searching the sky for the dragon. The trees have been modified from the vanilla edition of the game and now stand three times higher than normal and obscure my vision of the sky. The dragon's roar is louder and all around me; I turn my neck quickly and feel the extra pound on the front of my face swing with inertia. My heart is beating quickly and I realized I have been swearing aloud.	Responsive movements can be characterized qualitatively (e.g., evasive) and quantified according to force or form (i.e., fleeing)
[Recorded after interviewing developers via their own VR social game, Werewolves Within] "Five pairs of virtual eyes stare back at me. The avatars' eyes have been programmed to look at whoever is using the microphone. I can see that I have their attention, but I cannot understand their passive expressions. One-on-one makes it feel intimate, but a circle of cartoonish faces akin to ventriloquist dolls staring and blinking felt intimidating. I cannot read these inhuman interfaces. My voice shakes, and I unexpectedly feel something akin to stage fright. They move like humans, but they don't feel like humans."	Movement perceived as belong to a sentient may foster experiences of presence qualified as repulsive

Table 6.4. Selected examples from interviews. Selected examples of significant statements from interviews regarding presence and enaction of virtual spaces.

Significant Statements from Interviews	Formulated Meaning
"So, when you put the goggles…when you put on VR goggles and you look down, there are no feet there. You look down at your feet and there's no feet there. Or, almost as unsettling, you look down and there's somebody's else's feet there. You either a disembodied eye in the world…or you look down and it's somebody's else's feet, which is also kind of weird. Being able to look down and see yourself there is a much more natural thing and it kind of takes that unsettling part of it off the table completely. Makes it essentially a nonissue. Because this is the display, we spend most of our time in, I don't actually spend a lot of time thinking about presence because we have it…But we don't have to make you feel presence because you are." (T. Sgouros, personal communication, October 18, 2017; see Appendix A.1.)	Embodiment, perceiving a body, either virtual or corporeal, helps gives a sense to "being there" in a virtual space.
"You don't really need that powerful of a recoil. So, the idea…you can have a recoil that kicks back really hard, but for the most part it's diminishing returns in terms of immersion. People need a certain level of kick, but for the most part as long as people get that level of feedback, it's going to work. As long as the feedback…takes the right form. So, having a vibration really doesn't factor. It gets close, but it doesn't really count itself." (S. Sabora, personal communication, February 15, 2018; see Appendix A.4.)	Tactility need not be realistic but rather structured experientially to be immersive.
"I think it might be the physicality of it. Because being able to be within the same virtual-physical proximity of somebody and actually seeing them in front of you, hearing their voice come out of their avatar, seeing their hands move the way that their hands are actually moving, and being able to go up to somebody and high-five them, being able to throw something for somebody and them catching it, or being able to let go up to somebody and shooting them…. Even that is so much different than actually playing it online because if you're playing online, you're not actually interacting with that person. You're interacting with their character that they're playing. In VR, it's different because you're not just looking at the character or not just looking through the eyes of the character. You're in the character that you've made in VR. So, it's more you then it would be if you were playing on an Xbox, Call of Duty, or something like that." (Toxic VR Lounge employee, personal communication, February 16, 2018; see Appendix A.5.)	Sharing virtual spaces with virtual bodies can induce strong sensations of presence.
"For example, when I'm facing you, my eyes lock on to you because when we first created the game, we didn't have that system, so I'd just be kind of…my eyes would be looking past your shoulder, which feels just as weird in the virtual environment as it does in the real world. Other things like these gestures when you feel pointed at, or when somebody's staring at you. You get that sense of being stared at. You have the whole group staring at you. That same sort of, in the back of your mind uncomfortable feeling, so there's lots of really interesting aspects of VR in terms of social VR how the real-world social cues translate over to you, over to the virtual environment, and I think it's trying to replicate and create avatars to replicate that as closely as we could with the limited technology we have." (dvotypka25, personal communication, October 24, 2017; see Appendix A.2.)	Social cues can be powerful triggers for presence.
"And I'd also say that the roles that you can play, since the game play is asymmetric, and you play very different roles. There's a social context in the roles themselves, so there's an expectation if you're going to play as captain, that you're going to be a leader. You're going to, you're going to lead the group, and when you have a player whose personality or desire to play in that role fits well with that, the game works really well, and then when we see sessions where somebody is not comfortable being a captain, those tend to be	Roleplaying can give meaning and expectation to player's interactions, and induce sensations of presence; however, not participating in the

very awkward sessions. It's like having somebody who just sits there quietly in the captain's chair is very awkward for everybody and makes it really hard to play. So there's a kind of social pressure on the captain to be the one who's talkative, to coordinate the other players, and that's reinforced in the game by the captain having more information than all the other players. The captain has an overview of what everybody else knows, and that's to prompt the captain to talk, to coordinate." (MonkeyCheez, personal communication, October 24, 2018; see Appendix A.3.)	roleplaying can be immersion-breaking.

Table 6.5. Example of theme clusters. Associated formulated meanings from the data sets detail the cluster.

Example of Theme Cluster	Examples of Associated Formulated Meanings
Enaction occurs via choreographed movements among multiple bodies	Embodiment, perceiving a body, either virtual or corporeal, helps gives a sense to "being there" in a virtual space. Sharing virtual spaces with virtual bodies can induce strong sensations of presence. Social cues can be powerful triggers for presence. Intense sensations of presence can be experienced during cat-and-mouse maneuvers and other highly spatialized choreographies. Movement perceived as belong to a sentient may foster experiences of presence qualified as repulsive Roleplaying can give meaning and expectation to player's interactions, and induce sensations of presence; however, not participating in the roleplaying can be immersion-breaking.

6.2.1 Theme 1: Enaction of Virtual Space Is Experienced as an Assemblage of Stimuli

My findings suggest that the inclusion of immersive technologies for the mediation of my perception of space results in a trifurcation of my sensory stimuli into an assemblage of three phenomenologically distinct classes: *mediated* stimuli, which is supplied by the technological apparatus that intervenes between the my body's sensory receptors and the natural stimuli of the external world; *constrained* stimuli, which refers to stimuli mitigated or denied by the technological apparatus; and *unmitigated* stimuli, which are neither mediated nor constrained by the technological apparatus. An essential quality to my sensations of presence is the interplay of the mediated-constrained-unmitigated stimuli assemblage that informs my body's enaction of virtual space. This assemblage of mediated-constrained-unmitigated stimuli is explicated in Table 6.6. at the end of the section.

The mediated stimuli supplied by the technological apparatus, such as light from displays or sound from headphones, need not be realistic for my experiencing of presence, and that a more essential feature of the phenomenon is animation: My perception of movement, either as an image that decreases in size on a display screen or sound file that has been modulated to replicate the doppler effect, is fundamental to the experiencing of virtual space. Headphones and binaural audio software can mediate sound so effectively that the user can perceive direction and distance of the source quite accurately, such as an enemy's location after firing a weapon, or to attract attention: "Binaural audio… made a huge difference in being able to sort of listen into one person, as opposed to just having this cacophony of noise when everybody else was speaking" (dvotypka25, personal communication, October 24, 2017; see Appendix A.2.). Moreover, animation that replicates the movements of a human being correlates with intense experiences of presence, revealing that it is the perception of movement, not the representation, that gives form to living things. "I think it is sort of subconscious in our lizard brain. Our brain can differentiate that. Between an animated [hand gesture] or emote or motion-captured head movement" (dvotypka25, personal communication, October 24, 2017; see Appendix A.3.). Humans move, even when they think they are not.

> There's the way that that movement interacts with voice, for example, is really telling. When you talk, your body moves. You could try to hold your torso rigidly still, but you have to fight. You're just the way your lungs make your chest move and so forth. When we're doing the head tracking and relaying that to your avatar, all of that just happens. We don't have to figure out how it works. We just copy it, and it's very convincing. (MonkeyCheez, personal communication, October 24, 2018; see Appendix A.3.)

Thus, my perception of movement appears to be a structural property rather than an indexical property. However, the proximity of the mediated stimuli to the sensory receptors plays a crucial factor in their perception as first-order stimuli, and therefore enaction. Display screens, although lacking the technical capacity to provide photorealistic images on par with those images captured by the human eye, can capture the attention of the human sensory system due to their proximity to the sensory organs. Yet, proximity also reveals the technological shortcomings of the apparatus. The screen-door effect, for example, refers to the visible edges of the pixels comprising a display screen placed a few inches from the eyes, which draws attention to the technological apparatus rather than the mediated stimuli. Other examples include anti-aliasing effects, the lack of manual interpupillary distance adjustments, or minimal sweet spots, jargon for the small area of focus where the display screen, the HMD's lens, and wearer's eyes are optimally aligned for best resolution. Phenomenologically, what is understood to be technological defects in the apparatus I experienced as mediated stimuli that work against the mediated-constrained-unmitigated stimuli assemblage's effort to inform my body's perceptual model of circumambient space. Naturally, mediated stimuli also account for ergonomics, as the design of the technological apparatus informs the overall immersive strategies being applied (i.e., poorly design headsets may become uncomfortable after a short use, breaking experiences of presence). As mediated stimuli becomes first-order sensory stimuli for the human body, other natural stimuli are either constrained or denied by the technological apparatus. Technologically, most mediated stimuli lack the fidelity, richness, and complexity of natural stimuli, and the dwindling or absence of stimuli is felt by my body. By virtue of design, a head-mounted display narrows the user's natural field of view from approximately 190 degrees (Howard & Rogers, 1995, p. 32) to 110 degrees. Although this narrowing of the my field of view may have been unnoticed at times, my affective body is always aware of this deficiency and may focus attention more intensely on sensory receptors that are still receiving stimuli as a sort of compensation: My limited field of view in the headset is compensated by more turns of my neck or body; however, a limited field of view appears also to reduce peripheral motion during artificial locomotion, as if I were wearing ski goggles. Although the technological apparatus can mediate some sensory stimuli while denying other sensory stimuli, there will always exists stimuli that are neither mediated nor constrained by the technological apparatus. Unmitigated stimuli are the natural sensory stimuli that surround the human body of every moment of the lived experience whether or not these stimuli are consciously perceived. Dropped framerates, for example, may have been unobserved but impede my enaction of space nonconsciously. The forces of gravity, another example, are unaffected by the technological apparatus; thus, the floor or ground is tactile resistance to these forces. Smell and taste chemical receptors characteristically are unaffected as well by the technological apparatus, but I have, at times momentarily perceived a whiff of burning dust from my dirty computer as originating from the virtual blaster in my virtual hand.

Table 6.6. The mediated-constrained-unmitigated stimuli assemblage.

Class	Explication
Mediated Stimuli	Sensory stimuli supplied by the technological apparatus, such images on the display screen, sounds from the headphones.
Constrained Stimuli	Sensory stimuli constrained or prevented by the technological apparatus from reaching the body's sensory receptors: the limited field of view of the HMD not only narrows the body's natural field of view but also occludes images outside the mask.
Unmitigated Stimuli	Sensory stimuli that is unaffected by the technological apparatus, such as the feeling of the floor beneath the user's feet.

6.2.2 Theme 2: Enaction of Virtual Space Comprises of Three Phenomenological Structures

Sample statements taken from the auto-phenomenological self-reporting fieldnotes suggest that my body privileges movement as the essential structure for its enaction of virtual environments and experiences of presence. In the initial moments of the phenomenon, my body orientates itself in virtual spaces via movements, typically beginning with small motions in my neck and head across the x- and y-axis to survey the environment ("take in the landscape"; J. Coley, personal communication, 2017-2018), followed by reaching out my arms and hands into the virtual space ("poking the world into action"; J. Coley, personal communication, 2017-2018), and finally taking a step or two across the play space IRL ("getting my footing in the virtual world"; J. Coley, personal communication, 2017-2018). My perception of space is enacted via movement, and without movement there can be no experience of space; however, not all of my movements produce space: If a performed movement did not correlate with sensations of presence, my body quickly abandons it. Only movements that facilitate spatialization (i.e., the perception of volumetric space accessible along the x-, y-, and z-axes) do I repeat in variation ("testing the limits of the machine"; J. Coley, personal communication, 2017-2018). Furthermore, these movements are phenomenologically distinct according to three affective structures: quantitative movements, which reflect the fluctuation of intensities of presence during enaction of space; qualitative movements, which reflect the spatialization processes employed by the asymmetrical anatomy of the human body; and temporal movements, which reflect the changes in the sensations of presence over time.

Quantitative movements are structures that are characterized by their speed and range and correlate to the intense sensations of presence I experienced during my body's enaction of virtual spaces. Movements performed quickly, such as swinging the arm in a downward motion, correlated to greater sensations of experiencing volumetric space; movements executed over a wider range, such as my arm swinging in a 110-degree arc, also correlated to more intense sensations of "being there" in the virtual environment; furthermore, movements across large tracking areas also correlated with more intense sensations of presence. Not only is the area tracked by the Vive Base Stations significantly larger than the area tracked by the PlayStation Camera[51], but also the photovoltaic technology of the former is faster and more accurate than with the single-camera approach of the latter: Larger play-spaces and more accurate tracking technologies correlated with my experiencing of more intense sensations of presence. In addition, movements I performed during enaction acquired experiential properties according to the affordances and constraints of human anatomy, providing a qualitative structure to the experience of presence. These qualitative

[51] The Sony PlayStation Camera tracks an area approximately 32 square feet (Sony, 2016, p. 8), while the HTC Vive Base Stations track a maximum area approximately 130 square feet (HTC, 2016, p. 18).

movements are characterized also by my attitudes regarding a force-form continuum. *Offensive maneuvers* are movements that I connotate with forward advancement, affirmation, aggression, competition, destruction, and attack: *Strikes* and *slashes* emphasize force over form, such as when I swing lightsabers to slice floating blocks in the rhythm game Beat Saber (Beat Games, 2018); *pierces* and *punches* emphasize form over force, such as stabbing enemy soldiers with swords in Blade & Sorcery (WarpFrog, 2018) or throwing a right hook in boxing game The Thrill of the Fight (Ian Fitz, 2016). On the other hand, some movements I can characterize more as *defensive maneuvers* and connotate protection, alertness, and anticipation. Defensive maneuvers that embrace force over form are *parries*, while movements that are structured more for form over force are *blocks*. Although in Blade & Sorcery players deflect with longswords and block with shields, these maneuvers also describe the structure for movements during the enaction of space that I characterize as movements of preservation: Parries are embodied movements to redirect another force away from my body; blocks are embodied movements for withstanding or overcoming another force experienced upon my body (e.g., hitting virtual balls with one's face in Danger Ball, a minigame in PlayStation VR Worlds, 2016). Some movements, however, are not concerned with offense or defense, but rather avoidance. *Avoidance maneuvers* I connotate with danger and risk. Maneuvers that privilege force over form, *skedaddles*, evoke feelings in me of panic and chaos, are characterized as frenetic, and structured as dodges, sidesteps, locomotion, and other movements in which speed is prioritized. At the other end of the continuum, maneuvers that privilege form over force, *evasion*, evoke feelings of secrecy, deliberation, and purposefulness, such as crouching, hiding, and crawling to avoid detection. Budget Cuts (Neat Corporation, 2018) applies game mechanics and level design to facilitate such maneuvers as a dominant style of game play in which players physically step through teleportals to infiltrate a high-rise full of armed robots. In addition to the quantitative and qualitative affective qualities of movements, my body performs maneuvers in response to the changes between intensities and kinds of presence I experience. These movements possess a temporal structure in which duration and sequence of the maneuvers correlate to experiences of presence during the enaction of virtual space. Although I approached the session by first phenomenologically divorcing my presumptions and expectations from previous sessions, my body demonstrates phenomenological distinctions between the intensities of the sensations of presence as well as the complex interplay among the kinds of maneuvers executed during enaction. The *duration* of the movement correlates to stronger experiences of presence. For example, over multiple sessions, I learned to minimize simulator sickness by relaxing my eyes and focusing directly ahead, similarly how one perceives an autostereogram, which reduces the perceived peripheral motion. Jet Island (Master Indie, 2018) defies many design game axioms for virtual reality by having players surf hoverboards at perceived high speeds (i.e., the passing of massive objects) and taking to kilometer-high ski jumps, movements that conventionally should make the player sick due to vestibular disequilibrium, yet enaction occurs as I learn to relax my eyes and concentrate only on a small area before me. Over time, my body develops a kind of muscle memory in which *sequence* correlates to stronger experiences of presence: for example, learning how to reload a weapon in a VR shooter, such as Contractors (Caveman Studio, 2018), is typically a multi-stage process (i.e., eject the empty magazine, grab a fresh magazine from the hip, insert full magazine into the weapon, and finally load the chamber by pulling back on the slide). These three qualitatively distinct maneuvers are detail in Table 6.7. below.

Table 6.7. Qualitative movements described from Theme 2.

Maneuver	Explication	Force over Form	Form over Force
Offensive Maneuvers	Movements that connotate forward advancement, affirmation, aggression, destruction, and attack	Strikes and Slashes	Pierces and Punches
Defensive Maneuvers	Movements that connotate protection, regression, alertness, and anticipation	Parries	Blocks
Evasive Maneuvers	Movements that connotate danger and risk	Skedaddles	Sneaking

6.2.3 Theme 3: Enaction of Virtual Space Can Occur via Choreographed Movements

My findings indicate that the shared movements of my body with other bodies in virtual spaces perform a choreography that correlates with intense and diverse sensations of presence during enaction of virtual space. Choreography is used here to describe a relationship of responsivity among bodies in a shared virtual space, adapted from Kozel's term (Kozel, 2007, p. 207). Responsivity, following Kozel's lead, is more descriptive of the enaction of virtual space over interactivity: the latter lacks the philosophical room to account for the alterity of subjects within the choreography; the former accounts for how movement can change the "construction of the subject" (Kozel, 2007, p. 186), which describes the structure of an enaction of space that alters those subjects participating in the choreography. Sharing virtual spaces with other human beings—at least the perception of human beings—I correlate with accelerated enaction of virtual space and intense, varied sensations of presence: "It's your avatar, but it's still just seeing the motion of another. Because it still is…it's a human making those motions and stuff, yet so digitally enhanced, but that's kind of the interesting" (D. DeLane, personal communication, February 16, 2018; see Appendix A.5.). Echoing the structures of the experience of enaction presented in Theme 2 above, the movements constituting a choreography in virtual spaces can be phenomenologically distinguished by three classes according to their affective structures: quantitative choreographies, which refers to the number and density of perceived human-controlled avatars within a shared space; qualitative choreographies, which structure participation of the movements; and temporal choreographies, which describes the frequency and sequence of choreographies that constitute macro-choreographies over time.

Quantitative choreographies are collections of affective movements exchanged among a group of perceived sentient entities (i.e., human-controlled avatars) in which the number and density of beings occupying a given volume of virtual space provide structures to the experiencing of enaction. My findings suggest a correlation between (1.) an increase in bodies as well as the proximity of the bodies to one another and (2.) an accelerated enaction of virtual spaces. Generally, the more bodies I perceived in a given space coincided with more intense sensations of presence. Minecraft VR (Mojang AB, 2016), VRChat (VRChat Inc., 2017), and OrbusVR: Reborn (Orbus Online, LLC, 2019) allow for dozens of players to cooperate in large scale construction projects, socialize in virtual forums, and participate in large-scale dungeon raids to battle world bosses, respectively, affording space for affective choreographies to perform the kind of movements that give meaning to my body's experiencing of enaction in shared virtual spaces. My first-order attention is given to the number of beings and their spatial relations, including the positioning of the subject within a choreography of responses, which correlates with enaction. Some VR applications populate virtual spaces with non-player characters (i.e., computer-controlled characters that may or may not resemble other players), such as Tales of Glory (BlackTale Games, 2017), to mediate the phenomenological experiencing of crowds, correlating with fleeting sensations of presence.

Qualitative choreographies describe my participation within phenomenologically distinct collections of movements that structure enaction, and, mirroring the qualitative movements described in Theme 2, are characterized as continuums of force versus form. Cooperative responses characterize my ethnocentric movements that work toward shared goals or purposes of the group. My enaction of virtual space (i.e., my body's growing sense of occupying circumambient space) appears to correlate with cooperative responsive movements, and overall more intense or sustained sensations of presence. Furthermore, cooperative responses may be characterized according to privileging either force (i.e., emphasis on speed and power) or form (i.e., emphasis on precision and control) for the structure. Cooperative responses that emphasize force over form describe dynamic, atomic movements that respond to contentual movements in the shared virtual space: In Echo VR (Ready At Dawn, 2017), a VR sports game akin to soccer in zero gravity, players navigate the field by pushing or pulling their bodies on/off walls, structures, and even other players as they positions themselves to pass, carry, or intercept a frisbee. I describe these responses as dynamic as they are highly determinate on contentual clues, such as the positions of players on the field. Cooperative responses that emphasize form over force, on the other hand, I describe as stable, rhythmic movements that respond to contextual movements in the shared virtual space. In Star Trek: Bridge Crew, each of the four player stations (e.g., captain, engineer, helm officer, and tactical officer) operate some part of the starship yet function interdependently upon one, and so players must coordinate their efforts in order to command the ship properly, a design strategy meant to keep players engaged with other players despite interacting with the station's interface:

> So, we wanted to design, to try and have the players engage with one another, so we actually made the stations rely upon one another. So, for example, going to warp is not just the engineer sending the ship to warp. It's actually a multi-step process where each of the different stations need to be involved and rely on one another for power and for charging warp coils and those kind of things. So, we had to design more specifically to generate social discussion and social interaction and engagement for the players. (dvotypka25, personal communication, October 24, 2017; see Appendix A.3.)

Here, the varying movement across the virtual interface can accommodate structural (i.e., contextual) changes in the phenomenon. Cooperative responses impart a sense of altruism in their structures. My experience in roleplaying, as in Werewolves Within and VRChat, supports my enaction of virtual spaces by designing social experience around choreographies of cooperative responses. VRMMORPG's[52], such as OrbusVR: Reborn encourage roleplay as well as players respond to the performances of other players at the cast spells, shoot arrows, or play magical instruments.

Unlike the ethnocentric movements of cooperative responses, competitive responses describe egocentric movements that work toward my goal, which is usually in conflict with other movements in the choreography. Competitive responses are movements intended to influence the choreography in the subject's favor at the direct or indirect expense of the other subjects participating in the choreography. Participation is characterized as an elimination/domination, contest, or race over limited resources or accolades and phenomenologically nuanced according to emphasis on either force or form in performing bodily movements. Competitive responses that embrace force over form are described as direct and intimate. Death match or free-for-all modes in VR shooters, such as Pavlov (davevillz, 2017) and Onward (Downpour Interactive, 2016), are designed to encourage responsive movements performed in proximity to other virtual bodies as players zig and zag through tight corridors, duck or dive behind virtual objects for cover or concealment, and fire weapons blindly around corners in a choreography of competitive responses. I describe these movements as "frenetic," "cathartic," and "kinetic," and associate them with accelerated enaction of virtual space. Inversely, competitive responses that give more attention to form participate indirectly or distantly relative to the other movements in the choreography. Separating or distinguishing my movements from the choreography allowed the subject more time or space to plan and execute responsive movements. Stand Out (Raptor Lab, 2017) is a VR battle-royal game in which players compete for limit resources while systematically eliminating each other in a one-man standing free-for-all. As the timer counts down, the map (i.e., the area of the virtual

[52] Virtual reality, massive multiplayer online roleplaying game

play-space) shrinks, forcing encounters among players by removing virtual space. This continual re-spatialization of the virtual environment, coupled with the competitive goal of the game, affords space for choreographies that allowed or motivated me to undermine other players' maneuvers, such as destroying resources (i.e., health packs and vehicles) to prevent other players from performing their maneuvers within the choreography. Competitive participation performed in these precise, controlled choreographies are described as "premeditative" and "clandestine" (J. Coley, personal communication, 2017-2018), as found in Death Run, a game mode in the VR social application VRChat in which approximately twenty players compete simultaneously to complete a virtual obstacle course while avoiding instant-kill traps activated by one or two players. The goal is simple: The first player who reaches the end of the obstacle course wins the match. This novel game design encourages a complicated competitive choreography in which the players are competing with not only one another to be the first to finish the course, but also the smaller, invisible group of players who activate single-use traps (e.g., spikes springing from the walls, pathways collapsing into the abyss, ceilings crushing players) to keep all players from reaching the end. Hence, activating the traps in order to eliminate the rival players in the obstacle course becomes strategic to winning the game: my movements, such as feints and dashes meant to trigger traps, are indirect responses to the movements of other players, which requires, in part, me anticipating which movements are likely to be performed by individual beings to leverage control over the choreography. Both cooperative responses and competitive responses are distinguishable by the phenomenological nature of my participation of the choreography (i.e., ethnocentric-egocentric continuum) during the experience of enaction.

However, a third phenomenological class of participation that characterizes responsive movements as "secluding" or "shielding" my body from the choreography. Reclusive responses aim to minimize encounters with other choreographies; I participate within the reclusive choreography to the extent that I can move through the virtual space apart from other choreographies. VR multiplayer games often have simple features, such as mute and personal space boundaries options, to detour trolling and other anti-social behaviors. Players also can be voted out of matches. Reasons for avoiding other players range widely: offensive avatars, trolling, stalking, powerful players, distracting noise in the audio quality, or the presence of children[53]. Reclusive responses are also conceptualized as a continuum: Responsive movements "separate," "divorce," and "amputate" my body from the choreography emphasize force over form, whereas form over force participation "deflects," "protects," and "shields" my body from the choreography. Reclusive choreographies, as with other qualitative choreographies, may privilege speed and range structures to evade other choreographies, such as those found in player gatherings or hubs within virtual worlds, and characterized as "dynamic," "fluid," "high-energy," and "chaotic." At the other end of the continuum, reclusive choreographies that emphasize form over force to minimize my participation with other choreographies I describe as "stable" and "homogeneous," thus my engagement in the choreography shields my body from other movements. In VRChat, for example, players can create virtual spaces that are contentually (i.e., the aesthetics of the virtual space) and/or contextually (i.e., the game mechanics that govern interactions between players) consistent with themes that privilege some choreographies over others, such as escorting the bride in an avatar wedding held in a virtual chapel or waiting patiently for one's turn while playing I-never and other parlor games. Players who did not roleplay or participate acceptably were "blocked" by other players (i.e., muted, personal boundaries mechanics, or voted out of a space), coordinated evasive maneuvers among multiple bodies intent on preserving existing choreographies from unwanted choreographies. (See Table 6.8. below for explication of the three qualitative choreographies.)

[53] Although some VR software have implemented age restrictions, not all VR applications possess these features. Players were inferred to be minors due to their relative high voices and shorter avatar heights.

Table 6.8. Qualitative choreographies described in Theme 3.

Choreography	Explication	Force over Form	Form over Force
Cooperative Responses	Choreographies that connotate ethnocentric movements that work toward shared goals or purposes of the group	Speed and Power	Precision and Control
Competitive Responses	Choreographies that connotate egocentric movements that work toward the subject's goal, which is usually in conflict with other movements in the choreography	Directness and Intimacy	Indirectness Distance
Reclusive Responses	Choreographies that connotate a separation or indifference to other choreographies	Separation and Amputation	Protection and Nullification

My body's enaction of virtual spaces obviously can be characterized as a temporal experience. Temporal choreographies describe the structures of meaning for the frequency and sequence of choreographies across multiple sessions, such as returning to the same game for days or weeks, in which said choreographies "evolve" as I "get VR legs." Here, the choreography is performed across time with the same body: For example, the VR version of The Forest (Endnight Games Ltd, 2018), a cooperative survival horror game in which players mine resources and build walls during the day to protect themselves from cannibal mutant attacks at night, allows for multiple players to participate in building massive structures over several gaming sessions. My experiences in these sessions suggest that enaction of virtual spaces can be structured as a series of interrelated choreographies with a single body moving within a temporal dimension: revisiting the same camp in The Forest with the same players correlated with increasing sensations of presence for longer durations despite the changing virtual environment (i.e., trees are chopped down, new buildings are erected). Enaction, in part, is the structuring of aggregations of choreographies regarding the frequency between sessions, as shorter time between sessions correlated with increased or sustained sensations of presence. Intense and qualitatively distinct experiences of presence correlated more often when sessions were played in varying sequences. Moving from first-person-shooter Onward to Pavlov, for example, correlates with stronger experiences of presence for my body than the inverse order: The interesting distinction between the two VR first-person-shooters is that the former is designed to be a realistic military-simulation, and so limited ammunition, more precise game mechanics, and lack of enemy or friendly markers encourage a phenomenologically different game than Pavlov; the latter is more played more casually (i.e., my body may take a relaxed pose and turn with the controllers rather than the body) than the former.

Challenges to collecting data for auto-phenomenology include effective analysis of one's experiences to uncover the essence of the phenomenon while avoiding causality or psychological descriptions (Drummond, 2007, p. 61-62). To maximize analysis, the design study adapts Kozel's phenomenological methods for bodies in proximities and trajectories (Kozel, 2007) and Swink's metrics for virtual sensation (Swink, 2009), for reasons mentioned above. In addition, the sample size for the interviews is limited, and so a larger sample size is presumed to yield a better understanding of the phenomenon as it is understood by researchers, developers, designers, and new media artists. As previously discussed, it is this intention to provide only a starting point for the investigation of the body's enaction of virtual spaces and its intersection with presence and advocates further investigations into this research.

7. IMPLICATIONS OF FINDINGS FOR A DIRECTIONALITY OF PRESENCE

The discussion of findings supports the proposed theoretical framework for a third domain of presence characterized by the affective body's repertoire of bio-culturally-determined embodied movements employed to enact affective spatial experiences in mediated environments. Directionality gives these movements affective meaning and are strongly associated with spatial schemas derived from the Affective Spatial Schema proposed in Chapter 5. Findings support that the corporeality of movements provides structure for the affective body's enaction of virtual spaces: The moving body is the instrument of perception, as Hansen postulates (2006b), and susceptible to affectivity; movement is connected to sensation, emotions, and feelings. Therefore, movement has qualitative effects on perception, however slight: "motion functions as the concrete trigger of affection as an active modality of bodily action" (Hansen, 2006b, p. 7). Human bodies occupy spaces, and how those spaces are perceived are in part formed by how the affective body mediates these spaces through the gestures it makes, the postures it assumes, and the locomotive techniques it employs, and consequently, shapes experiences of presence. The affective body also perceives directionality in other living things via organic movement. AI-controlled beings in virtual environment are typically easy to recognize, as they lack the organic, highly responsive movement exhibited by a living human being. Under the theoretical framework for presence in which bodies are privileged, co-presence, an experience of presence in which human beings experience a sense of "being there" in a shared virtual environment (Campos-Castillo's review of the literature, 2012), is a choreography of responsive movements that provide structures for affective bodies to enact space and experience sensations of presence. As the affective body perceives space via embodied movement, so to does the affective body recognize this embodied movement in other living things: The affective body is differential to the organic, unpredictable yet responsive movements characteristic of human behavior that AI-controlled entities in virtual environments are seldom technologically capable of replicating[54]. In short, findings support that the Affective Spatial Schema assigns affective meaning to embodied movements, which phenomenological impacts on experiences of enaction. This chapter outlines two theoretical implications from the findings for a directionality of presence: the affective body's desire to (1.) manipulate its environment affectively and (2.) participate in roleplay as means to achieving compelling experiences of presence. These implications, along with the theoretical framework that positions affectivity as the organizing mechanism of presence, comprise the foundation for a topology that conceptualizes the important features of the directionality of presence, the affect-rich embodied movements the affective body performs to enact affective space in virtual environments. This topology for a directionality of presence is meant as a starting point for further investigations into the body's enaction of virtual spaces and the sensations of presence associated with the phenomenon.

7.1 Theoretical Implications for Presence

The implications of the findings suggest that the affective body desires a manipulation and sharing of spaces that can be leveraged in creating compelling experiences of presence. In the experiencing of presence, the affective body desires stimuli that can satiate these appetites, providing direction for movements that enact reverberating sensations of presence felt through circumambient space. Two such desires are implicated theoretically here: (1.) The affective body is driven by a desire to manipulate spaces affectively while mitigating the anxiety of living in a harsh and mysterious world; and (2) the affective body desires to participate with other perceived sentient

[54] Human-controlled avatars typically exhibit a greater range and expression, even if the avatar is technically limited to a few discernable outputs, as demonstrated in Journey's (Thatgamecompany, 2012) cooperative game mechanic in which two anonymous players communicate via tuneful chirps mapped to a single button on the controller that responds to the duration and speed of button presses allowing for the two strangers to "speak" to one another (Clements, 2012; Kuchera, 2011). Despite such a limited communication, a human-controlled avatar can exhibit behavior that is perceived to be a contextual response: a series of rapid, high emotive sounds seems to indicate a warning, beckoning, or some other attention-seeking behavior. More interesting are the non-tonal properties that have been mapped to tonal structures. Linguistically, a single chirp correlates to an affirmative response, while a double chirp is interpreted as a negative response.

beings in choreographies that facilitate sensations of presence. These implications for presence are reconciled with current theories of evolutionary psychology and anthropology, which inform the topological map for presence presented in the next section.

7.1.1 Implication 1: The Affective Body's Desire to Manipulate Affective Spaces

Returning to Yi-Fu Tuan, the theoretical implications for this experiencing of space affectively intersects two of his works: *Topophilia: A Study of Environmental Perception, Attitudes, and Values*, which explores the affinity between people and places (Tuan, 1990, p. 4), and *Landscapes of Fear*, which investigates how anxiety drives people to alter their environments in an attempt to mitigate the omnipresent forces of chaos (Tuan, 2013, p. 6). Tuan's topophilia is concerned with how human behavior is shaped by a love of place, "from visual and aesthetic appreciation to bodily contact," as well as relationships among bodies (Tuan, 1990, p. 92). Attachment to a place, as found in a home, involves an "awareness of the past" (Tuan, 1990, p. 99), but a sudden, arresting view of nature may evoke a deep sense of serenity (Tuan, 1990, p. 94). Because the environment provides the sensory stimuli in which the affective body uses to form mental images (i.e., the perception of space and the objects within it), Tuan argues that some environments can evoke directly or indirectly deep feelings of topophilia via sensory: the cabin in the woods, the seashore, the valley, the island, for example, are often depicted as scenes of the idyllic (Tuan, 1990, p. 113, 114-121). These places are the settings of folk stories and depicted in paintings. However, Tuan recognizes that a sense of place may also evoke deep feelings of fear, disgust, and dread, such as the mental image of a leper colony (Tuan, 2013, p. 98). Humans satiates these "landscapes of fear" (Tuan, 2013) through order: "Generally speaking, every man-made boundary on the surface of the earth's surface—garden hedge, city wall, or radar 'fence'—is an attempt to keep inimical forces at bay" (Tuan, 2013, p. 6). The diseased are quarantined. There are rules to keep ghosts out of the house (Tuan, 2013, p. 122-

123), and everyone knows to stay indoors at night because that is when the witches come out (Tuan, 2013, p. 110).

The cognitive adaptation that allows for humans to communicate, express, and symbolize altered states of conscious spatially provides architectures for the affective body not only to experience topophilia but also mediated its environment as a response to topophobia. The theoretical implications for a directionality of presence suggests that the affective body desires not just affinities with places, but actively mitigates the anxiety suffered in an unpredictable, chaotic world full of death by manipulating its surroundings. The affective body's capacity to experience topophilia and topophobia may be leveraged to encourage embodied movements that may be more conducive to experiences of "being there" in virtual environments. On one hand, some VR games, such as Duck Season (Stress Level Zero, 2017) and Pixel Ripped 1989 (ARVORE Immersive Games Inc., 2018), evoke topophilia by way of nostalgia: The premise of both games situates the player as a child trying to finish a video game[55] in virtual environments decorated with iconic representations of familiar toys, magazines, and pop culture of the late 1980's. VRChat, provides tools for users to build virtual environments and share them with the community, and many of these "worlds" are designed to evoke feelings or serenity or provide a place for meditations, such as a moon-light field of grass or jungle in a rainstorm; some rooms even provide a space for people to fall asleep together while talking or listening to the voices and snores of other people. On the other hand, some VR games evoke sensations of presence by providing gameplay mechanics that feed the affective body's desire to manipulate its environments. The previously mentioned VR survival horror game, The Forest, places the player on a cannibal-infested island in which she must mine resources, craft items, and construct shelters to stave off the cannibals nightly. As common with survival horror video

[55] In Duck Season, the player is trying to finish the game before returning it to the rental store; in Pixel Ripped 1989, the player's objective is to play her Gameboy-esque handheld in class when the teacher is not looking.

games, the player is confronted with limited visibility as inhuman screams pierce the night air, meant to evoke a sense of mystery and danger. Presence is achieved here by allowing the affective body to erect defensive walls and add light sources that push back the night: Game design encourages surviving the attacks, not defeating the cannibals, as they become progressively more dangerous after each night if players kill any of them. What these examples illustrate is that the affective body's desire to manipulate, modify, and mitigate environmental stimuli, to imbue a sense of history to a place, can be leveraged for creating compelling experiences of presence in virtual environments. As Tuan has noted, no other animal appears to experience either existential anxiety or deep appreciation for aesthetic beauty the way humans do (Tuan, 2013, p. 3-5). Taken together, the theoretical implications of Lewis-Williams, Mithen, and Tuan suggest that the affective body has evolved cognitive mechanisms that allows it to communicate affectively to the consciousness via spatial structures (i.e., the experiencing of altered states are understood, expressed, and described with spatial properties), which in turn, can be communicated among other affective bodies, providing a ready-made biocultural architecture for organizing group behavior toward large-scale manipulation of the environment[56]. For designers, developers, researchers, and artists interested in exploring the affective dimensions of presence, the theoretical framework for a directionality of presence provides avenues for further investigations into presence and the affective experiencing of space.

7.1.2 Implication 2: The Affective Body's Desire to Roleplay to Induce Presence

The second theoretical implication of the research findings suggest that the affective body has a desire for participating in roleplay choreographies that contribute to the intensity and quality of presence experienced in virtual environments. The research findings [connect] the theoretical framework for a directionality of presence with Johan Huizinga's and Roger Caillois' theoretical

---

[56] Turner writes extensively on the power of ritual and adds that peoples everywhere share an "identical cognitive structure" that gives power to symbolic actions (Turner, 1995, p. 3), actions that are always framed by affective spatial schemas.

works on play, *Homo Ludens* (1980) and *Man, Play, and Games* (2001), respectively. Huizinga proposes that not only does play serve a significant social function but also predates culture and found across the animal kingdom (Huizinga, 1980, p. 1-2), all of which point to significant theoretical implications for creating virtual reality experiences that encourage users to participate in an activity in which "ordinary" or "real" societal rules are suspended and users pretend that things are other than they really are (Huizinga, 1980, p. 8). For Huizinga, play is what makes life worth living:

> As a regularly recurring relaxation, however, [play] becomes the accompaniment, the complement, in fact an integral part of life in general. It adorns life, amplifies it and is to that extent a necessity both for the individual—as a life function—and for society by reason of the meaning it contains, its significance, its expressive value, its spiritual and social associations, in short, as a culture function. (Huizinga, 1980, p. 9)

As an integral activity of living, Huizinga's theory of play infers that the affective body must also desire to play, to suspend its disbelief, to participate in "a free activity standing quite consciously outside 'ordinary' life as being 'not serious,' but at the same time absorbing the player intensely and utterly" (Huizinga, 1980, p. 13). Play makes the affective body feel good. Building on Huizinga's work on play, Caillois takes a step further and theorizes the importance of games in play (Caillois, 2001). For Caillois, games are means by which the activity of play can be manifested and not necessarily aimed at having fun: One can cheat in a game but not cheat at play; one can be forced to participate in a game but not forced to have fun (Caillois, 2001, p. 7, 6). Doodling may be a leisurely activity but participating in a drawing competition can be laden with feelings of anxiety and failure. Caillois further identifies four fundamental classifications of games[57]: *agôn* (games of competition,

[57] Caillois also categorizes play broadly into two forms: play that focuses on competition or chance and play that embraces sensory/perceptual changes or simulation; he also notes that these two forms of play are privileged differentially: So-called "rational" societies (e.g., the Greek, Indian, or Aztec civilizations), which are characterized by rules, offices, and specialized occupations, favor games of competition or chance, while "Dionysian" societies (e.g., the indigenous peoples of the Americas or Africa) prefer feelings of rapture and pantomime in their play (Caillois, 2001, p. 87).

such as basketball or checkers); *alea* (games of chance, such as black jack or craps); *ilinx* (games for the pursuit of vertigo[58], such as skydiving or racecar driving); and most importantly, *mimicry* (games for roleplaying, such as "playing house" or pen-and-paper roleplaying games) (Caillois, 2001, p. 12). Caillois is quick to point out the enjoyment of roleplaying lies not in deception but the "pleasure" of "being or passing for another" (Caillois, 2001, p. 21), and stands apart, in respect to rules, from other games for the participants' need for ceaseless improvisation to maintain the shared illusion (Caillois, 2001, p. 22-23). Moreover, Caillois places mimicry on a continuum in which emphasis on a joy of improvisation is placed at one end (Caillois terms this *paidia*) and the obedience to rules at the other end (Caillois terms this *ludus*) (Caillois, 2001, p. 13). Caillois' conceptualization of mimicry parallels themes discussed in the research findings regarding the phenomenological descriptions of embodied movements as force-form continuums: Games of mimicry that privilege the joy of improvisation, such as impersonations or "playing grown-up," can be describe as improvisational, dynamic, and chaotic, which correlates to force over form; games of mimicry that privilege the importance of rules to achieve similar effects, such as theater or tabletop Dungeons & Dragons, can be characterized as orderly, ceremonial, or predictable, which correlates to form over force. Furthermore, mimicry play is likely to use props or costumes that contribute to the effects of the simulation. Huizinga also highlights the importance of masks and costumes in festivals, such as Carnival, in that they take participants out of "ordinary life" and serve significant social functions in rituals (Huizenga, 1980, p. 26), and Caillois notes that, particularly in so-called primitive societies, masks symbolize forces of nature, such gods, spirits, and long-deceased ancestors (Caillois, 2001, p. 97).

[58] Caillois' term, vertigo, denotes the changes in sensory perception one experiences "by a rapid whirling or falling movement, a state of dizziness and disorder" (Caillois, 2001, p. 12).

For a theoretical framework that situates affectivity as the driving force behind presence, the theoretical implications for roleplaying suggest that affective bodies can be encouraged to participate in roleplaying choreographies as a means to achieving and sustaining presence in virtual environments. The body's affective appetite for this participation can trigger the affective registers responsible for experiences of "being there" in virtual environments, which, given the affordances of the virtual reality technology, can be capitalized through design. With the ability to track the user's head and hands, today's consumer VR headsets, such as the HTC Vive and Oculus Rift, coupled with online multiplayer gaming features, offer unprecedented social experiences in which people separated by oceans can share virtual spaces together. As discussed in the previous chapter and the theoretical framework for a directionality of presence, the affective body privileges movements that exhibit the organic, real-time responses expected of living creatures, qualities that for the most part are not yet technologically replicated by artificial intelligence. Furthermore, players can "wear" their avatars in virtual spaces, much like children donning Halloween costumes to trick-or-treat and actors slipping into theatrical costumes, and "pretend play" to be other people in virtual environments designed to encourage and facilitate roleplaying. The customization of avatars is a popular design feature found in virtual reality games, such as Rec Room (Against Gravity, 2016) and OrbusVR: Reborn, which embraces a high degree of social play. The previously mentioned VRChat enables users to select from hundreds of avatars, commonly anime characters or other pop-cultural references) or even design and import their own avatars. As with avatars, users can also build and share their own virtual worlds: bars, discotheques, movie theaters, courtrooms, houses and apartments, churches (and divorce court)—including innumerable locales modeled on fantasy, anime, sci-fi, and other pop-culture inspirations.

Since video games are arguably the premier and dominant form of mass-consumer interactive entertainment, many studios and developers working on virtual reality games draw from video game design principles and sensibilities when creating those experiences. However, historically, most video games overwhelming embrace the form of play that Caillois identifies as games of competition (i.e., games design to win, achieve the highest score, complete in the shortest time, collect the most rare items, amass the greatest wealth, achieve the highest status, etc.) or games of chance (i.e., online porker, or more recently, the controversy surrounding microtransactions and loot boxes[59]). Of course, simulations have a long history in interactive media—from combat flight simulators (e.g., Microsoft's Combat Flight Simulator, 1998, and Eagle Dynamics' Digital Combat Simulator, 2008) to life simulators (e.g., The Sims Studio, The Sims, 2000, and Linden Lab's Second Life, 2003), the participants' capacity to roleplay operates within the narrow affordances of the technological apparatus, namely, the user's experience with the hardware's interface and the platform's technological capacity to represent living bodies. While flight simulators are arguable one of the most widespread forms of interactive media (Crogan, 2003, p. 275-276), flight simulators are design to train pilots in operating aircraft in a plethora of environmental and technological conditions that may arise during flight (Ryan, 2001, p. 66), *not* the experience of pretending to be a pilot[60]. Roleplaying in video games, such as the Final Fantasy franchise (Square Enix's,1987-present) or World of Warcraft (Blizzard, 2004), have traditionally approached roleplaying as reducible, quantifiable, statistical abstractions of hit points, damage points dealt, buffs and nerfs, and, consequently, tip toward Caillois' ludus end of mimicry play. Attempts have been made in video games to expand the player's capacity to roleplay their avatars, such as the Mass Effect (BioWare, 2007) or The Witcher (CD Projekt Red, 2007) series that allow players to respond to non-player

[59] A growing criticism toward AAA game studies centers on the implementation of buying in-game loot boxes akin to gambling: Not unlike dropping money in a slot machine, players can pay for the opportunity to win valuable gear, weapons, cosmetic items, etc., which often area accompanied by aesthetically pleasing effects that, critics argue, hooks players, especially children, into a impulsive buying or overspending (King & Delfabbro, 2019, p. 167). At the time of writing, legislation has been proposed that prohibits the sale of loot boxes and other such microtransactions to minors (Kelly, 2019).

[60] Although there may be roleplaying elements in such interactive experiences, they are seldom the primary aim of the simulation's design.

characters via dialogue trees, but the choices are limited, usually characterized as placating, aggressive, or neutral responses in order to accommodate the logic of computer code. In contrast to video games, virtual reality games are more technologically capable of accommodating forms of play that capitalize on the roleplaying that can occur among bodies sharing the same space, as the tracking technology captures more of the rich, organic movements of human bodies as input signals: To attract the attention of a non-player character in OrbusVR: Reborn, for example, players look toward the NPC and wave a hand in a greeting gesture, which prompts dialogue with the NPC. In Star Trek: Bridge Crew, the player as captain can issue orders to NPC crew members verbally through voice-recognition software. In traditional video games, embodied movements are limited to squeezing triggers, pressing buttons, pushing joysticks, or clicking mice as a means to roleplay within those virtual spaces[61] and so must do a lot of work to enact feelings of "being there" in virtual spaces, as they are not inducive to distal attribution as discussed in the theoretical framework for the affective body.

For users of consumer VR headsets, the technological apparatus interfaces with more of the body, which permits a wider bandwidth, so to speak, for quantitative and qualitative information exchange between the human and the computer, and, consequently, allows for the emergence of party games in virtual spaces. Mafia, I Never, and Twenty Questions are games in which the gameplay necessitates embodied movement to have meaningful play. Of course, these games can be played in other media via text, voice, or video, but these media lack the technologically capabilities to trigger presence in affective bodies. For the previously mentioned Werewolves Within, essentially a VR-version of Mafia, the fundamental gameplay requires players to bluff and interrogate one

[61] There are always exceptions and outliers: the Nintendo Power Pad (1986) or the countless video arcade machines with specialized interfaces using weapons, musical instruments, or—in one extreme example, Boong-Ga Boong-Ga (TaffSystem, 2001)—a plastic bum that players spank or poke to play the game.

another, watch for suspicious behavior, and make accusations[62], a kind of gameplay that had not found purchase in any media prior. Although the game is played with a VR headset, players use a conventional game controller, a technical constraint that the developers considered when designing for shared experiences of presence. The use of preset animated gestures, such as finger-pointing, arm-crossing, and thumbs' up, coupled with the natural movements of the players' heads, encourage bodies to participate in the choreography my mediating some of the roleplaying for the player. The developers even have implemented features that prompt suspicion (e.g., the player's ability to lean toward the player next to them and "whisper" in a private conversation) or silence (e.g., the player can mute all players by standing up). Here, the gameplay facilitates presences via roleplay mechanics dependent upon a player's ability to assess or measure other players' bodily movements against their voices and the words they use, a novel game mechanic that privileges not hand-eye coordination or number-crunching but rather emotional intelligence, which is also a fundamental skill for successful roleplaying with others. The theoretical implications for the affective body suggests that roleplaying satisfies a desire to pretend by providing a social structure for shared imaginations, and the VR technological apparatus provides the material structure that consolidates multiple affective bodies across physical space, gives players masks and roles, places them in thematically congruent settings, and directs social behavior through game design that privilege affective bodily movements. By leveraging the technological affordances of VR headsets and online gaming, designers and developers can create powerful experiences of presence via roleplay. Whereas with other interactive media, such as video games, the technological apparatus cannot accommodate the embodied

[62] The game is played in a single, 5-7-minute round, ending with a majority vote to cast one player out. The villagers, who constitute the bulk of the players, are trying to uncover the smaller group of werewolves hiding in their midst, who, at the end of the round, will kill the villagers. If players assume the role of a werewolf, their aim is to coordinate with the other werewolves to cast suspicion on other "human" players; if players take the role of the villagers, their goal is to ask questions and observe body language for suspicious behavior. The gameplay is further complicated by the addition of roles with specialized game mechanics that utilize the circular seating arrangement of the players: The houndsman role has the ability to learn the secret identity of the player sitting to their right or left; the tracker role can only discover werewolves who are sitting across from them; and the astrologer can learn of a role that is *not* currently being played.

movements associated with a directionality of presence, and so satiating the affective body's appetite for roleplay as a means to "being there" in a virtual space is a tall order. After all, there are obviously profound phenomenological differences between playing Dungeons & Dragons Online and playing Dungeons & Dragons tabletop. The exciting possibilities of roleplaying games in virtual reality is not that they will transform the former into the latter, but rather they will give rise to a novel experience that implements pro-social skills, such as emotional intelligence, with game design features that accommodate roleplaying. Gameplay design that satisfies this affective desire to pretend is an additional strategy that can be implanted by developers to help create compelling experiences of presence.

7.2 A Topology for a Directionality of Presence

These theoretical implications for a directionality of presence are incorporated into the larger the theoretical framework for presence, which is heavily modeled on Hansen's philosophy for new media that privileges the affective body as the primary instrument for perception (Hansen, 2006b) and the ideal interface for exploring the inhumane world of the machine. Hansen's work and methodology are extrapolated into a larger theoretical framework that presents affectivity—the body's capacity to experience its own affectivity, to affect and be affected upon—as the operational mechanism for the experiencing of circumambient space within a virtual environment. To the affective body, the sensorimotor's system encounter with the digital stimuli of the medium is one of mitigation, for no technology exists yet that can fully engage the body's billions of thermal, mechanical, and chemical sensory receptors organized in the skin, the inner ear, and the viscera in order to satisfy the affective body's quantitative and qualitative demands for total simulation of circumambient space. The feeling of "being there" in a virtual environment is not phenomenologically identical to the experiencing of space in the waking conscious. The same cognitive structures that permit *Homo sapiens* to communicate, express, and understand altered states of consciousness via affective spatial schemas are also responsible for structuring experiences of presence in virtual spaces. The affective body's encounter with the mediated stimuli and constraints of the technological apparatus does not negate or ignore the far more encompassing flux of natural stimuli that surrounds the body every moment of living experience, nor does the affective body necessarily forgets itself in time and place. As with the Necker cube, the affective body struggles to overcome limitations, gaps, and contradictions in the perceptual field, a process that is unnoticed normally in waking life but is experienced in dreams, hallucinations, psychedelic drug experiences, and pathologies. What the consciousness perceives is not necessarily what the affective body encountered, but rather, the latter's best interpretation of circumambient space in order to optimize the former's capacity to respond to environmental conditions. Thus, under the theoretical framework, the phenomenon known as presence is better understood as the affective body's *temporal* response to the mediated-constrained-unmitigated stimuli assemblage's technological shortcomings: This encounter between the affective body and the inhuman, "machinic" vision of the technological apparatus (Hansen, 2006b, p. 97)[63], enacts this phenomenologically distinct type of space in which presence becomes the moment-by-moment, fluctuating sensation of circumambient space pressing and rubbing on the borders of the affective body within a virtual environment.

With the affective body as the primary framing mechanism for the perception of space, movement becomes indicative with the act of seeing. The living body is a moving body, and a motionless body is an object. To repeat Bergson, action is the focus of all bodily powers (Bergson, 1988, p. 63), and thus movement—both conscious and nonconscious—is the means for the affective body to respond to the dynamics of its environment and construct perceptual models of circumambient space. Bodily movement subtracts nonrelevant stimuli (i.e., that which does not lend

[63] Hansen borrows "machinic vision" from John Johnston (Johnston, 1999, p. 46) to refer to the "digital obsolescence of the image with the massive deterritorialization of information exchange in our contemporary culture" (Hansen, 2006b, p. 97)

itself to immediate form-making), both mediated and natural, from the flux of external stimuli to construct a cohesive perceptual model of circumambient space, actions that are performed via three bodily modalities—proprioception, tactility, and temporality—which select, anticipate, and favor that sensory stimuli susceptible to Gestalt principles by interpreting changes felt between bodily movement of the external flux of stimuli. When the three bodily modalities encounter the mediated-constrained-unmitigated stimuli assemblage provided by virtual reality technology, the incorporeality of the digital information (i.e., the form and volume of the digital stimuli supplied by the VR system) resists enframing by embodied perception, resulting in a conscious awareness of affective registers being triggered in the perception of space. Ergo, the body's capacity to experience digital information with its own space-perceiving affective registers forms the principle basis for sensations of presence in a theoretical framework that situates the affective body as the framing mechanism for presence. Presence is a "thickening of the present" (Hansen, 2006b, p. 16) within the incorporeal space of digital information, the affective body's autopoietic attempt to give perceptual shape to the gaps and shortcomings of sensory stimuli supplied by the technological apparatus.

The findings support that the affective body applies spatial schemas in the organization of space and privileges some gestures, postures, and locomotions over others in the enaction of circumambient space in virtual environments. As the affective body moves through its environment, stimuli that falls within the sensory threshold of the sensorimotor system triggers sensory receptors that code the information about the stimuli electrically or chemically for transmission via the nervous system or the bloodstream, respectively; the receptors may relay this information to other receptors, integrate it into the larger sensory field, and/or amplify the intensity of the information in order to provoke some immediate response (Barlow & Mollon, 1982). As previously established, affectivity is the "power of the body that cannot be assimilated to the habit-driven, associational logic governing perception" (Hansen, 2006b, p. 8), and reigns supreme over not just perception, but cognition as well, raising age-old philosophical questions of free will: "Man likes to think of himself as a rational animal. However, it is more true that man is a *rationalizing* animal, that he attempts to appear reasonable to himself and to others" (Aronson, 1989, p. 134). The affective body, in a way, does this rationalizing for us, as evident in the aforementioned devil's tuning fork and Lazzarini's *Skulls* (2000), by structuring space according to a set of operational principles that map meaning and values to spatial properties within the Affective Spatial Schema. Termed here as directionality, the affective body not only experiences presence in varying intensities of sensation and qualitatively distinct cases of distal attribution of the phenomenal body, but also imbues the space with affective properties, such as security or fear, in order to satiate affective appetites that drive it to mediate the environment around it. The affective body responds to the mediated-constrained-unmitigated stimuli assemblage offered by the VR technology via gestures, postures, and locomotions that encourage the enaction of distal attribution intensities in accordance to the Affective Spatial Schema.

The directionality of presence is visualized here as a topological map to aid designers and developers in creating more compelling experiences of presence via affective, kinetic embodied movements. Unlike a topographical map in which scale and distance are accentuated in the mapping of valleys, mountains, and cliffs of a landscape, a topological map was selected as the metaphorical spatial representation for directionality because of the visualization's emphasis on (1.) properties that are not changed by deformation of spaces, and (2.) the connectivity and relationship among the properties[64]. Inspired by Susan Kozel's poetics of responsivity (Kozel, 2007), this topological approach is better equipped to depict the phenomenological structure of embodied kinematics and their relations with the Affective Spatial Schema and presence. The organization of gestures,

[64] In mathematics, topology is concerned more with the former, as in Möbius strip; in network architecture, topology is more concerned with the latter, as in a subway map.

postures, and locomotions are relative to the x- and y-axes that reference the degree to which the affective body privileges force or form and the degree to which the affective body phenomenologically "pulls" or "pushes" space, respectively. As the spatial relationships among embodied kinematics, not scale or distance, are of significance, a topological map offers an illustrative means to investigate the phenomenon of presence more fully. However, as has been stated previously, this topological map is intended only as a first approach to mapping embodied kinematics to the directionality of presence, as they are predicated on spatial schemas that are by no means universal geographically or historically, and so caution should be taken in their use. Nonetheless, mapping the directionality of presence can serve useful in creating powerful experiences of presence by leverage the affective body's heliocentric nature to seek out or create affective spatial dimensions via embodied kinetics. The four major components of the topological map are explicated: (1.) the center, representing the Affective Spatial Schema; (2.) the concentric rings, representing the gestures, postures, and locomotions of embodied kinematics; (3) the x- and y-axes, representing the force-form and phenomenological pull-push continuums, respectively; and, finally, (4.) the small circles, which correlate to clusters of embodied kinematics.

7.2.1 First Component: The Center Circle and the Affective Spatial Schema

The innermost circle on the topological map symbolizes the six affective spatial schemas introduced in Chapter 5. These spatial schemas are reconciled with Tuan's work on topophilia (Tuan, 1990) and topophobia (Tuan, 2013). Table 7.1. illustrates types of affective "orientations" to which the affective body is attuned. Each orientation is identified with an affinity (i.e., a type of space that attracts the affective body) and an anxiety (i.e., a type of space that triggers anxiety in the affective body). The far-left column denotes the values imbued onto the spatial schema. This table serves to orientate metaphorically the affective values associated with embodied movement in service of affinity or anxiety.

Table 7.1. Affective spatial schemas, affinity, and anxiety.

Value	Spatial Schema	Orientation	Affinity	Anxiety
Temporality	Front	Future Visual Forward motion Visibility Openness	Openness	Mortality
	Back	Past Nonvisual cues Dark Close	History, Memory, Mythology	Profane
Sublime	Above	Power Sacred	Superior/excellent	Acrophobia (fear of heights) Basiphobia (fear of not being able to stand or walk)
	Below	Profane Abyss	In utero	Bathophobia (fear of depths)
Imbalance	Right	Sacred power Truth/Knowledge Daylight/Heavens	Proper/legitimate	Hubris
	Left	Inferior Unknown Ambivalence/feeble Dark/underworld	Subversive	Profane/impure
Vitality	Upright	Alertness Authoritative	Defiance Independence	Fatigued
	Prone	Submissive Hiding	Relaxation	Subjugation
Safety/Mystery	Centrism	Prestige	Homeland Security	Repatriation Agoraphobia (fear of open spaces) Claustrophobia (fear of closed spaces) Confinement
	Periphery	Mystery/Unknown	Call to Adventure Frontiers Horizons	Fear of the Unknown Xenophobia (fear of strangers) Exile
Sociality	Solitary	Meditation Open	Seclusion	Desertion Autophobia (fear of isolation) Banishment/Exile
	Solidarity	Community Closed	Solidarity	Ochlophobia (fear of crowds)

On the topological map, the central circle signifies the affective body and the Affective Spatial Schema. The three primary schemas are oriented on the top half of the center circle, and the three secondary schemas occupy the bottom half of the circle. Furthermore, each affective spatial schema is represented as a binary: the favored or superior end of the continuum is located within the center circle, and the shunned or inferior end of the continuum is identified outside the center circle. Figure 7.1. is a depiction of the affective spatial schemas on the topological map.

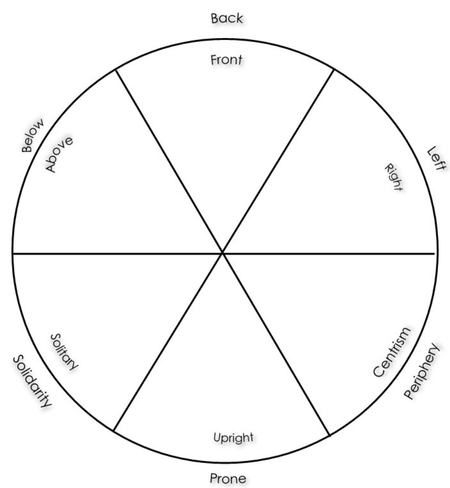


Fig. 7.1. The center circle and the Affective Spatial Schema.

7.2.2 Second Component: The Concentric Rings of Embodied Kinematics

The arrangement of the three concentric rings represent the three phenomenological structures for embodied kinematics—gestures, postures, and locomotions—and the investment of embodiment required from the affective body: Locomotions, the outermost ring, generally require a greater degree of effort on the part of the human body to perform than gestures, which are depicted by the innermost ring. Each ring is comprised of six small circles that represent phenomenologically distinct clusters of embodied kinematics that arranged according to the force-form and phenomenological pull-push continuums (see below). Table 7.2. below explicates each of the three structures along with their accompany clusters of embodied kinematics.

Table 7.2. The concentric rings of embodied kinematics. The explication of the three phenomenological structures for embodied kinematics depicted in the topological map.

Structure	Explication	Embodied Kinematics
Gestures (Inner Ring)	Movements characterized by high frequency, executed relatively close to the body, and primarily performed with the appendages for purposes of communication, attention, and interaction. Gestures have high degree of iterations, expressions, and capable of expressing explicit information, such as numbers, direction, measurements, and time. Gestures favor proprioception over the other two bodily modalities for embodied perception, as the awareness of bodily positioning is usually required.	Leaning, Punching, Stabbing Beckoning, Waving Communicating information Blocking, Bracing Striking, Slashing, Parrying Offering, Surrendering, Welcoming
Postures (Middle Ring)	Movements are characterized by emotive stances and positions the body assumes to convey authority or submission, defiance or capture, mediation or stealth. Postures are the most susceptible to simulator sickness and virtual forces. Postures favor tactility over the other two bodily modalities for embodied perception, as an awareness of interoceptive sensations helps the affective body enacts virtual space.	Standing sentry Crouching Sitting Supine, Prone Defensive stance Grabbing, Embracing, Catching
Locomotions (Outer Ring)	Movements characterized by the methods of traversing of space the affective body employs to advance, ascend, progress, and evade. Locomotions are the least susceptible to simulator sickness and virtual forces and the greatest investment of corporeality to perform. Locomotions favor temporality over the other two bodily modalities of embodied perception, as movement across space is concerned with duration of movements and rates of change.	Running, Walking, Climbing Crawling Dancing, Marching Walking backwards, Using non-dominant hand Jumping, Leaping Twirling, Spinning, Falling

7.2.3 Third Component: The Force-Form and Phenomenological Pull-Push Axes

The topological map for a directionality of presence is also arranged according to two axes: The x-axis represents a continuum characterized as the affective body's privileging of force or form in the execution of embodied kinematics, and the y-axis represents a continuum depicting the affective body's privileging of phenomenologically "pulling" or "pushing" space in the execution of embodied kinematics. The horizontal continuum represents the relative emphasis on either force or form regarding the performance of the embodied kinematic cluster, so that embodied kinematics favoring force over form (e.g., offering, embracing, and twirling) are organized to the left of the central affective body, and embodied kinematics favoring form over force (e.g., blocking, sitting, and marching) are organized on the right side of the central affective body. Force-over-form embodied kinematics are concerned with the speed, range, and power of the movements, while form-over-force embodied kinematics are invested in control, precision, and spatial positions/arrangements. Twirling and spinning, for example, are locomotions in which the experiencing of sensations (i.e., vertigo, inertia, falling) serve to facilitate experiences of presence in virtual environments. At the time of its release, Windlands (Psytec Games, 2016) broke many conventional rules regarding the implementation of artificial locomotion into their game by having players "swing" their way through three-dimensional levels. In game, players aim their grappling hook (i.e., the game controller) at an attachable point in the virtual environment and virtually swing high across landscape, slowing making their way to the top much like a traditional video game platformer. Such a disjunction between real and virtual sensations (i.e., perceiving that one is swinging across mile-high structures without the accompanying sensations of gravity or inertia) had been a recipe for simulator sickness, but Psytec Games developed a workaround by tinkering with perceived acceleration and deceleration forces, and, more interestingly, fill the ears with sounds of rushing wind, which has a tunnel-effect, appealing to the affective body investment into the virtual force. Inversely, dancing and marching are rhythmic and coordinated movements, and focus is more on form of the embodied kinematic. Audioshield (Dylan Fitterer, 2016), a VR rhythm game, requires players to block incoming blue and red orbs in time with game's soundtrack; furthermore, blue orbs must be blocked by blue shields (in the left hand) and vice versa for red orbs with red shields. Some orbs may arrive nearly simultaneously but spaced far apart, requiring the player to move laterally quickly across the play-space to maintain rhythm. The other continuum, represented by the vertical axis, indicates an emphasis for the phenomenological pulling or pushing of space toward the top and bottom of the topological map, respectively. The phenomenological pulling of space describes movements intended to bring objects, people, and places closer to the affective body. Embodied kinematics, such as running and crawling, are movements concerned with the phenomenologically shrinking, folding, and collapsing of space as a means to foster experiences of presence: Standing sentry, for example, is a posture characterized as high spatial awareness and anticipation and necessitates clear lines of sight; objects that enter the perceptual field are phenomenologically "pulled" toward the affective body's attention. Slingshot, one of the VR minigames in The Lab (Valve, 2016), allows players to launch talking orbs via a large slingshot-like contraption akin to the gameplay in Angry Birds (Rovio Entertainment, 2009). In the virtual space, players pull back the loaded slingshot, align its sights on a target (towering structures of crates speckled with explosive red barrels), and release the orb at the target; in the physical space, players squeeze the triggers on the controller while bringing their arms in toward the chest (i.e., anteromedially) or taking a step backwards (i.e., retropulsion), the head and hands are brought closer together (the head may bend down, or the hands raised to head-level), maintaining this position for a moment, and then the index fingers release from the triggers and the body relaxes. Although the body performs these discrete maneuvers simultaneously and sequentially, they are phenomenologically unified by their intent to reach and grab into space, to increase the effects of the affective body's agency by decreasing the phenomenological distance between it and the intended target. Near the bottom of the topological map are clusters of embodied kinematics characterized by their phenomenological pushing of space. Whereas the phenomenological pulling of space is concerned with increasing proximity, the phenomenological pushing of space emphasizes increasing distance within space. Jumping and leaping, for example, are movements that phenomenologically "push" against the pull of gravity as the affective body pushes space away, even if only a moment. Lying on one's back, for example on the play-space hardwood floor, pushes against the tangibility of the ground, and walking backwards—an anatomically awkward motion used primarily when one does not want to turn away from something—phenomenologically rebuffs or repels space in order to intensify the feeling of distance, regardless of whether such movements result in an actual increase in metric distance. Blade & Sorcery is a VR battle simulator that lets players command up to hundreds of troops to raid or defend medieval castles, villages, and bridges in up-close melee combat. Swords, maces, and other era-appropriate weapons have collision detection, meaning that the swords are treated as solid three-dimensional objects in the virtual space and therefore can cause varying damage depending on the angle, speed, and range of an axes' swing, for example. Likewise, weapons can block and parry other weapons even in mid swing. Furthermore, AI-controlled characters are programed to flank and surround players, forcing them to consider space volumetrically. Often, players may be overwhelmed by enemy forces and must execute a fighting retreat, deftly blocking and parrying enemy attacks while traveling backwards in the virtual space: players swing or hold their arms in front of them as they glance quickly over their shoulders, and if space permits, may take a step or two backwards without taking their eyes off the enemy. Phenomenologically, these movements are unified in the affective body's intention of increasing the distance between it and some object, person, or place. Figure 7.2. below illustrates the relationships between the x-axis force-form continuum and the y-axis pull-push continuum.

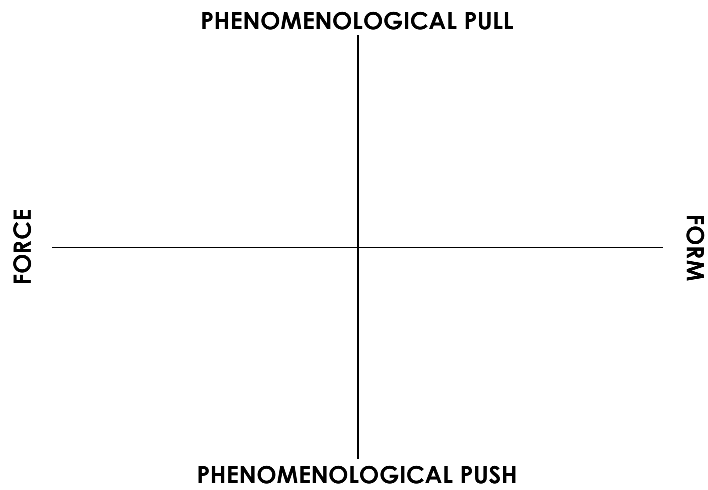


Fig. 7.2. The Force-Form Axis and Phenomenological Pull-Push Axis.

7.2.4 The Fourth Component: Embodied Kinematic Clusters

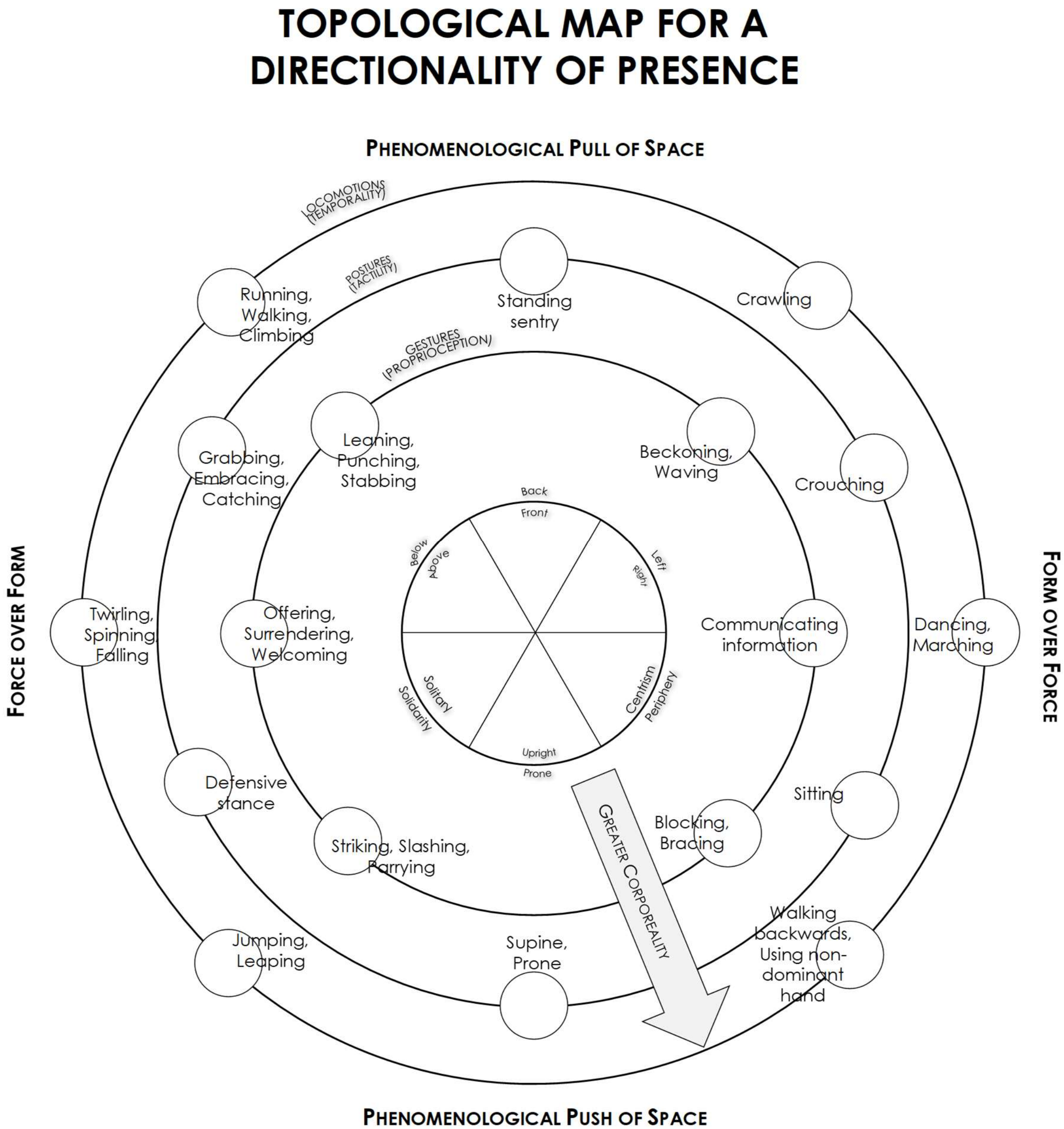
The topological map for a directionality of presence recognizes eighteen clusters of embodied kinematics that are organized according to the x-axis force-form and y-axis pull-push continuums as well as the amount of corporeal investment required to perform the movement. Thus, the embodied kinematic cluster crawling, which is resides on the outermost ring and positioned in the upper-right quadrant, are structures characterized aby form and the phenomenological shrinking of distance that requires significant bodily effort to perform. Table 7.3. below explicates each of the eighteen clusters identified on the map. To clarify, the movements named in each embodied kinematic clusters were chosen for their phenomenological qualities, which emphasize affect, rather than their anatomical qualities, which emphasize kinaesthetic properties: Lying on one's belly, for example, may be characterized phenomenologically as prone if the movements evoke calming effects, or characterized phenomenologically as crouching if the affect body's intent is evasion.

Table 7.3. **Explication of the eighteen clusters of embodied kinematics.**

Structure	Embodied Kinematic Cluster	Explication
Gestures: Emphasis on proprioception with little investment in corporeality	Leaning, Punching, Stabbing	Movements characterized as "reaching out" into the virtual space with an intention for interaction or inspection.
	Beckoning, Waving	Movements characterized as luring something not under the agency of the affective body closer.
	Communicating information	Movements characterized as exchanging quantitative, qualitative, or linguistical information.
	Blocking, Bracing	Movements characterized as counteracting some perceived force, real or virtual, through stable forms.
	Striking, Slashing, Parrying	Movements characterized as medial/lateral or superior/inferior motions and emphasize force as "slicing" or "cutting" space.
	Offering, Surrendering	Movements characterized as "welcoming" and aimed at calming anxiety or increasing affinity.
Postures: Emphasis on tactility with medium investment in corporeality	Standing sentry	Movements characterized as "alert" or "vigilant" and aimed to install a sense of security and responsibility.
	Crouching	Movements characterized as hunkering low to the ground or prone for the purposes of hiding, sneaking, or taking cover.
	Sitting	Movements characterized as "attentive" and "passive" and maintained for extended periods, whether performed on a chair, crossed-legged, or seiza (sitting on one's knees).
	Supine, Prone	Movements characterized as "restful" or "contemplative" while lying on the ground, floor, or furniture, either face-up or face-down.
	Defensive stance	Movements characterized as "anticipatory" to some source of anxiety, commonly in the form of arms raised to protect the face and feet shoulder-width apart for balance, as found in a boxer's stance.
	Embracing, Seizing, Catching	Movements characterized as "grabbing" something in the virtual space that is not under the agency of the affective body, implying resistance or evasion on the part of the target.
Locomotions: Emphasis on temporality with greatest investment in corporeality	Running, Walking, Climbing	Movements characterized as "progression," "ascension" or "advancement" in traversing space and necessitates a great investment in corporeality to perform.
	Crawling	Movements characterized as an advancement conditioned by non-bipedal movement, as for the purposes of stealth or evasion, and implies a "withdrawing inward" as the affective body attempts to occupy little space.
	Dancing, Marching	Movements characterized as "coordinated" or "rhythmic" and necessitates a spatial and temporal awareness.
	Walking backwards, Egressing, Using non-dominant hand	Movements characterized "awkward" or "unnatural" as they are performed counter to the anatomical operations of the human body.
	Jumping, Leaping	Movements characterized as resistance to the forces of gravity and inertia, real or virtual, and are typically fleeting.
	Twirling, Spinning, Falling	Movements characterized as "vertiginous" or "disorientating" by succumbing to sensations of gravity and inertia, real or virtual.

7.2.5 A Topological Map for a Directionality of Presence

The four components come together to constitute a topological map (see Figure 7.3. below) that illustrates spatially the relevant phenomenological features of affective embodied movements, giving meaning to the relationship and direction of the 18 clusters of embodied kinematics. A cluster positioning on the map is characterized phenomenologically according to the force-form continuum, the phenomenological push-pull continuum, and the investment of corporeality required to perform the embodied movement effectively. These clusters represent structures for actions characterized by affinity and anxiety that are created during the body's encounter with the incorporeality of digital information supplied by the technological apparatus, a relationship not unlike Graeme Kirkpatrick's application of aesthetic and dance theories to the movement and rhythm indicative of playing video games (Kirkpatrick, 2011, p. 1-2). Kirkpatrick adapts his aesthetic approach from Nigel Thrift (Thrift, 2008, as cited in Kirkpatrick, 2011) to analyze this "dance of the hands," which resists traditional analysis of meaning and interpretation (Kirkpatrick, 2011, p. 7-8), and how pressing buttons and squeezing triggers affectively gives form to experiences of play. Kirkpatrick focuses on the contact between fleshy hands and plastic game controllers, pointing to the tactility of the interface giving shape to play (Kirkpatrick, 2011, p. 96): the tensions of the buttons and joysticks; the mold, texture, and weight of the controller; and the number, variety, and range of permissible inputs constitute aesthetic qualities to the experience, and, consequently, eliciting theoretical implications with affect. This choreographed dance between a player's hands and the controller, in conjunction with the visual and audio outputs from the game console, is analogous to the touching of the face to the head-mounted display and the hands to the motion-tracked controllers of many consumer virtual reality technologies, with the significant exception that the latter affords much more of the human body to interface with the incorporeal ones and zeros of digital information. These clusters of embodied kinematics, like the gesticulations of the hands around a game controller, serve as aesthetic gestures, postures, and locomotions to which meaning can be mapped in order to intensity the sensation of "being there" in virtual spaces. As previously discussed, the exciting potential of VR technologies reach beyond play, but play itself is a strategy to creating more compelling experiences, as interaction for aesthetics' sake draws the affective body's attention toward the virtual space, prioritizing the stimuli supplied from the apparatus. The topological map aims to illustrate the phenomenological structures that shape different forms of play—here, interpreted as affinities and anxieties—between the human body and the mediated-constricted-unmitigated stimuli assemblage of the VR or immersive technology. However, like Penfield and Rasmussen's motor and sensory homunculus, the topological map for a directionality of presence proposed here is only as a starting point for further investigations into affective, movement, and presence, and so does not aim to be exclusive or comprehensive. Nonetheless, the topological map is intended to bring more attention ways in which the body's capacity to experience its own affect when confronting the incorporeality of digital information.



2

Fig. 7.3. A topological map for a directionality of presence.

7.3 Applications for Future Research: Interface for the Affective Technosphere

If past is precedence, "virtual reality," augmented reality," and "mixed reality," are likely to become anachronistic monikers in the way of the phenakistiscope (1833), the praxinoscope (1877), and the zoetrope (1887), which today have been dubbed collectively as "pre-cinema" technologies.

Audiences of early film were entertained with 45-second nickelodeons, often focused on human bodies in motion, such as the Lumiere brother's *Workers Leaving the Lumière Factory* (1895) and *Blacksmiths* (1895), and so could not have been expected to anticipate the cultural giant cinema has become today. Likewise, the term *virtual reality* is probably not up to task to account for the trajectories of several transformative technologies set to converge around a computer design philosophy in which Hansen's (2006b) affective body serves as the ideal interface for the emergence of a new kind of human-computer relationship. For Hansen, the digital image is not a representation of an autonomous reality, but rather as the process by which the affective body renders the intrinsically incorporeal data perceptible within an ever growing global technosphere informed by autonomous vehicles (e.g., driverless cars and drones), AR-capable mobile devices (e.g., Apple's ARKit 2), standalone VR headsets (e.g., Oculus Quest), and a more robust cellular network technology that penetrates more regions with faster and larger data transfers (e.g., the unfolding 5G cell network): The affective body's framing of digital information is "a *means* for the new media user to intervene in the production of the 'real,' now understood as a rendering of data," (Hansen, 2006b, p. 10). This emerging technosphere concerns not just the digitalization of objects and spaces, but also fitness trackers, health monitors, and other wearable technologies code corporeal processes into incorporeal ones and zeros, providing for unprecedented human-computer interfaces in which humans are interacting *nonconsciously* with the computers, with one another via a computer. The technosphere should not be understood as digital representations of volumetric spaces, but rather the "computerization" of space itself constituted of interdependently working technologies that recognize, track, and replicate bodies and objects—real, virtual, and everything in between—through space and their relative positions to one another. Thus, "virtual reality" appears a mischaracterization for a human-computer interface in which AI-controlled programs interact and track bodies across space and time with near omnipresence, for it is no longer reality that is becoming virtual, but rather the world of everyday lived experience (Hansen, 2006a, p. 2).

Implications are obviously transformative, but not necessarily predictable. The technology exists now to scan an object, say Michelangelo's *David*, with an omnidirectional camera and create a digital, three-dimensional representation that then can be viewed in virtual reality, augmented with meta information, or even printed three-dimensionally, all with little regard to scale, distance, or Benjamin's fears of mechanical reproduction (Benjamin, 2010). Artificial intelligence is now capable of constructing faces of people who have never existed (Vincent, 2019) and impersonating people's voices (Marr, 2019), stirring anxiety over the technology's potential. This uneasiness is reflected in Mori's concept of the uncanny valley hypothesis (Mori, 2012), which "predicted that perceptual difficulty in distinguishing between a human-like object and its human counterpart will evoke negative [effects]," such as feelings of "revulsion" or "eeriness" (Ciechanowski, Przegalinska, Magnuski, & Gloor, 2019, p. 540) toward a representation of a human that in some way exhibits some inhuman aesthetic, such as a face that does not blink or make any expressions. Theorized as an evolutionary adaption to detect pathogens or health concerns in mate selection (Ciechanowski, Przegalinska, Magnuski, & Gloor, 2019, p. 541), the affective body's anxiety fixes upon that which pretends to be human. It is quite possible that the day will come when users are not only interacting with one another affectively in a technosphere of mediated, connected bodies, but also are responding *affectively* to the AI-controlled entities, autonomous vehicles, and everything else in the Internet of Things in ways that are affectively reciprocal.

Within this affective technosphere arises homogenous virtual environments. A significant portion of the research sample comprises of virtual reality games known traditionally as VR shooters. Onward, Hover Junkers (Stress Level Zero, 2016), Arizona Sunshine (Vertigo Games, Jaywalkers Interactive 2016), Space Pirate Trainer (I-Illusions, 2016), Pavlov, Duck Season, Robo

Recall (End Games, 2017), Contractors, and many more VR shooters follow a parallel history to early video and arcade games in which the primary interaction mechanic is firing weapons at targets[65]. For arcade machines, plastic firearms with triggers and buttons are relatively intuitive and popular human-computer interfaces, further evident in the history of gun peripherals for home video game consoles, as early as NES Zapper released initially with the Nintendo Entertainment System's debut in North America in 1985 (DeMaria & Wilson, 2002, p. 232) and today with Sony's Aim Controller for the PlayStation VR system. Third-party manufactured gunstocks, such as the ProTube and LockStock, provide a rigid structure for VR controllers, affording users tactile (and in some cases haptic) feedback to aid in aiming and/or greater immersion. The ability to hit moving targets—whether by firing a rifle, shooting a bow, or tossing a grenade—is regarded typically as a game of skill, and so building an interactive experience that couples an intuitive interface, such as a plastic-molded sniper rifle, with a skill-focus game design in which players fire at moving targets (while avoiding being targets themselves), are compatible for an immersive experience via a game design that engages three primary skills: physical skills (e.g., aiming and dodging are skills that stress a player's dexterity and stamina), mental skills (e.g., players who know the map layout and high traffic areas have advantage over players who lack this knowledge or awareness), and social skills (e.g., the ability for a player to anticipate another player's actions as well as coordination with teammates) (Schell, 2008, p. 151). Implementing a similar approach to VR shooters is a more safeguarded approach for designers and developers striving to make footholds in an emerging, and volatile, mass-communication medium. There is an audience for VR shooters, particularly multiplayer shooters, and the hand- and head-tracking capacities of most consumer virtual reality

[65] Shooters themselves are evolutions from the novelty shooting galleries found in bars as early as the 1940's up until the electronic arcade boom of the 1970's and early 1980's and typically had the player fire at human- or animal-shaped targets with an air rifle (Kent, 2001, p. 10).

systems can offer a novel experience that implements an intuitive interface with the interactivity of video games.

This growing production of combat-orientated virtual environments raises many ethical and cultural implications for the use of bodies in the enaction of space. The military-entertainment complex, coined by Herz (Herz, 1997, p. 201), refers to the military-funded research poured into interactive entertainment for defense purposes, namely video games: America's Army: Operations (Capps, 2002) is a game, training simulation, and recruitment aid that gamifies abstract values, such as "loyalty, duty, respect, selfless service, honor, integrity, and personal courage" (Nitsche, 2008, p. 9), while analysis of flights simulators draws a connection between gaming and warfare (Crogan, 2003, p. 279). Dyer-Witheford and de Peuter critique of Full Spectrum Warrior (Pandemic Studios, 2004) offers an indicative example of the "enveloping sociocultural-emotional process habituating populations to the perpetual conflict of the war on terror" (Dyer-Witheford and de Peuter, 2009, p. 99), and their earlier work with Kline explores gender and combat-themed video games designed for young males, which they have termed "militarized masculinity" (Kline, Dyer-Witheford, & de Peuter, 2003, p. 247). At the time of writing, shooters are poised to be a dominant genre for VR applications and would appear equally likely to be exploited as a tool in the aforementioned military-entrainment complex. As with video games, esports have begun to take hold within the VR shooter community: VR League and VR Master League, two name two esports leagues, organize competitive multiply VR games that predominantly cater to VR shooters, such as Onward, Pavlov, and Echo Combat (Ready At Dawn, 2017), and offer similar incentives for tournament play and large prize pools (Hayden, 2019).

Perhaps more uniquely relevant to virtual reality shooters is the perception—whether true or not—that the real skills of marksmanship are mapped closely with the virtual skills of the player (Schell, 2008, p. 151), which possibly facilities notions of power fantasies (Bateson, 2003). With a game controller, the minimal physical action required to fire a weapon is squeezing a trigger with the index finger with perhaps aligning the weapon reticle or sites by pushing on the joystick with the thumbs; with most VR shooters, on the other hand, firing a virtual rifle entails not just squeezing a trigger on the motion-tracked controller but also orientating the hands, shoulders, and head to aim down the virtual sites. In some cases, players may crouch or lie prone for greater stability. The important points is that unlike the physical actions performed on a game controller (or even a keyboard and mouse), which are more or less arbitrary and demand far less physical force to execute typically than the virtual actions they are meant to represent (Gregersen & Grodal, 2009, p. 71), the embodied interface of the virtual reality system has the technological capacity to track movement and measure acceleration, which can inform the nature of the interactive experience. This direct mapping of movements is much more simulative than conventional physical actions performed while playing video games and brings attention to the kind of interface design being reproduced by dominant practitioners contributing to the expansion of the affective technosphere.

Consequently, this affective technosphere of unprecedented spatial computing demands an interface that can do more than punch keyboards, swipe touch screens, and navigate computer mice. Building on Hansen's original proposition that the affective body is the ideal interface for human-computer interaction (Hansen, 2006b, p. 10), this research charts a topology for a directionality of presence meant as an aid for designers, developers, and researchers in creating compelling experiences in virtual reality via affective embodied movements; moreover, the topological map also serves Hansen's "Bergsonist vocation" as a starting point to investigate how affective bodies move through the affective technosphere corporeally render digital information (Hansen, 2006b, p. 11). As with presence, the affective body's encounter with the inhuman digital information of the virtual reality apparatus expands the margins of indeterminacy (Hansen 2006b, p. 11); the affective body's encounter with the affective technosphere results in a "particular technical expansion of prepersonal bodily function that digital technologies facilitate," which Hansen terms *technogenesis* (Hansen, 2006a, p. 21). Returning to Kozel, this technical expansion is better characterized as a response between the human body and computer rather than as an interaction, as the former better characterizes the multisensory dimension of embodied interfaces (Kozel, 2007, p. 182). Kozel's poetics of responsivity accounts for the disruptive nature of the dynamic, moment-to-moment encounter between the affective body and the incorporeal digital in the production of affective technosphere in which the "subject and object fold into one another" in a "constant slippage of control" (Kozel, 2007, p. 202). Kozel terms this rhythmic response *reversibility* (Kozel, 2007, p. 202) to describe the ebbs and flows of responsivity across a multitude of affective bodies that constitute the affective technosphere in which the very production of space between two affective bodies is interfaced via a technological apparatus capable of responding to human emotion almost as quickly as the human user becomes aware of that emotion herself. Building upon Kozel's poetics of responsivity, future research should take up the Bergsonist vocation and investigate this intersection between affective spatial schemas and Hansen's technogenesis within the affective technosphere. As human-computer relations become ever more intertwined, there is a greater need to understand how humans respond to one another in a connected network that not only conveys digital information, but digital feelings as well, as technological advances poise to place machines in more intimate roles, from raising children to carrying for the sick. The topological map for a directionality of presence provides the first steps into understanding how affective embodied movement can become an input response itself.

REFERENCES

Abrash, M. (2014). *What VR Could, Should, and Almost Certainly Will Be within Two Years*. Presented at the Steam Dev Days, Seattle.

Acre. (2019). In *Oxford English dictionary*. Retrieved on April 11, 2019, from http://www.oed.com.libproxy.rpi.edu/view/Entry/1769?redirectedFrom=acre#eid

Alexander, R. D. (1990). Epigenetic rules and Darwinian algorithms: The adaptive study of learning and development. *Ethology & Sociobiology, 11*(4-5), 241-303. doi: 10.1016/0162-3095(90)90012-U

Aristotle & Kennedy, G. A. (1991). *On rhetoric: A theory of civic discourse*. New York, NY: Oxford University Press.

Arnheim, R. (1969). *Visual thinking*. Berkeley, CA: University of California Press.

Aronson, E. (1989). The rationalizing animal. In H. J. Leavitt, L. R. Pondy, & D. M. Boje (Eds.), *Readings in managerial psychology* (4th ed, pp. 134–144). Chicago, IL: University of Chicago Press.

Bachelard, G. (2014). *The poetics of space*. (M. Jolas, Trans.) (New edition). New York, NY: Penguin Books. (Original work published in 1958)

Bailenson, J. (2018). *Experience on demand: What virtual reality is, how it works, and what it can do* (First edition). New York, NY: W. W. Norton & Company, Inc.

Bailey, A. A., & Moersch, F. P. (1941). Phantom limb. *Canadian Medical Association Journal*, *45*(1), 37–42. Retrieved on December 31, 2018, from https://europepmc.org/articles/PMC1826976;jsessionid=39BF301592A4D904C721262060 4BDD5A

Barlow, H. B., & Mollon, J. D. (Eds.). (1982). *The Senses*. Cambridge [Cambridgeshire], UK; New York, NY: Cambridge University Press.

Bartusiak, M. (2009). The day we found the universe: January 1, 1925: Edwin Hubble's close observation of the Cepheids revealed that our galaxy is not alone. *Natural History*, *118*(5), 24+. Retrieved on April 7, 2019, from http://go.galegroup.com.libproxy.rpi.edu/ps/i.do?p=AONE&u=nysl_ca_rpi&id=GALE|A201549599&v=2.1&it=r&sid=ebsco

Bateson, G. (2003). A theory of play and fantasy. In K. Salen & E. Zimmerman (Eds.), *Rules of play: Game design fundamentals* (p. 314-328). Cambridge, MA: MIT Press.

Benjamin, W. (2010). The work of art in the age of its technological reproducibility. In V. B. Leitch (Ed.), *The Norton anthology of theory and criticism* (2nd ed, pp. 1051–1071). New York, NY: W. W. Norton & Co.

Bergson, H. (1988). *Matter and memory*. New York, NY: Zone Books.

Bhadra, U., Thakkar, N., Das, P., & Pal Bhadra, M. (2017). Evolution of circadian rhythms: From bacteria to human. *Sleep Medicine*, *35*, 49–61. doi: 10.1016/j.sleep.2017.04.008

Biedermann, H. (1992). *Dictionary of symbolism*. New York, NY; Oxford, UK: Facts on File.

Biocca, F. (1992). Will simulation sickness slow down the diffusion of virtual environment technology? *Presence: Teleoperators and Virtual Environments*, *1*(3), 334–343. doi: 10.1162/pres.1992.1.3.334

Birdwhistell, R. L. (1970). *Kinesics and context: Essays on body motion communication* (5th paperback printing). Philadelphia, PA: University of Pennsylvania Press.

Blackburn, S. (2008). *The Oxford dictionary of philosophy* (2nd ed., rev). Oxford, UK: Oxford University Press.

Boletsis, C. (2017). The new era of virtual reality locomotion: A systematic literature review of techniques and a proposed typology. *Multimodal Technologies and Interaction*, *1*(4), 24. doi: 10.3390/mti1040024

Bonato, F., Bubka, A., Palmisano, S., Phillip, D., & Moreno, G. (2008). Vection change exacerbates simulator sickness in virtual environments. *Presence: Teleoperators and Virtual Environments*, *17*(3), 283–292. doi: 10.1162/pres.17.3.283

Bracken, C. C. (2005). Presence and image quality: The case of high-definition television. *Media Psychology*, *7*(2), 191–205. doi: 10.1207/S1532785XMEP0702_4

Bradby, D. (2006). Editor's introduction. In D. Bradby (Ed.), *Theatre of movement and gesture* (pp. xii–xvi). London, UK; New York, NY: Routledge.

Braddick, O. J. (1982). Binocular vision. In H. B. Barlow & J. D. Mollon (Eds.), *The senses* (pp. 192–200). Cambridge [Cambridgeshire] UK; New York, NY: Cambridge University Press.

Bradley, M. M., & Lang, P. J. (2000). Measuring emotion: Behavior, feeling, and physiology. In R. D. Lane & L. Nadel (Eds.), *Series in affective science. Cognitive neuroscience of emotion* (pp. 242-276). New York, NY: Oxford University Press.

Bradley, M. M., Codispoti, M., Cuthbert, B. N., & Lang, P. J. (2001). Emotion and motivation, I: Defensive and appetitive reactions in picture processing. *Emotion*, *1*(3), 276–298. doi: 10.1037//1528-3542.1.3.276

Bradley, M. M., Codispoti, M., Sabatinelli, D., & Lang, P. J. (2001). Emotion and motivation II: Sex differences in picture processing. *Emotion*, *1*(3), 300–319. doi: 10.1037//1528-3542.1.3.300

Bradley, S. D. (2007). Dynamic, embodied, limited-capacity attention and memory: Modeling cognitive processing of mediated stimuli. *Media Psychology*, *9*(1), 211–239. doi: 10.1080/15213260709336810

Bruner, J. S. (1973). *Beyond the information given: Studies in psychology of knowing*. (J. M. Anglin, Ed.). New York, NY: W.W. Norton & Company.

Buchanan, I. (2010). *A dictionary of critical theory* (1st ed). Oxford, UK: Oxford University Press.

Burke, K. (1966). *Language as symbolic action: Essays on life, literature, and method*. Berkeley, CA: University of California Press.

Caillois, R. (2001). *Man, play, and games* (M. Barash, Trans.). Urbana, IL: University of Illinois Press.

Campbell, J. (1973). *The hero with a thousand faces* (2. ed., 3. print). Princeton, NJ: Princeton University Press.

Campos-Castillo, C. (2012). Copresence in virtual environments. *Sociology Compass*, *6*(5), 425–433. doi: 10.1111/j.1751-9020.2012.00467.x

Cappelli, A., Castellani, E., Colomo, F., & Di Vecchia, P. (Eds.). (2012). *The birth of string theory* [electronic resource]. Cambridge, UK: Cambridge University Press. doi: 10.1017/CBO9780511977725

Ceunen, E., Vlaeyen, J. W., & Van Diest, I. (2016). On the origin of interoception. *Frontiers in Psychology*, *7*, 743. doi:10.3389/fpsyg.2016.00743

Chirico, A., Ferrise, F., Cordella, L., & Gaggioli, A. (2018). Designing awe in virtual reality: An experimental study. *Frontiers in Psychology*, *8*, 1-14. doi: 10.3389/fpsyg.2017.02351

Ciechanowski, L., Przegalinska, A., Magnuski, M., & Gloor, P. (2019). In the shades of the uncanny valley: An experimental study of human–chatbot interaction. *Future Generation Computer Systems*, *92*, 539–548. https://doi-org.libproxy.rpi.edu/10.1016/j.future.2018.01.055

Clayman, C. B. (Ed.). (1989). *The American Medical Association encyclopedia of medicine*. New York, NY: Random House.

Clements, R. (2012, March 1). Journey review. *IGN*. Retrieved on May 20, 2019, from https://www.ign.com/articles/2012/03/01/journey-review

Conroy, G. C. (1997). *Reconstructing human origins: A modern synthesis* (1st ed). New York, NY: W.W. Norton.

Cooper, N., Milella, F., Pinto, C., Cant, I., White, M., & Meyer, G. (2018). The effects of substitute multisensory feedback on task performance and the sense of presence in a virtual reality environment. *PLOS ONE*, *13*(2), e0191846. doi: 10.1371/journal.pone.0191846

Coxeter, H. S. M. (1998). *Non-Euclidean geometry* (6th ed.). Washington, DC: American Mathematical Society.

Craig, E. (Ed.). (2005). *The shorter Routledge encyclopedia of philosophy*. London, UK; New York, NY: Routledge.

Creswell, J. W. (2007). *Qualitative inquiry and research design: choosing among five approaches* (2nd ed). Thousand Oaks, CA: Sage Publications.

Crogan, P. (2003). Gametime: History, narrative, temporality in Combat Flight Simulator 2. In M. J. P. Wolf & B. Perron (Eds.), *The video game theory reader* (pp. 275–301). New York, NY; London, UK: Routledge.

Cropanzano, R., James, K., & Citera, M. (1993). A goal hierarchy model of personality, motivation, and leadership. *Research in Organizational Behavior*, *15*, 267–322. Retrieved on April 29, 2018, from https://www.researchgate.net/

Cruz-Neira, C., Sandin, D. J., & DeFanti, T. A. (1993). Surround-screen projection-based virtual reality: The design and implementation of the CAVE. In *Proceedings of the 20th annual conference on Computer graphics and interactive techniques, SIGGRAPH '93* (pp. 135–142). Anaheim, CA: ACM Press. doi: 10.1145/166117.166134

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience* (1st ed.). New York, NY: Harper & Row.

Dainton, B. (2017). Temporal consciousness. In *Stanford encyclopedia of philosophy*. Retrieved on January 2, 2019, from https://plato.stanford.edu/entries/consciousness-temporal/

Damasio, A. R. (1999). *The feeling of what happens: Body and emotion in the making of consciousness* (Harvest ed.). San Diego, CA: Harcourt.

Deaky, B.-A., & Parv, L. (2017). Virtual reality for real estate: Its evolution in Bluemind software. In *2017 4th Experiment@International Conference (exp.at'17)* (pp. 83–86). Faro, Portugal: IEEE. doi: 10.1109/EXPAT.2017.7984408

Deleuze, G. (1986). *Cinema 1: The movement-image*. Minneapolis, : University of Minnesota.

Deleuze, G., & Guattari, F. (1987). *A thousand plateaus: capitalism and schizophrenia*. Minneapolis, MN: University of Minnesota Press.

DeMaria, R., & Wilson, J. L. (2002). *High score!: The illustrated history of electronic games*. Berkeley, CA: McGraw-Hill/Osborne.

Deutsch, D., Hamaoui, K., & Henthorn, T. (2007). The glissando illusion and handedness. *Neuropsychologia*, *45*(13), 2981–2988. doi: 10.1016/j.neuropsychologia.2007.05.015

Dorsch, F., & Macpherson, F. (Eds.). (2018). *Phenomenal presence* (First edition). Oxford, UK: Oxford University Press.

Drummond, J. J. (2007). Phenomenology: Neither auto- nor hetero- be. *Phenomenology and the Cognitive Sciences*, *6*(1–2), 57–74. doi: 10.1007/s11097-006-9037-8

Dyer-Witheford, N., & de Peuter, G. (2009). *Games of empire: Global capitalism and video games*. Minneapolis, MN: University of Minnesota Press.

Ear on the arm. (2019). Retrieved on January 8, 2019, from http://stelarc.org/?catID=20242

Ebenholtz, S. M. (1992). Motion sickness and oculomotor systems in virtual environments. *Presence: Teleoperators and Virtual Environments*, *1*(3), 302–305. doi: 10.1162/pres.1992.1.3.302

Emmorey, K. (2001). Space on hand: The exploitation of signing space to illustrate abstract thought. In M. Gattis (Ed.), *Spatial schemas and abstract thought* (pp. 147–174). Cambridge, MA: MIT Press.

Epple, M. (1998). Topology, matter, and space, I: Topological notions in 19th-century natural philosophy. *Archive for History of Exact Sciences*, *52*(4), 297–892. Retrieved on April 9, 2019, from https://search-ebscohost-com.libproxy.rpi.edu/login.aspx?direct=true&db=edsjsr&AN=edsjsr.41134050&site=eds-live&scope=site

Fisher, G. H. (1967). Measuring ambiguity. *The American Journal of Psychology*, *80*(4), 541. doi: 10.2307/1421187

Flanders, M. (2011). What is the biological basis of sensorimotor integration? *Biological Cybernetics*, *104*(1–2), 1–8. doi: 10.1007/s00422-011-0419-9

Frayer, D. W., Clarke, R. J., Fiore, I., Blumenschine, R. J., Pérez-Pérez, A., Martinez, L. M., … Bondioli, L. (2016). OH-65: The earliest evidence for right-handedness in the fossil record. *Journal of Human Evolution*, *100*, 65–72. doi: 10.1016/j.jhevol.2016.07.002

Freeman, J., Avons, S. E., Meddis, R., Pearson, D. E., & Ijsselsteijn, W. (2000). Using behavioral realism to estimate presence: A study of the utility of postural responses to motion stimuli. *Presence: Teleoperators and Virtual Environments*, *9*(2), 149–164. doi: 10.1162/105474600566691

Freeman, J., Avons, S. E., Pearson, D. E., & IJsselsteijn, W. A. (1999). Effects of sensory information and prior experience on direct subjective ratings of presence. *Presence: Teleoperators and Virtual Environments*, *8*(1), 1-13. doi: 10.1162/105474699566017

Front. (2019). In *Oxford English dictionary*. Retrieved April 11, 2019, from http://www.oed.com.libproxy.rpi.edu/view/Entry/74915?rskey=wKu2jk&result=1&isAdvanced=false#eid

Gaetz, W., Kessler, S. K., Roberts, T. P. L., Berman, J. I., Levy, T. J., Hsia, M., … Levin, L. S. (2018). Massive cortical reorganization is reversible following bilateral transplants of the hands: Evidence from the first successful bilateral pediatric hand transplant patient. *Annals of Clinical and Translational Neurology*, *5*(1), 92–97. doi: 10.1002/acn3.501

Gallagher, P., Allen, D., & Maclachlan, M. (2001). Phantom limb pain and residual limb pain following lower limb amputation: a descriptive analysis. *Disability and Rehabilitation*, *23*(12), 522–530. doi: 10.1080/09638280010029859

Garousi, M., & Kowsari, M. (2012). Fractal art and postmodern society. *Journal of Visual Art Practice*, *10*(3), 215–229. doi: 10.1386/jvap.10.3.215_1

Gattis, M. (2001a). Reading pictures: Constraints on mapping conceptual and spatial schemas. In M. Gattis (Ed.), *Spatial schemas and abstract thought* (pp. 223–246). Cambridge, MA: MIT Press.

Gattis, M. (2001b). Space as a basis for abstract thought. In M. Gattis (Ed.), *Spatial schemas and abstract thought* (pp. 1–12). Cambridge, MA: MIT Press.

Gattis, M. (2004). Mapping relational structure in spatial reasoning. *Cognitive Science*, *28*(4), 589–610. doi: 10.1016/j.cogsci.2004.02.001

Gentner, D. (2001). Spatial metaphors in temporal reasoning. In M. Gattis (Ed.), *Spatial schemas and abstract thought* (pp. 203–222). Cambridge, MA: MIT Press.

Gentner, D., & Markman, A. B. (1997). Structure mapping in analogy and similarity. *American Psychologist*, *52*(1), 45–56. doi: 0.1037/0003-066X.52.1.45

Gerardi, M., Rothbaum, B. O., Ressler, K., Heekin, M., & Rizzo, A. (2008). Virtual reality exposure therapy using a virtual Iraq: Case report. *Journal of Traumatic Stress*, *21*(2), 209–213. doi: 10.1002/jts.20331

Ghazanfar, A., & Schroeder, C. (2006). Is neocortex essentially multisensory? *Trends in Cognitive Sciences*, *10*(6), 278–285. doi: 10.1016/j.tics.2006.04.008

Gibson, J. J. (1986). *The ecological approach to visual perception*. New York, NY: Psychology Press.

Green, M. C., Brock, T. C., & Kaufman, G. F. (2004). Understanding media enjoyment: The role of transportation into narrative worlds. *Communication Theory*, *14*(4), 311–327. doi: 10.1111/j.1468-2885.2004.tb00317.x

Gregersen, A., & Grodal, T. (2009). Embodied and interface. In B. Perron & M. J. P. Wolf (Eds.), *The video game theory reader 2* (pp. 65–83). New York, NY: Routledge.

Grigorovici, D. (2003). Persuasive effects of presence in immersive virtual environments. In G. Riva, F. Davide, & W. A. IJsselsteijn (Eds.), *Being there: Concepts, effects and measurements of user presence in synthetic environments* (pp. 191–207). Amsterdam, The Netherlands; Washington, D.C.; Tokyo, Japan: IOS Press; Ohmsha.

Gunathillake, A., Thilakarathna, K., & Jayasumana, A. P. (2018). Topology preserving map for wireless sensor networks equipped with directional antennas. In *2018 IEEE 43rd Conference on Local Computer Networks (LCN)* (pp. 175-183). Chicago, IL: IEEE. doi: 10.1109/LCN.2018.8638243

Gylys, B. A., & Wedding, M. E. (2017). *Medical terminology systems: A body systems approach* (8th edition). Philadelphia, PA: F.A. Davis Company.

Hall, E. T. (1963). A system for the notation of proxemic behavior. *American Anthropologist*, *65*(5), 1003–1026. Retrieved on February 24, 2019, from http://www.jstor.org.libproxy.rpi.edu/stable/668580

Hall, J. (2008). *The sinister side: How left-right symbolism shaped Western art*. New York, NY: Oxford University Press.

Hansen, M. B. N. (2006a). *Bodies in code: Interfaces with digital media*. New York, NY: Routledge.

Hansen, M. B. N. (2006b). *New philosophy for new media*. Cambridge, MA: MIT Press.

Hartcher-O'Brien, J., & Auvray, M. (2014). The process of distal attribution illuminated through studies of sensory substitution. *Multisensory Research*, *27*(5–6), 421–441. doi: 10.1163/22134808-00002456

Hartmann, T., Wirth, W., Schramm, H., Klimmt, C., Vorderer, P., Gysbers, A., … Maria Sacau, A. (2016). The spatial presence experience scale (SPES): A short self-report measure for diverse media settings. *Journal of Media Psychology*, *28*(1), 1–15. doi: 10.1027/1864-1105/a000137

Hayden, S. (2019, March 4). ESL & Oculus announce esports VR League Season 3, biggest prize pool yet. Retrieved on June 22, 2019, from https://www.roadtovr.com/esl-oculus-announce-vr-leagues-season-3-biggest-prize-pool-yet/

Heidegger, M., & Stambaugh, J. (1996). *Being and time: A translation of* Sein und Zeit. Chicago, IL: University of Chicago.

Held, R., & Durlach, N. (1989). *Telepresence, time delay, and adaptation*. Presented at the NASA Conference Publication 10032, Massachusetts Institute of Technology; Cambridge, MA: NASA. Retrieved on January 1, 2019, from https://ntrs.nasa.gov/search.jsp?R=19900013628

Heron, W. (1957). The pathology of boredom. *Scientific American*, *196*(1), 52–56. doi: 10.1038/scientificamerican0157-52

Herz, J. C. (1997). *Joystick nation: How videogames ate our quarters, won our hearts, and rewired our minds* (1st ed). Boston, MA: Little, Brown, and Co.

Hetherington, N. S. (1982). Philosophical values and observation in Edwin Hubble's choice of a model of the Universe. *Historical Studies in the Physical Sciences*, *13*(1), 41–67. doi: 10.2307/27757505

Hettinger, L. J., Berbaum, K. S., Kennedy, R. S., Dunlap, W. P., & Nolan, M. D. (1990). Vection and simulator sickness. *Military Psychology: The Official Journal of The Division of Military Psychology, American Psychological Association*, *2*(3), 171–181. Retrieved on May 4, 2019, from http://ezproxy.mariacollege.edu:2068/login.aspx?direct=true&db=cmedm&AN=11537522&site=ehost-live

Holloway, R. L. (1967). The evolution of the human brain: Some notes toward a synthesis between neural structure and the evolution of complex behavior. *General Systems*, *12*, 3–19.

Homa, D., Haver, B., & Schwartz, T. (1976). Perceptibility of schematic face stimuli: Evidence for a perceptual Gestalt. *Memory & Cognition*, *4*(2), 176–185. doi: 10.3758/BF03213162

Howard, I. P., & Rogers, B. J. (1995). Binocular vision and stereopsis. In *Oxford Psychology Series*: *Vol. no. 29*. New York, NY: Oxford University Press.

HTC. (2016). HTC Vive: Vive pre-user guide. Author.

Huang, Y. C., Backman, K. F., Backman, S. J., & Chang, L. L. (2016). Exploring the implications of virtual reality technology in tourism marketing: An integrated research framework: The implications of virtual reality technology in tourism marketing. *International Journal of Tourism Research*, *18*(2), 116–128. doi: 10.1002/jtr.2038

Huizinga, J. H. (1980). *Homo ludens.* London: Routledge.

Husserl, E. (1991). *On the phenomenology of the consciousness of internal time (1893-1917)*. (J. B. Brough, Ed.). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Hvass, J., Larsen, O., Vendelbo, K., Nilsson, N., Nordahl, R., & Serafin, S. (2017). Visual realism and presence in a virtual reality game. In *2017 3DTV Conference: The True Vision-Capture, Transmission and Display of 3D Video (3DTV-CON)* (pp.1-4). Copenhagen, Denmark: IEEE. doi: 10.1109/3DTV.2017.8280421

Iggo, A. (1982). Cutaneous sensory mechanisms. In H. B. Barlow & J. D. Mollon (Eds.), *The senses* (pp. 369–408). Cambridge [Cambridgeshire], UK; New York, NY: Cambridge University Press.

Ijsselsteijn, W. (2002). Elements of a multi-level theory of presence: Phenomenology, mental processing and neural correlates. In *Proceedings of Presence 2002* (pp. 245-259). Presented at Universidade Fernando Pessoa, Porto, Portugal. Retrieved on January 1, 2019, from https://www.researchgate.net/publication/228586530_Elements_of_a_multi-level_theory_of_presence_Phenomenology_mental_processing_and_neural_correlates

IJsselsteijn, W., de Ridder, H., Freeman, J., & Avons, S. E. (2000). Presence: Concept, determinants, and measurement. In B. E. Rogowitz & T. N. Pappas (Eds.), *Human Vision and Electronic Imaging V*, (pp. 520–529). Presented at the Electronic Imaging, San Jose, CA: SPIE. doi: 10.1117/12.387188

Ijsselsteijn, W., & Riva, G. (2003). Being there: The experience of presence in mediated environments. In *Studies in new technologies and practices in communication* (pp. 3–16). Amsterdam, Netherlands: IOS Press.

Ijsselsteijn, W., de Ridder, H., Hamberg, R., Bouwhuis, D., & Freeman, J. (1998). Perceived depth and the feeling of presence in 3DTV. *Displays*, *18*(4), 207–214. doi: 10.1016/S0141-9382(98)00022-5

Iliev, A. (2014). *Towards a theory of mime*. (M. M. Chemers, Ed., M. Dabova, Trans.). London, UK; New York, NY: Routledge, Taylor & Francis Group.

International Society for Presence Research. (2000a). ISPR measures statement and compendium. Retrieved on April 29, 2018, from https://ispr.info/about-presence-2/tools-to-measure-presence/ispr-measures-compendium/

International Society for Presence Research. (2000b). Presence defined. Retrieved on April 29, 2019, from https://ispr.info/

IRL. (2019). In *Oxford English dictionary*. Retrieved on April 11, 2018, from http://www.oed.com.libproxy.rpi.edu/view/Entry/90670?redirectedFrom=irl#eid1209717390

James, W. (1890). *The principles of psychology, volume I* [Google books]. New York, NY: Henry Holt & Co. Retrieved on December 31, 2018, from https://books.google.com/books?id=lbtE-xb5U-oC&printsec=frontcover&vq=sensible+present&source=gbs_ge_summary_r&cad=0#v=onepage&q=sensible%20present%20has%20duration&f=false

Johnston, J. (1999). Machinic vision. *Critical Inquiry*, *26*(1), 27–48. doi: 10.1086/448951

Juan, M. C., & Pérez, D. (2009). Comparison of the levels of presence and anxiety in an acrophobic environment viewed via HMD or CAVE. *Presence: Teleoperators and Virtual Environments*, *18*(3), 232–248. doi: 10.1162/pres.18.3.232

Kandel, E. R. (2012). *The age of insight: The quest to understand the unconscious in art, mind, and brain: From Vienna 1900 to the present* (1st ed). New York, NY: Random House.

Kawashima, N., & Mita, T. (2009). Metal bar prevents phantom limb motion: Case study of an amputation patient who showed a profound change in the awareness of his phantom limb. *Neurocase*, *15*(6), 478–484. doi: 10.1080/13554790902950442

Kearney, R. (2014). Introduction. In G. Bachelard (Ed.), & M. Jolas (Trans.), *The poetics of space* (New edition, pp. xvii–xxv). New York, NY: Penguin Books.

Kelly, J. (2012). *The graves are walking: The great famine and the saga of the Irish people*. Retrieved April 6, 2019, from http://rbdigital.oneclickdigital.com

Kelly, M. (2019, May 8). Game studios would be banned from selling loot boxes to minors under new bill. *The Verge*. Retrieved on May 16, 2019, from https://www.theverge.com/2019/5/8/18536806/game-studios-banned-loot-boxes-minors-bill-hawley-josh-blizzard-ea

Kelly, S. D. (2005). The puzzle of temporal experience. In A. Brook & K. Akins (Eds.), *Cognition and the brain* (pp. 208–238). Cambridge, UK: Cambridge University Press. doi: 10.1017/CBO9780511610608.007

Kendrick, S. (2016). *A royal vow of convenience* [Audiobook]. Retrieved on December 31, 2018, from https://soundcloud.com/millsandboon/3daudio-cut

Kennedy, R. S., Lane, N. E., Berbaum, K. S., & Lilienthal, M. G. (1993). Simulator sickness questionnaire: An enhanced method for quantifying simulator sickness. *The International Journal of Aviation Psychology*, *3*(3), 203–220. doi: 10.1207/s15327108ijap0303_3

Kent, S. L. (2001). *The ultimate history of video games: From Pong to Pokémon and beyond: The story behind the craze that touched our lives and changed the world* (1st ed). Roseville, CA: Prima Pub.

Kind, A. (2018). Imaginative presence. In F. Dorsch & F. Macpherson (Eds.), *Phenomenal presence* (First edition, pp. 165–180). Oxford, UK: Oxford University Press.

King, D. L., & Delfabbro, P. H. (2019). Video game monetization (e.g., 'loot boxes'): A blueprint for practical social responsibility measures. *International Journal of Mental Health and Addiction*, *17*(1), 166–179. https://doi-org.libproxy.rpi.edu/10.1007/s11469-018-0009-3

Kirkpatrick, G. (2011). *Aesthetic theory and the video game*. Manchester, UK; New York: NY: Manchester University Press.

Kita, S., Danziger, E., & Stolz, C. (2001). Cultural specificity of spatial schemas as manifested in spontaneous cultures. In M. Gattis (Ed.), *Spatial schemas and abstract thought* (pp. 115–146). Cambridge, MA: MIT Press.

Kline, S., Dyer-Witheford, N., & De Peuter, G. (2003). *Digital play: The interaction of technology, culture, and marketing*. Montréal, Canada; London, UK: McGill-Queen's University Press.

Kolasinski, E. M. (1995). *Simulator sickness in virtual environments* (Technical No. 1027; p. 68). Retrieved on May 4, 2019, from Army Research Institute for the Behavioral and Social Sciences. Alexandria, VA: website https://apps.dtic.mil/dtic/tr/fulltext/u2/a295861.pdf

Kooi, F. L., & Toet, A. (2004). Visual comfort of binocular and 3D displays. *Displays*, *25*(2–3), 99–108. doi: 10.1016/j.displa.2004.07.004

Kozel, S. (2007). *Closer: Performance, technologies, phenomenology*. Cambridge, MA: MIT Press.

Kuchera, B. (2011, July 7). Journey turns strangers into friends in odd, desolate landscape. *Wired*. Retrieved on May 20, 2019, from https://www.wired.com/2011/07/journey-hands-on/

Lang, A., Dhillon, K., & Dong, Q. (1995). The effects of emotional arousal and valence on television viewers' cognitive capacity and memory. *Journal of Broadcasting & Electronic Media*, *39*(3), 313–327. doi: 10.1080/08838159509364309

Lang, A., Newhagen, J., & Reeves, B. (1996). Negative video as structure: Emotion, attention, capacity, and memory. *Journal of Broadcasting & Electronic Media*, *40*(4), 460–477. doi: 10.1080/08838159609364369

Lecoq, J. (2006). *Theatre of movement and gesture*. (D. Bradby, Ed.). London, UK; New York, NY: Routledge.

Lee, K. M. (2004). Presence, explicated. *Communication Theory*, *14*(1), 27–50. doi: 10.1111/j.1468-2885.2004.tb00302.x

Lefebvre, H. (2011). *The production of space*. (D. Nicholson-Smith, Trans.). Malden, MA: Blackwell.

Legge, E. L. G., Madan, C. R., Ng, E. T., & Caplan, J. B. (2012). Building a memory palace in minutes: Equivalent memory performance using virtual versus conventional environments with the Method of Loci. *Acta Psychologica*, *141*(3), 380–390. doi: 10.1016/j.actpsy.2012.09.002

Lewis-Williams, D. (2004). *The mind in the cave: Consciousness and the origins of art*. London, UK: Thames & Hudson.

Liben, L. S. (2001). Thinking through maps. In M. Gattis (Ed.), *Spatial schemas and abstract thought* (pp. 45–78). Cambridge, MA: MIT Press.

Lie. (2019). In *Oxford English dictionary*. Retrieved on April 11, 2019, from http://www.oed.com.libproxy.rpi.edu/view/Entry/108041?rskey=i54RVC&result=6#eid

Llaurens, V., Raymond, M., & Faurie, C. (2009). Why are some people left-handed? An evolutionary perspective. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1519), 881–894. doi: 10.1098/rstb.2008.0235

Llinás, R. R. (2002). *I of the vortex: From neurons to self* (paperback ed.). Cambridge, MA: MIT Press.

Llinás, R. R., & Paré, D. (1991). Of dreaming and wakefulness. *Neuroscience*, *44*(3), 521–535. doi: 10.1016/0306-4522(91)90075-Y

Lombard, M., & Ditton, T. B. (2000). *Measuring presence: A literature-based approach to the development of a standardized paper-and-pencil instrument*. Presented at the Third International Workshop on Presence, Delft, The Netherlands. Retrieved on January 1, 2019, from https://pdfs.semanticscholar.org/6a2b/fd20b2933f075dc505d3048831f6443ad8d3.pdf?_ga=2.139682416.290987036.1546349986-804114570.1546349986

Lombard, M., & Ditton, T.B. (2006). At the heart of it all: The concept of presence. *Journal of Computer-Mediated Communication*, *3*(2), 0–0. doi: 10.1111/j.1083-6101.1997.tb00072.x

Loomis, J. M. (1992). Distal attribution and presence. *Presence: Teleoperators and Virtual Environments*, *1*(1), 113–119. doi: 10.1162/pres.1992.1.1.113

Macpherson, F., & Dorsch, F. (Eds.). (2018). *Perceptual imagination and perceptual memory* (First edition). Oxford, UK: Oxford University Press.

Marr, B. (2019, May 6). Artificial intelligence can now copy your voice: What does that mean for humans? *Forbes*. Retrieved on May 20, 2019, from https://www.forbes.com/sites/bernardmarr/2019/05/06/artificial-intelligence-can-now-copy-your-voice-what-does-that-mean-for-humans/#3e216d8772a2

Massumi, B. (2002). *Parables for the virtual: movement, affect, sensation*. Durham, NC: Duke University Press.

Masterton, B., & Kennedy, J. (1975). Building the devil's tuning fork. *Perception*, *4*, 107–109. doi: 10.1068/p040107

McGonigle, B., & Chalmers, M. (2001). Spatial representation as cause and effect: Circular causality comes to cognition. In M. Gattis (Ed.), *Spatial schemas and abstract thought* (pp. 247–278). Cambridge, MA: MIT Press.

Mennecke, B., Triplett, J. L., Hassall, L. M., Heer, R., & Conde, Z. J. (2008). Embodied social presence theory. *SSRN Electronic Journal*. doi: 10.2139/ssrn.1286281

Merleau-Ponty, M. (1968). *The visible and the invisible: Followed by working notes* (C. Lefort, ed.; A. Lingis, trans.). Evanston, IL: Northwestern University Press.

Merleau-Ponty, M. (2008). *Phenomenology of perception* (C. Smith, trans.). London, UK: Routledge.

Messinger, P. R., Stroulia, E., Lyons, K., Bone, M., Niu, R. H., Smirnov, K., & Perelgut, S. (2009). Virtual worlds—past, present, and future: New directions in social computing. *Decision Support Systems*, *47*(3), 204–228. doi: 10.1016/j.dss.2009.02.014

Minsky, M. (1980, June). Telepresence. *Omni*, 45–51. Retrieved on January 1, 2019, from http://www.housevampyr.com/training/library/books/omni/OMNI_1980_06.pdf

Mithen, S. J. (1999). *The prehistory of the mind: The cognitive origins of art, religion and science* (1st paperback ed). London, UK; New York, NY: Thames and Hudson.

Morgen. (2019). In *Oxford English dictionary*. Retrieved on April 11, 2019, from http://www.oed.com.libproxy.rpi.edu/view/Entry/122221?redirectedFrom=morgen+#eid

Mori, M. (2012). The uncanny valley [from the field] (K. MacDorman & N. Kageki, Trans.). *IEEE Robotics & Automation Magazine*, *19*(2), 98–100. doi: 10.1109/MRA.2012.2192811

Morse, M. (1998). *Virtualities: Television, media art, and cyberculture*. Bloomington, IN: Indiana University Press.

Moustakas, C. E. (1994). *Phenomenological research methods*. Thousand Oaks, CA: Sage.

Moyer, R. S., & Bayer, R. H. (1976). Mental comparison and the symbolic distance effect. *Cognitive Psychology*, *8*(2), 228–246. doi: 10.1016/0010-0285(76)90025-6

Mrozowski, P. (1993). Genuflection in medieval western culture: The gesture of expiation: The praying posture. *Acta Poloniae Historica*, *68*, 5–26. Retrieved on January 5, 2019, from http://www.rcin.org.pl/dlibra/docmetadata?id=28176&from=publication

Murray, C. D. (2001). The experience of body boundaries by Siamese twins. *New Ideas in Psychology*, *19*(2), 117–130. doi: 10.1016/S0732-118X(00)00018-0

Nelson, R. J. (2013). Is virtual reality exposure therapy effective for service members and veterans experiencing combat-related PTSD? *Traumatology*, *19*(3), 171–178. doi: 10.1177/1534765612459891

Nichols, S., Haldane, C., & Wilson, J. R. (2000). Measurement of presence and its consequences in virtual environments. *International Journal of Human-Computer Studies*, *52*(3), 471–491. doi: 10.1006/ijhc.1999.0343

Nitsche, M. (2008). Video game spaces: Image, play, and structure in 3D game worlds. Cambridge, MA: MIT Press.

O'Dea, J. (2018). Art and ambiguity: A Gestalt-shift approach to elusive appearances. In F. Dorsch & F. Macpherson (Eds.), *Phenomenal presence* (First edition, pp. 58–76). Oxford, UK: Oxford University Press.

Olivares, J. (1996). Sandra Cisneros' *The House on Mango Street* and *The Poetics of Space*. Paper presented at the Chican Creativity and Criticism: New Frontiers in American Literature, Irvine, CA (pp. 233–244). Albuquerque, NM: University of New Mexico Press. Retrieved on January 15, 2019, from https://www.eriesd.org/cms/lib02/PA01001942/Centricity/Domain/376/HOMS%20Lit%20Crit%206%20-%20The%20Poetics%20of%20Space.pdf

Oxford English dictionary. (2019). Oxford University Press. Retrieved on April 11, 2019, from http://www.oed.com/

Palmisano, S., Mursic, R., & Kim, J. (2017). Vection and cybersickness generated by head-and-display motion in the Oculus Rift. *Displays*, *46*, 1–8. https://doi-org.libproxy.rpi.edu/10.1016/j.displa.2016.11.001

Pinker, S. (1994). *The language instinct* (1st ed). New York, NY: W. Morrow and Co.

Psotka, J. (1995). Immersive training systems: Virtual reality and education and training. *Instructional Science*, *23*(5–6), 405–431. doi: 10.1007/BF00896880

Ramachandran, V. S., & Blakeslee, S. (1998). *Phantoms in the brain: probing the mysteries of the human mind* (1st ed). New York, NY: William Morrow.

Ramachandran, V. S., & Rogers-Ramachandran, D. (2000). Phantom limbs and neural plasticity. *Archives of Neurology*, *57*(3), 317–320. doi: 10.1001/archneur.57.3.317

Reagan, R., & Hubler, R. G. (1981). *Where's the rest of me?* New York, NY: Dell.

Reeves, B., & Nass, C. I. (1996). The media equation: How people treat computers, television, and new media like real people and places. Chicago, IL: Center for the Study of Language and Information; New York, NY: Cambridge University Press.

Regenbrecht, H. T., Schubert, T. W., & Friedmann, F. (1998). Measuring the sense of presence and its relations to fear of heights in virtual environments. *International Journal of Human-Computer Interaction*, *10*(3), 233–249. doi: 10.1207/s15327590ijhc1003_2

Richardson, C., Olleveant, N., Crawford, K., & Kulkarni, J. (2018). Exploring the role of cortical reorganization in postamputation phantom phenomena, including phantom limb pain in lower limb amputees: A cross-sectional study of the patterns of referral of sensations into the phantom. *Pain Management Nursing*, *19*(6), 599–607. doi: 10.1016/j.pmn.2018.04.004

Riemann, B. L., & Lephart, S. M. (2002). The sensorimotor system, part I: The physiologic basis of functional joint stability. *Journal of Athletic Training*, *37*(1), 71–79.

Riva, G., Waterworth, J. A., & Waterworth, E. L. (2004). The layers of presence: A bio-cultural approach to understanding presence in natural and mediated environments. *CyberPsychology & Behavior*, *7*(4), 402–416. doi: 10.1089/cpb.2004.7.402

Rizzolatti, G., & Arbib, M. A. (1998). Language within our grasp. *Trends in Neurosciences*, *21*(5), 188–194. doi: 10.1016/S0166-2236(98)01260-0

Roberts, W. A. (2001). Spatial representation and the use of spatial codes in animals. In M. Gattis (Ed.), *Spatial schemas and abstract thought* (pp. 15–44). Cambridge, MA: MIT Press.

Rothbaum, B. O., & Hodges, L. F. (1999). The use of virtual reality exposure in the treatment of anxiety disorders. *Behavior Modification*, *23*(4), 507–525. doi: 10.1177/0145445599234001

Ruitenberg, C. W. (2007). Here be dragons: Exploring cartography in educational theory and research. *Complicity: An International Journal of Complexity and Education*, *4*(1). doi: 0.29173/cmplct8758

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110*(1), 145-172. doi: 10.1037/0033-295X.110.1.145

Ryan, M.-L. (2001). *Narrative as virtual reality: Immersion and interactivity in literature and electronic media*. Baltimore, MD: Johns Hopkins University Press.

Sagan, C. (1977). *The dragons of Eden: Speculations on the evolution of human intelligence* (1st ed). New York, NY: Random House.

Sagan, C. (1980). *Cosmos* (1st ed). New York, NY: Random House.

Satosphère. (n.d.). Retrieved on April 11, 2019, from http://sat.qc.ca/en/satosphere

Schell, J. (2008). The art of game design: A book of lenses. Amsterdam, The Netherlands; Boston, MA: Elsevier/Morgan Kaufmann.

Schoen, J. P. (1976). *Silents to sound: A history of the movies*. New York, NY: Four Winds Press.

Schott, G. D. (1993). Penfield's homunculus: A note on cerebral cartography. *Journal of Neurology, Neurosurgery, and Psychiatry*, *56*(4), 329–333. Retrieved on January 1, 2019, from https://search-ebscohost-com.libproxy.rpi.edu/login.aspx?direct=true&db=cmedm&AN=8482950&site=eds-live&scope=site

Schubert, T. W., & Crusius, J. (2002). Five theses on the book problem: Presence in books, film and VR. In F. R. Gouveia & F. Biocca (Eds.), *Proceedings of the 5th International Workshop on Presence* (pp. 53–59). Porto, Portugal: Universidad Fernando Pessoa. Retrieved January 2, 2019, from https://pdfs.semanticscholar.org/eb0b/b2182870edcb376724987229bdb604fe2afc.pdf

Seeley, R. R., VanPutte, C. L., Regan, J., & Russo, A. (2011). *Seeley's anatomy & physiology* (9th ed). New York, NY: McGraw-Hill.

Sharples, S., Cobb, S., Moody, A., & Wilson, J. R. (2008). Virtual reality induced symptoms and effects (VRISE): Comparison of head mounted display (HMD), desktop and projection display systems. *Displays*, *29*(2), 58–69. doi: 10.1016/j.displa.2007.09.005

Sheridan, T. B. (1992). Musings on telepresence and virtual presence. *Presence: Teleoperators and Virtual Environments*, *1*(1), 120–126. doi: 10.1162/pres.1992.1.1.120

Sherrington, C. S. (1906). *The integrative action of the nervous system*. New Haven, CT: Yale University Press.

Shields-Zhou, G. A., Hill, A. C., & Macgabhann, B. A. (2012). The Cryogenian Period. In *The geologic time scale* (pp. 393–411). Amsterdam, The Netherlands: Elsevier. doi: 10.1016/B978-0-444-59425-9.00017-2

Sienaert, E. R. (1990). Marcel Jousse: The oral style and the anthropology of gesture. *Oral Tradition*, *5*(1), 91–106. Retrieved on January 20, 2019, from http://www.marceljousse.com/wp-content/uploads/2017/11/article-Oral-Tradition-1990.pdf

Slater, M. (2002). Presence and the sixth sense. *Presence: Teleoperators and Virtual Environments*, *11*(4), 435–439. doi: 10.1162/105474602760204327

Slater, M., & Steed, A. (2000). A virtual presence counter. *Presence: Teleoperators and Virtual Environments*, *9*(5), 413–434. doi: 10.1162/105474600566925

Slater, M., Linakis, V., Usoh, M., & Kooper, R. (1999). *Immersion, presence, and performance in virtual environments: An experiment with tri-dimensional chess*. Presented at the ACM Symposium on Virtual Reality Software and Technology, Hong Kong, Peoples Republic of China. Retrieved on January 1, 2019, from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.34.6594&rep=rep1&type=pdf

Slater, M., Usoh, M., & Chrysanthou, Y. (1995). The influence of dynamic shadows on presence in immersive virtual environments. In M. Göbel (Ed.), *Virtual Environments '95* (pp. 8–21). Vienna, Austria: Springer Vienna. doi: 10.1007/978-3-7091-9433-1_2

Slater, M., Usoh, M., & Steed, A. (1995). Taking steps: The influence of a walking technique on presence in virtual reality. *ACM Transactions on Computer-Human Interaction*, *2*(3), 201–219. doi: 10.1145/210079.210084

Snyder, D. C., Conner, L. M., & Lorenz, G. F. (2007). *Kinesiology foundations for OTAs*. Australia; [Clifton Park, NY]: Thomson Delmar Learning.

Sony. (2016). PlayStation VR: Instruction manual. Author.

Spivak, G. C. (1997). Translator's preface. In Jacques Derrida, *Of grammatology* (Corrected ed, pp. ix–lxxxvii). Baltimore, MD: Johns Hopkins University Press.

Stand. (2019). In *Oxford English dictionary*. Retrieved on April 11, 2019, from http://www.oed.com.libproxy.rpi.edu/view/Entry/188960?result=3&rskey=iIptJx&

Stanney, K. M., Mourant, R. R., & Kennedy, R. S. (1998). Human factors issues in virtual environments: A review of the literature. *Presence: Teleoperators and Virtual Environments*, *7*(4), 327–351. doi: 10.1162/105474698565767

Steed, A., Friston, S., Lopez, M. M., Drummond, J., Pan, Y., & Swapp, D. (2016). An "in the wild" experiment on presence and embodiment using consumer virtual reality equipment. *IEEE Transactions on Visualization and Computer Graphics*, *22*(4), 1406–1414. doi: 10.1109/TVCG.2016.2518135

Steuer, J. (1992). Defining virtual reality: Dimensions determining telepresence. *Journal of Communication*, *42*(4), 73–93. doi: 10.1111/j.1460-2466.1992.tb00812.x

Stokstad, M., & Cothren, M. W. (2011). *Art history* (4th ed.). Boston, MA: Prentice Hall.

Suied, C., Drettakis, G., Warusfel, O., & Viaud-Delmon, I. (2013). Auditory-visual virtual reality as a diagnostic and therapeutic tool for cynophobia. *Cyberpsychology, Behavior, and Social Networking*, *16*(2), 145–152. doi: 10.1089/cyber.2012.1568

Sur, S., & Sinha, V. (2009). Event-related potential: An overview. *Industrial Psychiatry Journal*, *18*(1), 70. doi: 10.4103/0972-6748.57865

Swink, S. (2009). *Game feel: a game designer's guide to virtual sensation*. Amsterdam, The Netherlands; Boston, MA: Morgan Kaufmann Publishers/Elsevier.

Tamborini, R., & Skalski, P. (2006). The role of presence in the experience of electronic games. In P. Vorderer & J. Bryant (Eds.), *Playing video games: Motives, responses, and consequences* (pp. 225–240). Mahwah, NJ: Lawrence Erlbaum Associates.

Taylor, R. M., Jerald, J., VanderKnyff, C., Wendt, J., Borland, D., Marshburn, D., … Whitton, M. C. (2010). Lessons about virtual environment software systems from 20 years of VE building. *Presence: Teleoperators and Virtual Environments*, *19*(2), 162–178. doi: 10.1162/pres.19.2.162

Tranel, D. (2002). Electrodermal activity in cognitive neuroscience: Neuroanatomical and neuropsychological correlates. In R. D. Lane & L. Nadel (Eds.), *Cognitive neuroscience of emotion* (pp. 192–224). Oxford, UK: Oxford University Press.

Treisman, M. (1977). Motion sickness: An evolutionary hypothesis. *Science*, *197*(4302), 493–495. Retrieved on May 4, 2019, from http://www.jstor.org.libproxy.rpi.edu/stable/1744991

Tuan, Y. F. (2011). *Space and place: The perspective of experience*. Minneapolis, MN: University of Minnesota press.

Tuan, Y.F. (1990). *Topophilia: A study of environmental perception, attitudes, and values* (Morningside ed). New York, NY: Columbia University Press.

Tuan, Y.F. (2013). *Landscapes of fear*. Minneapolis, MN: University of Minnesota Press.

Turchet, L. (2015). Designing presence for real locomotion in immersive virtual environments: An affordance-based experiential approach. *Virtual Reality*, *19*(3–4), 277–290. doi: 10.1007/s10055-015-0267-3

Turner, V. W. (1995). *The ritual process: structure and anti-structure*. New York: Aldine de Gruyter.

Tversky, B. (2001). Spatial schemas in depictions. In M. Gattis (Ed.), *Spatial schemas and abstract thought* (pp. 79–112). Cambridge, MA: MIT Press.

van Baren, J., & IJsselsteijn, W. (2004). *Measuring presence: A guide to current measurement approaches*. Deliverable of the OmniPres Project IST-2001-39237. Retrieved January 1, 2019, from https://ispr.info/about-presence-2/tools-to-measure-presence/omnipres-guide/

Varela, F. J. (1999). Chapter 9: The specious present: A neurophenomenology of time consciousness. In *Naturalizing phenomenology: Issues in contemporary phenomenology and cognitive science* (pp. 266–329). Stanford, CA: Stanford University Press.

Varela, F. J., & Depraz, N. (2005). At the source of time: Valence and the constitutional dynamics of affect: the question, the background: How affect originarily shapes time. *Journal of Consciousness Studies*, *12*(8–10), 61–81. Retrieved on December 31, 2018, from Retrieved from https://search-ebscohost-com.libproxy.rpi.edu/login.aspx?direct=true&db=aph&AN=20295013&site=eds-live&scope=site

Varela, F. J., Thompson, E., & Rosch, E. (1991). *The embodied mind: Cognitive science and human experience*. Cambridge, MA: MIT Press.

Vernooij, E., Orcalli, A., Fabbro, F., & Crescentini, C. (2016). Listening to the Shepard-Risset glissando: The relationship between emotional response, disruption of equilibrium, and personality. *Frontiers in Psychology*, *7*, 1-10. doi: 10.3389/fpsyg.2016.00300

Villani, D., Riva, F., & Riva, G. (2007). New technologies for relaxation: The role of presence. *International Journal of Stress Management*, *14*(3), 260–274. doi: 10.1037/1072-5245.14.3.260

Vincent, J. (2019, February 15). ThisPersonDoesNotExist.com uses AI to generate endless fake faces. *The Verge*. Retrieved May 20, 2019, from https://www.theverge.com/tldr/2019/2/15/18226005/ai-generated-fake-people-portraits-thispersondoesnotexist-stylegan

Virilio, P. (1994). *The vision machine*. (Norman E. Spear, Trans.). Bloomington, IN: Indiana University Press.

von Holst, E., & Mittelstaedt, H. (1971). The reafference principle: Interaction between the central nervous system and the periphery. In P. C. Dodwell (Ed.), *Perceptual processing: Stimulus equivalence and pattern recognition* (pp. 41–71). New York, NY: Appleton-Century-Crofts.

Wade, C., & Tavris, C. (2014). *Invitation to psychology books a la carte edition* (6th ed.). London, UK: Pearson College Div.

Waterworth, E. L., & Waterworth, J. A. (2001). Focus, locus, and sensus: The three dimensions of virtual experience. *CyberPsychology & Behavior*, *4*(2), 203–213. doi: 10.1089/109493101300117893

Weinberger, P. (2014). Niels Bohr and the dawn of quantum theory. *Philosophical Magazine*, *94*(27), 3072–3087. doi: 10.1080/14786435.2014.951710

Welch, R. B. (1999). How can we determine if the sense of presence affects task performance? *Presence: Teleoperators and Virtual Environments*, *8*(5), 574–577. doi: 10.1162/105474699566387

Wetherell, M. (2012). *Affect and emotion: A new social science understanding*. Los Angeles, CA; London, UK: SAGE.

Wilding, E. L., & Rugg, M. D. (1996). An event-related potential study of recognition memory with and without retrieval of source. *Brain*, *119*(4), 1416–1416. doi: 10.1093/brain/119.4.1415-a

Wilson, C. J., & Soranzo, A. (2015). The use of virtual reality in psychology: A case study in visual perception. *Computational and Mathematical Methods in Medicine*, *2015*, 1–7. doi: 10.1155/2015/151702

Witmer, B. G., & Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence*, *7*(3), 225–240. doi: 10.1162/105474698565686

Wolcott, H. F. (1990). *Writing up qualitative research*. Newbury Park, CA: Sage Publications.

Wolcott, H. F. (1994). *Transforming qualitative data: description, analysis, and interpretation*. Thousand Oaks, CA: Sage Publications.

Working memory. (2019). In *Oxford English dictionary*. Retrieved on April 11, 2019, from http://www.oed.com.libproxy.rpi.edu/view/Entry/230237?redirectedFrom=working+memory#eid316994425

Zinchenko, Y. P., Menshikova, G. Y., Chernorizov, A. M., & Voyskunskiy, A. E. (2011). Technologies of virtual reality in psychology of sport of great advance: Theory, practice and perspectives. *Psychology in Russia: State of the Art*, *4*(1), 129–154. Retrieved January 5, 2019, from http://psychologyinrussia.com/volumes/pdf/2011/08_2011_zinchenko_menshikova.pdf

A.1 Transcript of Interview with Prof. Tom Sgouros

Prof. Tom Sgouros
Brown University
October 18, 2017

Participants
Jason Coley JC
Tom Sgouros TS

00:01-01:00

JC: Testing. October 18, 2017, at Brown University. Is that okay, Sir? So…I'll start with some occupational responsibilities, so we'll get Question #3 here. "How would you define the roles of a designer and a developer? How are they alike, and how are they different?" If you think there is a difference. (Pause). A lot of people use them interchangeably…So in regard to designing for systems such as…uh…virtual reality systems I have often heard that there is maybe one person who does the coding, but then there's another talent that perhaps designs for the larger experience.

TS: Oh, I see what you're saying. Well, you know, our…our main use case is not environment

01:01-02:00

or…its data. And so…the teams we have tend to be the scientist and the developer. Um…I mean we do know one developer who—actually, he's also a scientist—who has the world's worst taste in colors and uh lines. He makes these 3D environments out of teeny tiny little lines that are very hard to render in stereo because there's some ambiguity in the way they resolve so…and I can't get him to stop doing that. And so he's made—I can show you a demo that we have that he does—like, it's okay, but it's not very…um…very satisfying in some ways. It's very difficult to make the 3D pop…uh…unless you're like him who seems

02:01-03:00

to have independently focusable eyes. And…um…so you know, but uh…so we do have some cases where we know people are doing it badly but the teams that we have tend not to be designer and developer but scientist and developer.

JC: I see.

TS: And…and the ones that work well…it's sort of an iterative thing. But maybe the scientist is being the designer but like the dinosaur footprint thing that you saw there. Um…Josh is a—Josh Tidy (?) was a grad student here last year—and, um, they—it was an iterative type of thing—they were working with Josh saying things like, "oh, I wish we could see all the, um, oh I wish we could in red all the mud particles that end up on the surface. I wish we could see the paths of the mud particles that they take." You know, then Josh would go away and

03:01-04:00

come back in a week and go "I got the paths" whatever. So, that's kind of how, uh, things work. I think that if we were doing more, uh, you know, more complicated experiences…Unity environment, game play kind of thing, you know there might be some…you know, there might be that kind of split, but, uh, cause like I said, there's a—heaven knows there's a bunch of programmers who are pretty bad at making nice things to look at. But that's not really… it does not really representable of the work that goes on here.

JC: If I may ask this then. Can you tell me a little bit more about…I haven't seen too much of the productivity side of VR, such as data representation, I have only seen, um, mostly with

04:01-05:00

medicine. That's what I've seen. Have you explored…such as other forms of data representation, such as the VR equivalent of pie charts or graphs or—

TS: You know the funny thing…I'm hoping to do that, but we have lots of data, lots of data to look at that all have a spatial component to it. You know the dinosaur footprint is a real thing in real space. And some of the medical stuff…and some of that. Mars is out there. I feel like there is a place for visualizing abstract, uh, abstract spaces, too. But, you know we're very project-driven. So it relies on us finding a project that has that in mind. So there is a guy that wants to use 3D to visualize 4D. He wants to look at complex value functions of

05:01-06:00

a complex variable. Two dimensions in, two dimensions out is four. And those…you know you can't visualize those. But to visualize it on a screen you would be projecting it down to two dimensions. At least here he thinks that maybe you can just project them down to three dimensions and get a leg up on, get a dimension up on what you know—so, so he's working in a kind of abstract space. And there's a, there's a information theory application that is sort of…just getting off the ground where we are looking for basically exploring the parameter space of a fairly complicated algebraic equation. It's the kind of thing where you

06:01-07:00

have one equation and 27 unknowns, right? And, and we're just looking for ways to characterize the parameter space. So, usually in that kind of situation, 27 variables in one equation usually you would just give up and say this is not solvable. But I think there are things that you can say about the solution space, and so we are trying to find ways to visualize the solution space to see if there…if some of the features that we know are there can be made visible in some way. So far no. But so what that is…is like a 27-dimensional space that you can see three dimensions of at any time but it is like a big splatter plot. So, I

07:01-08:00

am really hoping to find things like that, but we don't really have a lot going right now largely because I haven't found the people to do it.

JC: So, a project like…if I may extrapolate, something like, if somebody wanted to create a model of the curvatures of space, for example, that might be something that could be applied to this type of VR system would lend a good understanding of how gravity and a sense of impossible spaces—

TS: So those questions are basically complex values…functions of a complex variable. So those are basically four-dimensional manifolds, so visualizing them could be part of

08:01-09:00

the…potentially be something we could…I mean, I could show you one of the 4D things. It has the world's worse user interfaces, so it's typically not part of the demos I do, but you kind of see what's going on.

JC: Okay, yeah. After this I'd love to see it, Tom. So another questions is—I can skip a few of these since you already answered them—so lets start with a "presence." So, how would you define this phenomenon of presence? Any way you want.

TS: So, when you put the goggles…when you put on VR goggles and you look down, there are no feet there. You look down at your feet and there's no feet there. Or, almost as unsettling, you look down and there's somebody's else's feet there. You either a disembodied eye in the world—that's the way the *New York Times* 360 videos work—or you

09:01-10:00

look down and it's somebody's else's feet, which is also kind of weird. Being able to look down and see yourself there is a much more natural thing and it kind of takes that unsettling part of it off the table completely. Makes it essentially a nonissue.

JC: And—

TS: Because this is the display, we spend most of our time in, I don't actually spend a lot of time thinking about presence because we have it. I think the people who spend a lot of time thinking about it are the ones who have you locked up in a goggle like that and they have to figure out how to make you feel like you're present. But we don't have to make you feel presence because you are.

JC: That's an interesting point. I didn't think about it. In VR systems such as this, they're not

10:01-11:00

rendering a body. It's just a user.

TS: There you are. You're already there. There's no…there's nothing extra you have to do to do it. The same way collaborative stuff—I don't know if you've tried to do collaborate stuff with the goggles—but you know it's a pretty elaborate thing. You have to be able to visualize the pointer, the other person's avatar…it's technically a challenging thing to do. Whereas here…the guy I am collaborating with is just standing there. The only technically hard part is because of the view that is projected on the screen is the one for the person who's wearing the glasses of power…if you point with your finger, you disagree what you

11:01-12:00

are point to. And so a lot of the programs in there have a pointer built in to them so that I can use the pointer that I know you can see where it is. You may perceive it in a different place…I got the wand and the glasses, and I perceive the pointer right here and I am using it to point at stuff very naturally. You don't perceive the pointer right; here, you perceive it like over here, but it's still pointing at the same stuff. I can use it to say, "oh, look at this." But that is about the only acknowledgement the collaboration we have to do. Otherwise, it's

12:01-13:00

a very natural thing because you're standing there and I'm standing there and we're both present. It's all good.

JC: That's an interesting point is that this technology simulates a space that is just beyond the borders of the skin., in a way. So the bodies are there, but everything else around it is what's being simulated. And this lends itself to an advantage to collaboration in that the avatars and the virtual bodies aren't' in the way of that.

TS: Right. You don't need that stuff, cause you're just there and can say, "Look at that."

JC: That's an interesting point. I haven't considered that…level. Let me ask you another question regarding to presence, if it is possible, or at least how we can talk about it maybe at the immersion level of the device. Do you think that the…is it possible to isolate the

13:01-14:00

phenomenon of presence, such as…. These notions of hands presence, or head presence, if you're familiar with those terms.

TS: I know what you mean by them. But again, for us, it's not really an issue. So, you now, the directed and concentrated thought that was applied to the presence problem to the point that people started--somebody said that there are really "hands presence" and "head presence" and "they're really different things." Those are many steps beyond where we need to go. We don't need to go there because your heads and your hands are right here. It's just not a salient issue for us.

JC: I see your point.

TS: I hope it's not a disappointment for you—

14:01-15:00

JC: Oh, no. This is fascinating because…this technology shines a part on virtual reality systems that…I haven't thought of this system as a way of keeping the bodies intact, so to speak, wrapping them in a virtual space, as oppose to most of the VR that I've used is actually simulating other bodies as well.

TS: Right. And yours.

JC: And mine as well. So, this is…an often times there is a difference in scale and things like that and other issues. So, I'm really wrapping my head and realizing with not having that mediated space between the bodies when the bodies have more of this direct contact and space, unfiltered so to speak, that kind of virtual reality space for collaboration and what not.

15:01-16:00

Since we're dealing with…have you notice any…let me rephrase some of these questions here. So…you mention before that a few people have gotten sick or you know headaches or whatnot from using this device. Have you noticed any other trends, such as any people of a certain age or a certain physical condition that are more susceptible or maybe didn't find it as immersive or have you notice any trends?

TS: So, I give people tours. I'm just talking about the people who I've noticed…want to step outside after the tour is gone on for a little while, but they're not really people that I know. They're must people stopping in, so I don't really interview them in any…. Could I

16:01-17:00

characterize who they are? Not in any way that would make a dime store's worth a difference.

JC: So, have you noticed if any of the programs had been "more successful" or "more compelling" than others. And if so, have you noticed any trends. For example, when we first stepped in there, I saw the demo of the game, as opposed to let's say, the one with the dinosaur footprint. Do you find that when it come to the visualizations, are there certain trends that some people seem to favor as best practices, so to speak?

TS: Could you explain that again?

JC: Let me rephrase my question. So, another way to think about this is: When I was in there, you mentioned that there was a master goggles that you can wear, whoever that person is,

17:01-18:00

that's the person perspective.

TS: Those were the ones you were wearing?

JC: Yes, yes. So, have you noticed anything such as certain trends…such as maybe the inclusion of sound or has there been any best practices or things you want to avoid when you design these? Like maybe perhaps you noticed that if you are using the controller and moving it too fast makes people uncomfortable or if there was any….

TS: No…you're asking whether there are any bests practices for the experience? Not in any way that we're…but again, you know, we're just looking at data. And so…well, probably, I should have some bests practices. Like the guy I mentioned who always draws things with

18:01-19:00

these teeny tiny lines that you can't get them to resolve. I should point out to him—well, I have pointed out—but maybe I should actually codify that kind of thing. But, no we haven't. We haven't done anything like that.

JC: What about users who maybe have colorblindness or only see through one eye or anything like that? Have you had any—

TS: Yeah, actually we had a guy who I think we're going to do—I hope we we're going to do a project with—came and he had some sort off put of coming because he has very bad vision in one eye and basically does not have stereo. But the parallax that you get actually still creates a compelling illusion and you know to a certain extent I think that we undervalue the things we can achieve by simply tricking the brain. Like we spend a lot of time manufacturing the experience for you. These are stereo, they are really high resolution, the

19:01-20:00

refresh rate is 120 hertz…all to be the best possible experience. And to rely as little as possible on tricking your brain. You're tricking the brain at one level because your showing it something that doesn't exist but you're not…you're using your regular senses to do it, whereas I'm talking about…well things like—we went to the…the Navy has a pretty substantial investment in VR for simulating ships, for doing training and stuff. So we went down there to see their training and they brought us to the bridge of this battle ship. You know, there're the bridge, and the little steering console and the throttle and the whole thing

20:01-21:00

looks like a bridge and then out beyond the bridge is the ocean. And while we were there, the said, "Would you like to see a hurricane?" Sure, we'll see a 50-mile wind and a 75-mile hour wind or something and so they dialed their thing up to 75-miles an hour and everybody in the room started swaying. You know, you reach out to grab the wall or you're swaying. They're not rocking the floor or anything like that there just overpowering you with this experience but there weren't any goggles involved. It was just, I mean what was VR about wasn't actually not really clear. It wasn't stereo, it wasn't…but you weren't in the goggles.

21:01-22:00

You had presence. But everybody was borderline seasick and what you saw though was the console of the ship and then beyond it these huge waves and you see the bow of the ship riding up the waves and down, but you're standing on the ship, so the bow isn't actually changing relative to the…. But, you can tell that its going up and down and it made me think that there's a lot of…you're brain is a pretty powerful thing and fooling it that way is something they we don't actually do a lot of in here. And so, makes me wonder if there isn't even more we can do by concentrating on that. For example, you're interested in presence, which is kind of abstract, hard to define thing but maybe there are features of presence or

22:01-23:00

lack of presence that we could be capitalizing on rather than…. And maybe if we could find some way to design presence that we'd get some—I don't know—some more realistic effect with less electronics. I don't know, but that's one of the things that experience made me ponder.

JC: When you do visualization programs in here, how often do you use…in your case you have a floor that also does the projection, which a lot of other facilities don't have. How has that changed your programming or practices when it comes to design three dimensions. The fact that you can look down or that you can look completely in 360 in an enclosed space. Like for example, at RPI we have one, but it's only like three…half of a…it doesn't have a floor.

23:01-24:00

So, I'm curious on how…when you can completely surround someone on all those sides, how does that change how you approach the visualization of data?

TS: You know, I don't think it has changed that. It's just made us more satisfying with what we were already doing. I don't think…I don't think it's actually changed. It just means that you can walk all the way around a thing. Look at the top of it and look at the bottom of the thing and so it gives you much more latitude to explore, but I don't think it's changed what we put in it.

24:01-25:00

JC: Would it be fair to say that it just increases the real estate, so to speak?

TS: Yeah.

JC: You can? Okay. But doesn't necessarily lend itself to a more compelling experience per se?

TS: Well, I think if I increase the latitude, you get a more compelling experience, but I don't think that anybody has changed what they were doing because there's a floor. In the old one we had had a floor, too. It was, actually it was…I'll show you something later that…in the old one, the floor was projected from the top, so when you were in it, you cast a shadow on the floor and somebody wrote a paint program for painting in the air and I guess that he figured that since he cast a shadow in the display, that the wand that he was using and object that he was painting should also cast a shadow, and so he created shadows for the objects.

25:01-26:00

Which is sort of funny, because this is rear projection on the floor, so you don't cast a shadow. So, know the only thing that casts a shadow is stuff that's written for that…this wand the stuff that is being drawn in this program. So, I don't know, maybe that's something that's a little different because of the floor.

JC: That's interesting. How the programmer responded to…he was unable to remove his own shadow, so he made this for his own experience.

TS: By adding a shadow.

JC: That's interesting.

TS: And it's actually sort of funny because when somebody paints something in that room casts a shadow, it gives everybody else a much better idea where the thing actually is. Which for the other ones that don't cast a shadow, it's a little harder to tell.

26:01-27:00

JC: So, I noticed that you had…it looked like a Wii remote or an old Razer or something for a controller.

TS: Yeah, I don't even know what it is. A PS2 something or other.

JC: Yeah, it looks like a half of a num-chuk.

TS: There's a guy here who buys them on eBay. I mean its something from some PS2 game and he found it. I know nothing about it. It's a nice unit, and we 3D-printed a little armature to hold the constellation of the tracking balls, but that's all it is.

JC: Well, it also looks like you have a keyboard and some other controllers up there.

TS: Yeah, one of the programs has a keyboard and some keyboard controllers and one of the most inconvenient things…standing in there and you got this keyboard. He bought a

27:01-28:00

keyboard—do you see that keyboard over there? He bought a Bluetooth--hanging on the charger there—he bought a little Bluetooth controller because it was so annoying. It is still annoying. Because the paint program has two wands so there are two wands and this keyboard thingy. What are you supposed to do with this keyboard? Maybe like a marching band. You know, like for the glockenspiel.

JC: I was going to ask you, this kind of segues into, "When you're looking at the data, has there been a yearning for a better interface? Something like maybe a…do any of these controllers feel like ad hoc solution?

TS: Oh, they're all ad hoc solutions. And, yeah, maybe this is part what you were talking about

28:01-29:00

with the experience. We are all interested in finding better user interfaces for this stuff that we are doing, but so far, we haven't settled on anything. I mean this is an experiment. This was designed to be an experimental facility. It is kind of open for whatever. Actually, so a guy did just make another wand. It's more like a pen. I was just going to show it to you. More like a pen. But we're just open enough that he can try that out if he wants to.

29:01-30:00

JC: That makes sense. There is a lot of discussion and excitement about how virtual reality systems an be used for the visualization of data and maybe you know new perspectives and I was curious about how if the interfaces are still playing catch-up with that. Even though we haven't…if they're…so like you mentioned before the keyboard doesn't seem like the right interface. The wand don't seem like the right interface, perhaps.

TS: I mean the wands are fine. The wand, I don't know if you notice, but the button is for the game … is kind of a little awkward. The…some auto-update thing from Windows auto-updated it and all the button definitions changed. So it had been that the trigger button had fired the thing, and know you have to push down on the joystick. It's stupid. But somebody has to get back in there to reassigned those...some configuration file that got un-updated.

30:01-30:26

You know, wasn't protected from an update, so and it got un-updated. [Unintelligible]

JC: Well, I can't think of any more questions off the top of my head, other at this moment, but I'd love to see more of the demos.

TS: Actually, let's do that. I should run through a few.

[*End of interview*]

A.2 Transcript of Interview with Red Studio (Werewolves Within)

Red Storm Studio
Werewolves Within
October 24, 2017

Participants
Jason Coley JC
MonkeyCheez MC
dvotypka25 DV
JustinAchilli JA

01:34

JC: I'm interested in your work because of the approach you did with particularly this game *Werewolves Within,* and how the mechanics of it are so different…this game doesn't seem comparable. Really, I don't know any other media that you could really play this kind of game in, other than like a face-to-face parlor game. I'm really interested in how all of you designed and developed and worked toward this particular type of experience. How you're fostering this feeling of presence. I'm also interested in knowing what do you think presence is.

02:16

DV: Sure. It was all starting with presence, obviously. It's the idea of convincing your mind that you're actually in this space, in this environment, in this body, so to speak. But then additionally with these two games that we worked on there was the aspect of social presence, the feeling of being in a shared environment with another person or multiple people and having that convincing experience of feeling like, "Yeah, that's another person," so when you look around—I was just watching you talk now, and you can see my hand gesture animations, which is actually done with the system and algorithms that analyzes the voice input, and it plays certain gestures on the face and the hands and the arms. These speaking gestures. It actually worked out even better than I thought because this game didn't ship with hand tracking, so we wanted to bring the characters to life and in order to give that sense of "this is another person." We wanted to replicate the social cues that you get in the real world as much as possible. So, just watching you speak and talking about your dissertation, and so on it's really ironic actually how well they sometimes line up with what you're saying. Like, you'll sweep your hands to the left and the right when you're declining, when you're saying like, "That's not the way it is," and a lot of the players actually feel like this is a super complex system that we've made, and it is in some ways complex. But on the other hand, it just kind of ended up working out. It just sort of times up well, and so that was kind of a happy surprise. But there's a lot of things that we did with the avatars specifically. For example, when I'm facing you, my eyes lock on to you because when we first created the game, we didn't have that system, so I'd just be kind of…my eyes would be looking past your shoulder, which feels just as weird in the virtual environment as it does in the real world. Other things like these gestures when you feel pointed at, or when somebody's staring at you. You get that sense of being stared at. You have the whole group staring at you. That same sort of, in the back of your mind uncomfortable feeling, so there's lots of really interesting aspects of VR in terms of social VR how the real-world social cues translate over to you, over to the virtual environment, and I think it's trying to replicate and create avatars to replicate that as closely as we could with the limited technology we have.

Then, of course, when you jump into the Star Trek, you get hand tracking in that, so that adds another layer to it. I'm sure it's more you might want to add to that, Justin?

04:53

JA: [To] kind of build on that, on what they've said, we're also doing this specifically with other real people. There aren't any AI's you're playing with. There's no bots. We're not trying to trick you into thinking that an NPC is a real person. We couldn't build, or we didn't intend to build a game, that was a pure logical deduction. If we wanted you just talking to bots and building a logic puzzle sort of grid from the clues they gave you. I'm here, that the focus is on the purely social play, so the fact that I may or may not be lying to you is something that you're going to need to read from my behavior and my interaction, as opposed to 60% of the time, this bot lies. I'm on a roll the dice here, but I'm sure Dave may have sent you some links, or you've probably done your research on stuff that Michael Abrash has said. He said that he thought VR would be the most social medium of the modern era, and that's really kind of was a sort of driving mantra here is, how can we take this kind of…put the toaster on your face and wall out the outside world, and yet have a an intense interaction with other real people.

06:10

JC: What I noticed is when I would come to *Werewolves Within*, the lobby—when there's waiting to fill up—how many times I entered it, and the people in there, while they're waiting, we're already playing some other kind of game. They were playing I Spy, Twenty Questions, or in this case when I got up at 6:00 a.m., they're playing Dungeons & Dragons inside of it. I found that very fascinating. That just them seeing each other and be able to hang out was enough for them to just hang around and find something to do.

06:46

DV: We read that a lot on the forums. What's the game where you like pass the secret to the left? All sorts of games that they play while they're waiting for the match to fill up. We've read so many interesting stories on the forums. Another one is this this girl in Ireland, and I guess our community moderator plays once a week with the same group, and she's one of them. And this Irish girl's one of them. They've gotten to know each other, and she told us that the girl from Ireland, she says she doesn't really have much of a social life in the real world, but she's sort of developed this social clique of people inside *Werewolves Within*. She plays it almost every night and it's become this kind of social group for her. Some of the other things we've read that's really interesting is that people said that they've added more friends to their friends list in two weeks of playing *Werewolves Within* than the entire time that they've own their PlayStation 4 console. They said that the reason isn't because like, "Oh, you were super skilled at this game…I want to study with you again." It was because they felt like they actually got to know the people they were playing with, which is something I've never heard before in video games.

08:10

JA: Players have said, too, that this particular game helps them overcome specific social anxieties that they experience in the real world. One of the things that I've called on presentations before, too, is that we had a reviewer in or a journalist in, and she said she felt like the game…the actual face-to-face game of *Werewolf* makes her very nervous, makes her very anxious, but playing this version of it, because it has the digital avatar, she feels like she's able to put on a mask, and it's where this eases that anxiety for her. So, you're seeing me here is this kind of beardy blacksmith, and you were the peddler woman, and there's obviously kind of cartoon avatars that sort of take the heat off feeling like you're putting yourself out there socially.

08:53

DV: It's convincing enough to feel like you're there with other people, but it's kind of like the mask at the masquerade ball. There's just easy separation to help with that anxiety.

09:03

JC: It's also interesting that in video games, we have a whole genre called role-playing, and yet this feels like the most authentic role-playing I've ever played in any digital media. This idea of I'm disguising an entire personality in front of people, and what would usually be the social cues, like my body language, my expressions, are being mediated through this technology, and so I'm also very interested in how did you come about designing for the emotes, and which ones you thought would be effective, which ones you thought might be universal, and were there any that didn't make the cut, so to speak.

09:45

DV: Yeah, we had a pretty big list. One of the original reasons we put them in was because the game didn't have hand tracking, and so we want the players to be able to point. Like this one that Justin did [*player's avatar crosses arms across chest*] speaks volumes. Just combining the emotes like that, with the stand, and the cross arms, and the shake your head. Really, it's your sense of expression that we wanted to give players, and so when you open the book you can go to the different emotes. We have…sixteen. There are some of the classic ones, like "I'm watching you." How would you say didn't make the cut, Justin?

10:40

JA: We had a big list. We probably close to thirty on the list, and in developing them, we worked with the animators who were really excited about doing it because it was a chance for them to be kind of creative and humorous, and the ones that we erred toward ended up being the ones that were able to offer just, that kind of, that much more nonverbal communication. So, if you want, you can put the point on the d-pad, but we put the point on the right trigger, because we figured that something you're always going to want. You could even have four more communicative ones. You could do the subtle menace, the subtle threats, or nonverbally communicate, like, Brian over there says, "Oh, I'm not the werewolf!" and I know he is, I can potentially…even things that our purely volitional are not systemic things, like, over here I'm nodding my head. Let's maybe cast a vote this way. You're really able to use the full body emergently even though you're pretty much stuck to a sea.

11:55

MC: Actually, in our testing environment and development, it's possible to play the game without a VR headset, just for like basic functional testing. And it's remarkable what the experience is like to have somebody running a test client that doesn't have this movement. It's disturbing. People get used to how effective it is, that you're your head moves, your body, and everything goes with it, and then you see somebody that's not doing that, and they…it's like there's a corpse at the table with you. It really drives home to us how important it is that we pick up on this as much of your body language as we can. And even just the head tracking is enough to get a lot of sense of real life into the avatars.

12:42

JA: Yeah, we watched this presentation like Abrash did at Carnegie-Mellon, and he talked about his first social sort of experiment in VR, which was when he was still at Valve...it was just an empty room. You come in and put the headset on, and you just have a box representing you. Just a box with a smiley face painted on it…so then he was sitting there waiting for the other person to come in, and…the other person's box just sitting on the floor, but as soon as it raised up and the person put their headset on, and it started moving and turning like a real human can, he said his mind immediately knew that was another person. So, that was a very interesting [inaudible] from how simple that representation was, but it still gave that sense of social presence. I think your brain can tell the difference between an animated avatar and real human movement. And then, of course, the more you add to it, the memes, the facial expressions, and so on, and then eventually I think, probably the next generation of VR headsets, you're going to get eye tracking, facial expression tracking, and that's just going to take it to a whole other level.

13:50

MC: I happen to be wearing a prototype eye-tracking headset right now. It's not implemented in the game, so don't expect anything, but the hardware exists. It just hasn't been taken advantage of yet.

14:07

JC: Have you notice that there are certain social cues that may be more impactful or compelling, such as the lips matching the voice or eye contact? Are you able to identify any kind of minimal threshold to sustaining this?

14:20

DV: Yeah, three that really jump out. Eye contact is the big one and the whole staring phenomenon. I can't remember how many times I heard in the game and people were like, "Stop staring at me. What are you staring at me for?" and getting agitated about it, which is ironic because nobody is staring at them in the real world. Pointing is another one I mentioned. Also, proximity is another one. A story with one of our engineers was just hilarious. He was playing—we don't have the character in this in this match—but this little blonde barmaid character. And some of the others were sitting around next to him, and we're like, "Hey, honey, how are you doing? Do you want to go for a beer?" Sort of harassing jokes, and he was like, "Get out of my space!" and became agitated about it, which is cool and uncool at the same time, but just from a psychology perspective, it's very interesting on how those cues translate, and even something like proximity comes across in VR.

15:20

JA: I think it's actually been really good for building empathy as well. You can see this. Brian over there obviously is not an African-American woman, but because we randomly assigned the avatars…and so when the other players perceive this, this mismatch between the voice and the avatar they're seeing there, that player in that role sort of gets a taste of, "Oh, well, this is what it's like to be on the receiving end of this sort of thing," and sometimes it's humorous, and sometimes there's a gravity to it, but, overall, I think that it's kind of like *Rust*—is one of the other games that does it, where it randomly determines [the gender and ethnicity of the player's avatar] forces you to confront. "Oh, okay, I've never had this perspective before," so we can kind of luck the players into having just a little bit of that for each session.

16:14

MC: So, another thing you were talking about—the minimum threshold for achieving presence—one of the challenges we had with this game was eight people talking simultaneously, and our audio team did a huge amount of work on the spatialization of the audio and adjusting levels based on different context like, who you're looking at when you're talking, and to get it to the point where players didn't have to think about it. They just naturally separate out who's talking to who just by listening, and it's after working on this game, and then going into other games and in just conventional chat and voice chat and stuff, I can't stand it anymore because it's so natural in *Werewolves Within* to have a conversation with multiple people without thinking about it. And in other games that lack that audio spatialization and they lack the other cues, like eye contact. It's all who's talking. It makes conversation really difficult, and so there was a huge amount of effort put into making conversation be effortless.

17:27

JA: For example, the player that you are looking at. You will hear them at a higher volume level as opposed to, like if Brian was speaking right now while you were looking at me. Brian's audio would be [lower] for you because your attention is over here on me.

17:47

DV: And the other part of it is binaural audio, which reflects how we actually hear sound with the left and right ear. That made a huge difference in being able to sort of listen into one person, as opposed to just having this cacophony of noise when everybody else was speaking, so that was also really interesting.

18:09

JC: You also implement a mechanic in which the avatar stands up and mutes the other players, correct? Can you tell me a little bit about how that decision came about?

18:19

DV: Yeah, there's two features really: There's whisper in the monologue. I never—when we were designing the game, one of the important things was like, okay, what VR specific aspects are we going to put in the game? This when you make a VR game, I think you always have to ask the VR question: Why is VR an advantage or something special over this game design, as opposed to something you just play in the traditional world? So, we wanted to leverage the VR hardware in terms of mechanics, but not just make them gimmicky either. We wanted them to tie into the game itself. Very naturally and ideally into the social aspect. So, the whisper mechanic was the idea [that] when you're sitting around the table, and just move over and whisper to somebody, you enter a private voice channel and everybody else at the table just hears that [whispering] kind of noise. But, so, this is, I think successful in the sense that it's a very natural social mechanic that you would do if you're actually playing our game around the table, like *Werewolf,* and be it's actually valuable for gameplay as well because it's the only way to communicate privately with one player. So, it was a nice synergy. One sort of checked those boxes, and then the monologue was mechanic was another one….

19:31

JA: Let me kind of sneak in here real quick. One of the other things that the whisper also does real well, is because the game trades on secret information and suspicion, people who are whispering inherently carry that kind of suspicion. When you see two people whispering, it's the same as in real life. What are they talking about? What are they trying to hide from me? So, that the suspicion of the game is elevated. You start to doubt them. What are they talking about? What are they going to tell me after the fact? So, like Dave says, it kind of ties back into the gameplay itself, but also has that same presence, that same social cue that you see in face-to-face whispering.

20:07

DV: And the monologue when we thought, "Well, we can also track when the player's standing up." And if you're sitting around the table with a group of people in a meeting in the real world, and somebody literally stands up at the table, you're all probably going to be, "Oh, this person has something to say. I'm going to stop and listen to them." It has that similar effect in VR, but we also mute the other players for, I think, ten seconds or so to allow you to give your case of why somebody is a werewolf, or why you're innocent or whatnot, and so again it's a very natural social cue relationship with the real world. But it's also a valuable game play mechanic.

20:47
[*Interview comes to end; development team gives the researcher a walkthrough to the game*.]

A.3 Transcript of Interview with Red Studio (Star Trek: Bridge Crew)

Red Storm Studio
Star Trek: Bridge Crew
October 24, 2017

Participants
Jason Coley JC
dvotypka25 DV
JustinAchilli JA
MonkeyCheez MC

00:55
JC: In regards to *Star Trek: Bridge Crew*…in this game of course you have four people trying to work together to try to accomplish mission. There's communicate. How did you approach this game experience differently than you did with *Werewolves Within*?
[*Developer invites other players to the interview*.]
01:44
DV: So, yeah, it was pretty…well, there are some key differences, but there's also some key similarities. The differences obviously are really in the game design, the game mechanics affect the gameplay that we have in this game. It's a co-op game. It's about being at your station, operating your controls, and the sort of social hierarchy is different as well. In *Werewolves Within*, you are around a circular table, and everybody has sort of an equal footing and equal social status, so to speak. Well in this game, immediately you have this captain who's actually sitting higher up and sort of back behind and you can see everybody in front of them. I think just that seating arrangement in itself sort of brings a different dynamic, social dynamic, to the game. So, from a game mechanics and game design side, obviously is very different. *Werewolves* is completely conversation and personality driven, and this has those aspects, but it's also mechanics- [and] activity-driven, so there's more sort of action to it. But, at the same time, we wanted this social connection, the social presence that we had in *Werewolves Within*, and to try and sort of replicate that in *Star Trek*. But it's actually a little harder to do in this game for a few different reasons. One of them is that, [first], they're not sitting around the table facing each other, which is usually the best-case scenario for social presence. Where you can just look face-to-face and have these conversations and start tracking them. There's two seats up front facing the view screen. There's the captain, and the engineer's off to the side. Secondly, everybody's kind of a—cellphone-at-the-dinner-table problem is one of the design challenges we had because you're busy tip-tapping at your station and kind of not interacting necessarily. So, we wanted to design, to try and have the players engage with one another, so we actually made the stations rely upon one another. So, for example, going to warp is not just the engineer sending the ship to warp. It's actually a multi-step process where each of the different stations need to be involved and rely on one another for power and for charging warp coils and those kind of things. So, we had to design more specifically to generate social discussion and social interaction and engagement for the players. Are you there, Justin?
03:58
JA: I am. I don't have hand trackers, too, so you will see that I will be performing some more rote gestures because the difference between the way the hand trackers work, and we kind of move you to hotspots on the control panels. This also is exactly how I look in real life.

04:25

DV: And then of course one of the big things was delivering on the Star Trek fantasy. For the first time, we could bring players into the bridge of a federation ship and actually reach out, have them reach out with their hands to operate a station and live that fantasy they've been seeing in the shows and the film's for decades. Many of them. So, really delivering on Star Trek and making sure it felt like that was a huge focus and a really important part of this game, which ties into the presence. Like, I remember the first time…we also made the original bridge, which I don't know if you tried or not, but the first time we put the sort of [inaudible] uniforms in there, as opposed to these sort of newer Abrams-verse uniforms, and I spawned in the captain's chair, and I had all the [inaudible] uniform and my black leather boots. And I'm like, wow, I feel like Kirk. It's just so cool to be like in that body, so to speak, and on that bridge, and in that captain's chair. So, we really wanted to deliver on that sense of stepping into the brain and becoming those characters.

05:28

JC: I thought pretty fascinating that in this game, and *Werewolves Within*, the focus of the social experience on, actually a seated experience, with some exceptions to standing, in *Werewolves Within*. How fundamental, if any, do you think keeping a person in a chair might be you to this social presence? Is there, in other words, could you see a design of a game where people weren't seated, or if they were moving around, and if so, [does] that pose any other kind of challenges? Trying to keep people working together or in one place together?

06:02

DV: Well, I think there's game design challenges, but solvable ones, where, let's just say we're…let's take *Gauntlet.* Remember the old game, right, where you're sort of in this fantasy, in the dungeons. You got a wizard and a warrior and elf and so on. So, you could create a game like that VR [with] these players running around as a squad, as a crew, and you would still get a sense of social presence if you kept them in close proximity, and perhaps they have to work together. And you can design abilities where I freeze a guy and then you have to shoot them or things like that. So, I think you could create that co-op coordination, but the social presence, of course, happens most strongly when you're in this face-to-face conversation, and you really feel like that's another person. I think we still get it in *Star Trek*, not as strongly as *Werewolves*, and in a game, like *Gauntlet VR* that I just made up, it would probably similar to Star Trek in the level of social presence. I think the bigger challenges there are how you make the players look in terms of full-body locomotion. And here. So, we did we did arms right? With hand tracking. And the thing is, we have data for the hands' position, and we have data for the head, but we don't have data for the elbows' position. We're thinking a lot of this and trying to calculate it the best we can. And same for the shoulders. But it'll still get sort of out of whack sometimes, so it's things like that. And you look at the avatar, and they're like, "Oh," and that kind of breaks your sense of presence. That sense of suspension of disbelief. Also, if you see it in first-person, there's that concept of proprioception where you start like, "Oh, wait that's not my body. My wrists don't bend like that," or whatever. The more you do for the avatar with the limited VR tracking that we have…that's sort of greater the risk you have to presence and breaking presence there.

07:57

JA: I think you can have a kind of a similar *Werewolf*-style game where you're not necessarily up and moving around a deck, but something more like a murder mystery where you and I are in the salon, and we're talking to one another, and Dave and Brian are in the library, and they're talking to one another. It's so there's a benefit to moving around various locations, but even there it doesn't seem to me like the traversal would be a feature that you would necessarily care about. You would want to care more about, "Okay, who's in here with me?" Is it Clue-style where I can…the person who performed the murder was obviously not in the kitchen with you and I, so it must be someone else. That kind of exonerates me there. But, that's again, just kind of an iteration of the *Werewolf* game that we had set up.

08:49

[*MonkeyCheez joins the interview*.]

MC: Well, I don't know what you answered, but I mean the two share the avatar tech, obviously, and the speech recognition driving the facial animation, all those things we talked about as the minimum threshold for achieving social presence that absolutely carries over to a *Star Trek: Bridge Crew*. But from there it was…there were some additional challenges because while flying a starship…. It's not like *Werewolves* where everybody's focused entirely on one another. People focusing or they're like, "God, I'm doing my thing,"…and we have to draw your attention away from your computer station and get you to look at the other players and talk, and that's where there was a lot of work done on collaborative game mechanics that force players to depend on one another to get them talking. You can't do what you need to do without him doing his part first, or that kind of thing. So, the way shields interact with transporters, the way the power systems interact with everything, and the way engineering and helm have to work together to get the ship to warp, those are just a few examples of mechanics that really force the conversation.

10:19

DV: One other thing is the avatars. So, in *Werewolves Within* we have cartoony avatars with these larger eyes, and…larger heads and faces and larger hands, and it really helps us sort of generate, or bring, the sort of most important parts of human anatomy to the forefront for that social connection. And, they're cartoony, so we can sort of get away with some sort of suspension of disbelief. Here, obviously, we didn't want to make the cartoony Star Trek. We want to try and make it closer to reality in a sense of realism, but it's much easier to get into this uncanny valley of like, "These guys just look weird," because the tech is just not at the level where we can convincingly, 100%, create a human avatar that is indistinguishable from looking at a photorealistic version, or whatnot. So, there's definitely some challenges there as well.

11:12

MC: And I'd also say that the roles that you can play, since the game play is asymmetric, and you play very different roles. There's a social context in the roles themselves, so there's an expectation if you're going to play as captain, that you're going to be a leader. You're going to, you're going to lead the group, and when you have a player whose personality or desire to play in that role fits well with that, the game works really well, and then when we see sessions where somebody is not comfortable being a captain, those tend to be very awkward sessions. It's like having somebody who just sits there quietly in the captain's chair is very awkward for everybody and makes it really hard to play. So there's a kind of social pressure on the captain to be the one who's talkative, to coordinate the other players, and that's reinforced in the game by the captain having more information than all the other players. The captain has an overview of what everybody else knows, and that's to prompt the captain to talk, to coordinate.

12:26

JA: Even in the seating arrangement, too. The captain's sitting up at their perch, looking over everyone else. Whereas the distribution of seating in *Werewolves Within* is much more…democratic. We want everyone to have a voice there. Where here. We're relying on the captain to feed information to the players.

12:46

JC: So, the position of the bodies actually kind of dictate the social rules you're following, whether it's a circle…it's the idea that everybody has a voice, as opposed to a pyramid. There's a hierarchy.

13:04

DV: We have a theory that, if we went into *Werewolves* and were to replace the round table with a rectangular table, and one person was seated at the head. We have a theory that that might change the dynamic. People might listen to that person that's sitting at the head of the table as well. So that's an interesting consideration.

13:30

MC: But there's some practical benefit to it, too. Like, I can remember when we first started demonstrating the game to the public at E3. And the way we chose to demonstrate was we would have any of us…. We've all three done this a lot where we have three completely new players, and you kind of guide them as the captain and introduce them to the game. It's really fun for one thing. Some of the most fun I've ever had in my career is just playing with these new players and them, "Oh, my God!" is so much fun to do. But it's also the social presence. There's a practicality to it that you don't get in the other games. I could sit in the captain's chair and see Justin at helm, and he's struggling, and I can be like, "Oh, no, no, no. That thing over there. Yeah. Nope. Nope…your warped throttles…no further to left. Yep. That's the one. Grab that and do it." Just being able to kind of mentor a player as if you were really in the room with them is an experience I've never had in any other kind of game. I've mentored or been the mentee in other games, but it's mediated through so many levels of interface, and people trying to explain what buttons do what, or whatever. Whereas in *Bridge Crew*, it's literally just, "Yeah, that thing to your right there. Yeah. I hit that." Or, "I can see that you've got targets on your map. Why aren't you selecting anything?" It's pretty amazing to feel like you're actually on a starship coaching each other through the game.

15:15

JC: So, speaking of social presence, as designers or developers, how would you define presence, and then how would you differentiate from, let's say, the quantifier "social presence"?

15:26

DV: I think presence is really about your sense of being there and your sense of proprioception with your body. And then the social presence is your sense of being there with other people and believing that these are actual human beings and having your mind convinced of that. So, it's an extension of presence, really.

15:49

JA: One of the Abrash examples of presence is being on top of the Eiffel Tower and knowing in his mind that he was not actually at the Eiffel Tower, but his body still felt the kind of aversion to leaning over too far because he was some part of his mind was fooled into thinking that he was there at the top of it, and he didn't want to lean over or otherwise he'd fall. And so that to me says very much he felt like he was present there. But then this sense of like, right now, you're looking at me, and I very much feel like you are here in the situation room or in the briefing room with me, and it would be very different if it were an AI looking at me because we would tell the AI through computer logic, "Look at the player and break the eye contact." And I would know on some level that this is all being handled procedurally, whereas right now, I just have to trust that it's you there, and your body movement tells me that "Oh, yes, this is an actual person."

16:43

DV: I think actually if it's…if you're sitting here with three NPC's, well, obviously wouldn't be having this type of conversation, but, secondly, just looking at them, they wouldn't act as naturally. I think that would hurt your sense of presence as well as. they wouldn't be that social presence, too. But I think one other thing with VR that gets said a lot is this…the idea of immersion. Where I think what it really is…the VR hardware allows us to take the player senses and immerse them into this environment, which in turn creates a sense of presence, if that makes sense.

17:19

MC: As far as getting back to the social aspect of that, what with both of these games one of our hopes was that we would see a different kind of community emerge around these games. Well, I'm having my Vive is just stopped tracking again. I apologize. I'm having hardware issues today…It's freaking out. We've all worked, say, on like technical shooters quite a bit, which I love, but there are elements of a community that you work with that are very aggressive, and it can be draining at times. It's overbalanced by the positive, but you're always having to deal with this negativity that comes in with games like that, whereas with *Werewolves Within* and *Star Trek*, it's been nothing but a joy to work with the community because this sense of actually being present with other players, it seems to encourage a very positive kind of communication with people. People are less likely to be a dick to somebody if they feel like they're actually there with them then if they feel like they're talking to a screen, and threw up their phone, and they're thinking about all that. The mediated interface between them and another person. We often liken it to being in traffic in your car and yelling at other drivers is what it can be like to play your typical video game. But with social presence, you don't have that feeling at all. It doesn't feel like there's anything, or there's very little I should say, mediating it. I feel like I'm actually talking to you, and it changes the way I behave.

19:04

DV: I think the social guidelines come into this that you get from the real world come into this type of situation much more than having a monitor separating us.

19:16

JC: One of the things I've noticed is [that] for years I was a big *Call of Duty* player, and I devoted a lot of ours to it, and of course when you play a game like that, it doesn't take long to figure out what's a bot and what's a human through their behavior. So, when I start playing like, *Werewolves Within*, I've notice how much I was sold on movement rather than appearance. If something just moved like it was alive, I believed it was alive, almost regardless of what it looked like. Can you comment more on that?

19:52

DV: It comes to that Abrash example with the box and the smiley face painted. There was no voice in that experience. There was no body or anything. It was just the head movement. I think it is sort of subconscious in our lizard brain. Our brain can differentiate that. Between an animated [hand gesture] or emote or motion-captured head movement. I think that, actually, the minimum threshold for social presence is that sense of movement. And then everything you layer on top of it just makes it even stronger.

20:26

MC: There's the way that that movement interacts with voice, for example, is really telling. When you talk, your body moves. You could try to hold your torso rigidly still, but you have to fight. You're just the way your lungs make your chest move and so forth. When we're doing the head tracking and relaying that to your avatar, all of that just happens. We don't have to figure out how it works. We just copy it, and it's very convincing. Very convincing. Add to that all the other stuff we talked about with the facial animation and the audio spatialization, and so you can tell who's talking and understand them clearly. And it's transformational in terms of the way you interact with other players.

21:17

DV: I think the base layer is this movement. Then you got voice, and facial expressions, and body movement, and whatever on top of it, and it just gets stronger and stronger, and more convincing and compelling, and so next will be facial expressions and eye tracking and so on, and perhaps one day before too long full-body tracking. That's a tough one for home VR.

21:45

JA: In *Werewolves*, we don't have a lot fighting for your attention. The only things that really move are the players because we want your attention on the players and reading their body language. There's not a whole lot of stay awake animation. Every now and then something moves in the breeze or the snow blows through, but like even the only speaking AI is the vampire in the crystal ball who—and we don't even give you the full body there. We just give you the ghost effect and just the floating head in the crystal ball. So, we're not even trying to trick you into thinking that's a person. Your attention is on the people around the table and that bot is just there to kind of, "Okay, next phase of the game. Go."

22:24

[*Interview comes to end; development team gives the researcher a walkthrough to the game*.]

A.4 Transcript of Interview with Mr. Sebastian Sarbora

Interview with Sebastian Sarbora
CEO, Ilium VR
February 15, 2018

Participants
Jason Coley JC
Sebastian Sarbora SS

00:01

JC: February 15, 2018, with Sebastian Sarbora. If you don't mind Sebastian, tell me about how you came to this project?

SS: So, initially around 2011, or 2012, I was interested in making a more immersive experience for shooter games—video games in general, but shooter games are what I primarily play at the time—and so I…what would be a good way to do this? Virtual reality really didn't exist at the time, at the military level and the research level, but not what consumers have access to, it didn't exist and so what I did was I took…made a prototype of a gun controller using a replica rifle and fitted it with electronics from an Xbox controller, and used some sensors and microcontrollers and stuff like that so the general gist was you have an accelerometer and gyroscope and when you move the gun controller left it would move the stick left the way a first-person shooter was and there would be a small screen, which would be your actual screen from the game. As long as you were looking down the site, it would always be linen up pretty well. And…it was alright…I mean…the end goal to it like the industry and the ecosystem wasn't quite there to do what I wanted to do. So, I kind of shelled that project for a couple of years after making a few prototypes. I always wanted to start a company with it, but the time wasn't right. Xbox and all that sort of stuff wasn't really the right platform to do it, so around 2013, 2014, when the Oculus Kickstarter happened and consumer virtual reality seem like a viable option, I kind of revive the project…brought on my two co-founders…all of us went to RPI together…we'd worked on some projects together—hackathons, things like that—and so thought this would be a pretty good team to do this. So from there we decided to let's figure out what are the technologies that we need to make this possible, whether the business goals that we have to achieve are possible, that sort of thing. But at the end of the day, the real thing was at the time the Oculus was the only headset around, so we got an Oculus, and we figured out okay how can we reliably make these games work. We're not going to retrofitting games; we are going to be building games from ground up, or integration of other games from the ground up, built for virtual reality. Like ports for virtual reality don't really work that well. So that meant we had to make all this technology that didn't really exist in the virtual reality industry yet, versus 3D positional tracking. The first headset at the time only had rotational tracking, so if you were to move around like this, you'd be perfectly fine, but if you would sidestep, you'd see nothing. There'd be no change and that can cause motion sickness and can cause other problems like that, so we had to come up with a tracking system to track the headset and track the gun at the time, so we can get that immersive feel to it. We worked on that for a couple of years, eventually Oculus came out with its own tracking system, the Vive came out with its own platform. Tracking is not what we primarily do. It was a means to an end, so we then integrated our core technology, which is the actual gun and the immersiveness of that, with the platform of the Oculus or the Vive or all that other tracking technology. So, that's kind of the process that we went through a long time…with the Vive when it came out it was a lot more open platform, so it was viable to make other third-party hardware for it. So, we eventually entered a relationship with HTC to manufacture the model and Valve and few other companies in that ecosystem, so we could make third party controllers. We were the first third-party tracked controller for virtual reality at all. But really all that is to achieve this one thing, which is we want a gun to be in your hand, when you move it, it moves in the game, when you pull the trigger it fires, it feels…doesn't have to feel extremely realistic, but it does have to feel immersive. Like there's a kind of balance. 50% of the people say "I want this gun to be extremely realistic, extremely powerful," and the other 50% go "I just want the fun experience." I had to toe the line there, find the balance. And that's kind of what we spend a lot of our time doing. We didn't emphasize a great deal of technology, like advance technology or anything like that, it was really about how do we make this product…the exact user experience, the right level in immersion that we want to.

05:21

JC: So, what are some of the things that—as you go through the design process, to finalize the design to this peripheral—what are some of the things that seemed like good ideas at the start, but as you went through you realized that in practice they are not so great?

SS: There are kind of a lot of things like that, I think. A lot of the decisions we made at the user-interface level, a lot of them weren't necessarily pure user reasons. There are a lot of things that are affected by…what's our budget? There are a lot of things affected by our time to do. What's our schedule like? So, early on the early prototypes that I made were…they were like AR-15-, M-16-style guns, and they worked fine with the TV solutions that I was making because you would put your head down against it and look at the screen, that's fine. But when you…because the M-16, its butt stock is in line with the rest of the gun when you aim, so when you put on a headset and try to do that, your headset bangs into it. There's not enough space for it. So, while it's a really cool gun, it's really sci-fi, it's modern but realistic—that sort of thing—if you don't have that space you, if you don't have the stock space in particular…you'll bring your headset in the way. It's not going to track. You're going to have all these issues. So, that was an early on issue. One that's kind of tangentially related to your question, we talked a lot about early on, is that when we made our first prototype—this is more of a case of us getting out there and making sure we had people demo our product's and give us feedback and stuff like that—so, we would frequently have demo days. On our first demo day that we had, we had a bunch of people come to the office and try out the product…There's these buttons in joysticks on it, so you can control other things. You can walk and do stuff like that. A lot a lot of the people were like, "I don't understand these buttons and joysticks. I can't really…I don't know what to do with them. They don't seem right." We were trying to figure out what they mean, so everyone is really clear about it. The user doesn't necessarily know exactly what…eventually, pretty quickly, we figured out that it's because me and both my co-founders were left handed, so we designed all the prototypes for left-handed people. Ninety percent of the world is not left handed, so early on we had to think about ambidextrousness of it…so that ended up in our final development kit and products was that these modules could be taken off and rearranged. A part of the user interface part of that, when you take it off and move to the other side, you'll see it in virtual reality. The buttons will appear on this side; take them out and move the module on the other side, and they appear on the other side, so you…just look at it, you don't need to do this…every time you have to take off your headset to do something, that's breaking immersion. It makes you realize there was a real world, as oppose to the virtual world you are in. So, those are the kind of things we tried to optimize.

08:35

JC: So, I noticed that the product had some features that I wanted to ask you about. So, let's start with the really sexy one, the "inertia mass spring recoil." Can you tell me a little bit about that?

SS: Yeah, so, recoil is a kind of question we were trying to solve for a long time. As I said earlier, there are kind of two schools of thought and make a solution that fits both. What we found in general though is that for the majority of people prefer who actually care, besides the military and the police…you don't really need that powerful of a recoil. So, the idea…you can have a recoil that kicks back really hard, but for the most part it's diminishing returns in terms of immersion. People need a certain level of kick, but for the most part as long as people get that level of feedback, it's going to work. As long as the feedback is…it takes the right form. So, having a vibration really doesn't factor. It gets close, but it doesn't really count itself. The inertial mass spring recoil essentially is the same sort of force you get with a real gun. The majority of the force you are experiencing is both the fire and gas expels from the front, which pushes it back, and also the bolt pushes back. So, we decided [to] simulate that bolt. So, there's a spring, and either a motor, or solenoid, and things like that, that will cause that to move back and forth. And that can get you…because that's using that, the motion is happening in the same direction, it's kind of the same vector, the magnitude of it isn't in the same, but if you get the speed right, you can get the direction that it's actually going, you'll impart pretty much feeling the same force, or the same type of force, but not the same amount of force. The barrel will rise to the same sort of way. It won't do it as a real gun would, but also real guns…start hurting your arms if you play them for four hours. That's a sort of balance that would makes sense.

10:35

JC: I notice that you had…"the slap mag." I take it that that is a something like a clip? A magazine clip? Can you explain that a little bit?

SS: Magazines are another part. We always emphasize that we wanted to have a realistic interaction. The recoil is one thing, but the recoil is something that happens to you. It's not something that you do. So a lot of the important parts about that are the magazine is an action that you make. Racketing the bolt is an action that you take. Other things that you might do [is] adjust the scope…those are extra things that we worked on…. In a regular Xbox game…everything that you do is a representation of an action. It's not an actual action. So instead of jumping, you press A. Instead of reloading, you press X. We learned to say "This isn't buttons." You want to get as close as possible to that actual action. Because how are you going to represent that? Your arm is here, but you are seeing the animation happen or whatever. Initially, that started on with a button on the bottom of the magazine. So, the idea was…when you take a magazine in general, you expand the magazine, you shoot a couple of rounds, you pull the magazine out, you get a different one, and you put it back in. Early on in our prototypes it's going to be complicated to do all that sort of stuff, so let's see steps we can get. One of the big portions of it is going to be that putting the magazine in. That's a real important aspect. For the most part, for a lot of guns, if you just hit the magazine release, you don't actually have to pull out the magazine. It will just drop out. So, that push is really important. So, we just had a button on the bottom. You would slap that. So, that's what we had…Ballista [name of virtual rifle] when we were working on . In our second development kit, which was called the Persuader, that was like a Tommy gun sort of. We did two rounds of developer kits. Those were just to reach out to developers so that we can make games with them, build an ecosystem for the product. The second one had a different version of Slap Magazine [in which] you hit the magazine release, the magazine would drop down in a channel. It would actually slide down…It was locked, it was captive to the actual magazine well, but it would drop down, and so you didn't have to just slap it. You could grab it…More of a realistic aspect. And, actually, it was tracked the whole way. So, you can actually bring this slide magazine up just a little bit, and you could see it. An analog of value of where it is distance to the actual thing. So, those are these sort of things that we…some of the prototypes we went that far, and some of the products went less because we wanted to see what is the bare bones we can do. We got to be cost effective. But also was the best experience we can buy with that in mind. That was a really cool feature I liked.

13:42

JC: You also had another…I saw on the website a release gun an "Analog Slot Slide Reload"?

SS: The bolt action and the slide…on a regular gun you have the bolt, which is the thing that pushes forward the rounds and also usually has the firing pin in it. This slide is something you can use to actually pull back. It essentially the bolt is forward, the bullets are under it; you pull the slide back, it allows the next round to go in. So, the slide is meant to help you chamber the round, sometimes it can help you if there is a malfunction. If the bullet is…fails to feed, fails to eject, you can rack the slide to eject the bullet. Another thing that people use it for is you pull it back a little bit, and you can see if there is a round in the chamber. Those are all functions that you would do…with real guns. Or, some guns have it as a safety to pull back…There are a billion different types of things, but, essentially, we had in the same way I described that analog magazine, we had a slide as an analog. So, earlier ones that we used just had button in the back, and so you wouldn't get any feedback if you hit that button. So, you could pull it 99% of the way, and if you don't get that 1% that hits the button, you didn't actually rack the slide. So, the analog value allowed us to (1) visualize it the whole way. You can see it when you're doing it and see there's a round…allows you to pull back all the way, it allows you to accidentally not pull back the full way, and that's user error that we can reasonably represent because you don't just want to represent the good parts of it. You want to you want it to be realistic. You want the malfunctions…. So, that just allowed it to (1) be much more reliable, and (2) be much more immersive so that it feels like a real object. Almost every action that you can do to the controller, you can physically see. That's kind of what we wanted. Really the main difference between looking at this gun in the virtual world and doing stuff to it, and looking at it in the real world, is the resolution. That is what we were trying to go for a lot of it.

16:07

JC: So, it sounds like, what may be on the Xbox controller, what might have been one button "press X to reload," you have unpacked that mechanic and completely really design it, where it has become a multi-stage process?

SS: Exactly.

16:19

JC: So, it seems like what has for 20 or 30 years…at least since Call of Duty, triggers, aim down sites—standardized—and now you're redesigning that whole paradigm and some parts that had been consolidated, such as reloading, are suddenly given much more expressive and become even possible to have errors, such as misfires things like that…Do you have any other peripherals by the way?

SS: We worked on, pretty much the whole time…on various iterations of rifles. That was our main core product line. We also did contracts for other companies, so we worked on shotguns, we worked on bolt-action sniper rifles, but primarily were focusing on gun controllers because it's enough of a constrain problem set. We could work on all hardware ever, but we really were able to see the value specifically from those both a business perspective and optimizing our time for that.

17:40

JC: Regarding the peripherals, how close is it to scale and weight regarding real weapons and was that even important?

SS: Dimensional scale is super important. Most of them were one-to-one. The only ones that weren't one-to-one were not based on real guns. We had the M-4; that was one-to-one. We had the Thompson submachine gun; that was one-to-one. We had the bold-action rifle; those were one-to-one. Then we had the Ballista…not a real gun. Like a sci-fi replica of a gun though if a gun were to look like that it would be that size. When it comes to weight, actually a lot of time we went for a lower weight…for a couple of reasons. One, it's meant for a game, so if we have it too heavy, it becomes a limitation on the player. So, you want them to be able to maneuver and hold it for a long time. We don't want to induce fatigue. A real weapon in a real battlefield situation, if your gun is an extra pound it's not really going to matter because you're trying to survive. But you're playing a game, you don't need to make that balance. Our whole thing isn't made out of metal for the most part. We want a balanced play the same way your gun is balanced. The center of mass to be the same place essentially. And there are ways that we do that. We weighted stuff with metal inside the body. Batteries generally only factor into that equation. A lot of the models that we had very, very closely replicated the real guns that they represented. Generally, they were more plastic than metal though.

19:42

JC: In addition to the recoil, where there any other haptic features on the device? Or, did you find that the recoil was more than enough to do what you were trying to do?

SS: The way we think of them is tactile sort of experience. You got the haptic sort of stuff, and the bolt, and the recoil, and stuff like that, but just the ability to touch and move everything in the same way…. We spent a good amount of time making sure that the 3D models we had in the game were matched 100% to what was physically in front of you. There weren't really any other active components like that, but…just to the way in which you could. A lot of controllers now and VR have this problem where you're simulating a gun. Where you take two controllers that are not connected to each other…and the issue is [that] you're not getting the sense of touch that you need from that. You can't reliably aim because you can't hold a stock to you. You can't rightly move it because it's not a rigid body. You're inferring [as] if it were a real gun. If you had the muscle memory, you could do something perfectly, exactly…because you have that structure there. Whereas you go this virtual realm, not being able to feel your touch it, is a real detriment to the experience.

21:15

JC: In *Pavlov* and *Onward* [a VR first-person shooters], I find it almost impossible to use sniper rifles or anything with a scope on them. It's a huge blemish in these games…. You're bringing two controllers and trying to put up something in the air and this is how you're shooting. Of course, it feels nothing like shooting an actual weapon. When you design a weapon, unlike a traditional Xbox controller or even the PC mouse, when we use a rifle, we're probably using more of an aim-down-sites, more of an actual marksmanship, more like a physics simulator. Can you walk me through a little bit of that? How does that work compared to your traditional game? **22:07**

SS: One big thing that you point out there is aiming. When you aim in *Halo* or *Call of Duty* [traditional video game first-person shooters], you hit a button, and then it will automatically [aim] dead center of your screen…the red dot and hit the button, the trigger, they're both going to hit. That's not the case in real life, and that's not the case in virtual reality. That's something that we try to emulate. We could make it so that you every time, but that's not the point. These games are meant to highlight how difficult the experience it, how much skill goes into something like that. How stressful the situation like that can be. I play *Onward* as well and think it does a pretty good job of that in some respects, but…if you were to play…say you had crossplay [platform compatibility that allows for VR and traditional gamers to play together]. You had somebody playing Xbox or PC, and somebody could play on virtual reality. The person in virtual reality would get destroy every single time. One hundred percent of time. They can't turn around as fast…they're going to get motion sick, [the VR player] can't jump, and do all these 360's and stuff. You can't aim automatically, perfectly. You can't aim with a flick of the thumb. But, there a lot of things that you can't do in a lot of regular games that you can do in virtual reality really well. If you have a physical controller, you can choose to not aim at all. You can point the gun around a corner and blind fire. You can give suppressive fire. You can aim down or up in the exact ways you want to move, conceal or reveal whatever parts of your body that you want or whatever part of your weapon. You've got a lot more fluidity. It's meant to be harder. You have iron sights in the game, and some of the games you have to put a little scope on there, or whatever, but you still have to line it up correctly. You still have to put it in, and the idea is that, eventually, when you keep playing the game, you're going to get that muscle memory. You're going get to be better and better at it. You're going to get more skill, and that's what you're going to see. In a regular video game with the Xbox controller, it's all about who's the fastest. Who can flick their thumb the fastest? Who's got their sensitivity set up correctly. In virtual reality experiences like this, it's all about who's legitimately more skilled at this action. So, shooting is actually firing the weapon, using the tactics, but your tactics are affected the same way, too. You're forced into first person. You can't do any of the third person stuff to that'll give you a better view, better perspective of things that you would normally have. You have the exact sensory ability that everybody would be in that conversation in real life would have. We talked a lot about the game play aspect, and then there's the training aspect of this, but what is the emotional impact of this? What's to say that we couldn't ten years from now…. We got all this information. Why can't we get all the information that we can about a particular battle in World War II. Get the gun. Get the trenches. Get all those sort of things and do as much as we possibly can to simulate that exact experience, so put it in a class and go "This is why it was so scary." Kids in sixth grade see the history class, "Why don't they just go over the trenches? I do in *Battlefield 1* all the time." No, you can create the sort of empathy by showing, making it as real as possible.

25:51

JC: To change the focus a little bit, I'd like to talk to you about just *presence* in general. How would you define *presence*? Can you give us a definition? What would you say to this?

SS: I'm always really bad at this question in terms of giving an actual definition, but there's kind of an example that I like to go. If you have a good sense of presence, one good you metric you can have is kind of whether or not your brain subconsciously reacts at a reflex level, reacts in a way that it believes you are there. For instance, you're in just a simple experience, but on the other side there's a character or person and they throw a brick at you. If you instinctively duck, you got presence. Your brain believes that you're there. If you're not thinking about "okay, oh this virtual reality thing is cool…that butterfly is so cool," you're subconsciously at a lower level treating them as real objects, then I think that you there. That's a sort of presence.

27:00

JC: A lot of designers and developers, when they talk about hardware…to create experiences of presents, you often hear spiels about…resolution, or a latency, or frequency, or even some people will bring in the aural aspect, like 360-sound, and whatnot. Where do you see tactile, or haptic feedback…in creating these immersive experiences? **27:36**

SS: I think it's going to be equally, if not more important. For the most part, I think it depends actually on the experience they're trying to provide. You're doing a really high level like drawing app or user interface, you probably won't need that. There's not something that you're simulating touching, so it's really that important. But you know for very specific experiences, the more physically immersive you can get, the more the feeling of your hands that you can get out, the better it's going to be. And that's the real balance a lot of people have to make. For instance, *Onward.* At Ilium, we developed partnerships with [approximately] 40 companies who wanted to make games and develop games with our product. But those are really for very specific experiences. *Onward* is one of them we talked to and they were not really interested. *Hotdogs, Horseshoes, and Hand Grenades* [VR shooter]—not interested and the reason is that that physical aspect, that thing in your hand, is really great if it looks exactly like the thing that you're seeing virtual reality. But those experiences are built around this versatility. I have a gun or a grenade and all these sorts of things, and so been helped away from it is actually more beneficial. For the most part, we designed a lot of controllers that could fit into the model of a lot of rifles, but at the end of the day, it's only rifles. As long as the magazine, and the hold of the trigger are really all the same kind of place, it's going to get the job done. But, when you're talking about "oh, you've got to have all these wealth of different physical experiences" while actually physical controllers kind of box you in. There's that kind of physical feel of objects that you can have. I think that's really important for those specific experiences. When you get to these like general experiences, then you get into the question of "what's a haptic glove?" Where is this sort of get? Say you got to game like *Oculus Medium* [VR digital sculpting software]. Imagine if you've got a glove for that and instead of doing all this…whatever. You're actually sculpting it the way a potter would on a wheel. You can feel it. You…ergonomically change that. That textures can be important. I think, to sum up and try to answer questions more concisely, I think that for very specific experiences, you are going to need these tactile and haptic responses [with] these objects and peripherals. When you get to these more general experiences, sometimes they're either not so very valuable or detrimental to the experience. It's really important to know exactly what you're building, and why you have that. I don't think every VR thing is going to have [a VR peripheral] and that's what we said from Day One. A lot of shooters will be great with this. Some of them aren't. This is really to make that haptic experience to 100%. We're trying to get to the one 100% solution. And it's not necessarily fit every single way experience, and we wouldn't want it to because we want virtual reality have all these dozens of experiences, all these different things. If you ask me when the Oculus came out, I was like, "oh, that's going to be really great for shooters." I couldn't imagine any other games. Honestly. I didn't think we would have drawing apps. I didn't think we would have *Lucky's Tale* [VR platformer]. I couldn't even imagine a third person VR game. But because we're not boxed in, you've got a lot of these really cool experiences that you didn't even knew you wanted.

31:33

JC: You make an interesting point. VR technologies, for all intents and purposes, is a new platform, and there's many ways to interact with virtual environments. We know that from video games that there is a strong consumer interest in shooters, and unlike a lot of other games or experiences where you're using controller to interact with the world, the peripheral is meant to replicate a singular experience, like firing a weapon. That's how you interact with the world. With an experience like that, the tactile…firing a weapon is a very bodily experience. The tactile weight of the rifle, the recoil, the smell of the gunpowder, the sound of the muzzle flash, all those things. It seems that when you're highlighting this one peripheral for that particular experience, like a shooter, you could check off a lot of things off the immersive box just by a single controller. Where do you think some of the future lies in these kind of technologies, or even some of the obstacles that they're going to have to overcome? **32:54**

SS: Well, there's kind of the technology and then there's business run into. I think they kind of intertwine. A lot of the issues that people have right now is like, "okay, the barriers to entry for the consumer are really high. The Oculus actually pretty cheap right now. It's like $350. Most people would buy that without an issue. The problem is that they have to buy the computer with it, and the computer cost exact same amount as a PlayStation, but the issue is that PC has this, "Okay, do I have the right graphics card?" When you buy a PlayStation you know that you're going to get it off the shelf, and it's going to work. Whereas you buy a PC you have to [ask] "Does this have the right USB? Does it have the right…there's so many different factors. It's not bundled together. So Oculus and other people working on that sort of thing with standalone headsets that use inside-out tracking and stuff like that. I think those are going to push the industry pretty far. Do it well. If they can provide almost the same what they do right now with a standalone experience, that's going to solve a great deal of those business hurdles. In terms of technology in general, I think that we're going to see hand tracking, really good and tracking. You've already got the Leap Motion, which works pretty well. We use the Leap Motion for some of our demos and things like that to represent the hand because what we found actually is that most people…there are two sort of people that you demo to. You get people who have never tried VR before, and they're experiencing VR, and they're experiencing your product at the same time, so you like, "Okay, what did they more amazed about?" And then you've got the people who are have already done VR, but they're trying your product. They're a little bit better control group because their excitement is about just our product, but what we notice of the people who never tried VR before is almost the first thing they asked almost every single time when they put the headset on, is "Where my hands? Where's my body?" So, that's an important experience there. The Oculus Touch solves that really well to some extent. The Vive controller doesn't do it as well as the Oculus Touch. I actually prefer the Vive to the Oculus, but its controllers are just not as good from an ergonomic perspective, but you can forget that you have the Oculus controllers in your hands. But I think hands are really big portion of it. I think body tracked is going to get involved. I deal with a lot of…most of my time is spent talking with other game studios, other companies, advising and stuff like that, and a lot of the limitation that they have is like, "Okay, we want to make this game, but it's really hard to do the damage correctly because where's your body? Where is your arm?" We're not tracking all that sort of stuff. [In] *Onward,* someone could hit you…you could be like this, like completely contorted, and a bullet would actually miss you but your body get hits right here, so you gain no benefit from doing that. That's going to be big for…right now there are some games that do inverse kinematics pretty well. *Hover Junkers* is one that comes to mind. They do it really, really well, but it's still not as good as it were if they were tracking your body 100%. I think that's going to be a big one. Technological hurdles, computer power obviously. The race…resolution, graphics power sort of stuff. As soon as you get there, resolution on the thing, you got to take a more graphics powers, but as soon as you have more graphics power, people are going to want to make more impressive experience. It's always how computers are still slow? Because software is bloated to fill up the processing power that we have. I think we're going to see that as well, and also Moore's law is kind of dead, so we're going to succeed even worse, but the real big problem in virtual reality is having experiences that you want to go back to. Retention is a lot of problems people are having because it's like a lot of games…I'll play for an hour, but am I going to…is this is something to keep coming back to. And that goes back to the cost perspective. Someone who's rich enough, has enough disposable income to buy headsets or something, maybe it's fine for them to pay $30.00 for an hour-long experience. I prefer regular people, the Xbox little kid crowd, They're buying $60.00 game and putting 1000 hours into it. The cost is way different. Cost benefit is way different terms of their time. So that's a big thing, finding games. And there are games that are getting there, but I actually play *Onward* pretty much every day. I think other games are getting retention, but it's just hard because you got to really like sample size of people, and virtual reality is not yet that big, yet you got to figure out how do we get past limitations technology, what happens when we got the next version? Some people are just staying out of virtual reality right because they're going to wait until Version 5 comes out. And one last thing I will say is that at a hardware level, the Vive tracking is like infinitely better than the Oculus tracking, so it's a hurdle they day in particular have to deal with, Oculus, is that their tracking just isn't as good, and ii theoretically can't even come close to [the HTC Vive], so they get a lot more problems that they have to overcome. But inside-out versus outside-in versus image-based tracking, all sort of stuff. Forty different ways to do the tracking and Vive has solved the problem, but it still had issues to it.

39:01

JC: I agree with you. I think, except for maybe *Onward* and *Pavlov,* it seems like a lot of the multiplayer games go through "a flavor of the week" A bunch will play for a little while and then it'll be bad. It's been heartbreaking because some of these games are really liked, and then just like not as many people are going online. One of the other games that I've gotten into lately *Standout VR*. Have you heard of it? It's like a…battle royal mode.

SS: Yeah, that's right. Yeah, I was going to buy it last week but then I didn't.

JC: I picked it up on sale for like half price or so, and I feel it was complete worth the money just because…there's not a lot of other games doing what it's doing in VR quite like that. One of the things…I pick up a virtual weapon inside [*Onward* and *Standout VR*]…there's almost been like a standardization…everyone knows, "Okay, got to take [the weapon] out, maybe you grab a clip from [the player's hip] or you grab it from [over the player's shoulder], but it's starting to become standardized in a way. When you were designing your games for this experience, or some of the others, did that inform you in anyway? Did you try to look for some kind of way to…"conventionalize" this? **40:31**

SS: Yeah, I think a lot of what we were trying to do is to conventionalize at least physical aspects of the experience. One of the things you may have noticed when you get into that…pick up the pistol, reload, all that sort of stuff, almost every single time, you bang your controllers together. That's not really good user experience, but it's just obligated. You have to do it. There's no other way. We wanted to create a software [for the] hardware level, saying, "This is the standard of the experience. You probably should have a slide." This is very not well known, but…like USB. USB is trying to standardizes all sorts of things: keyboards, mice, whatever. It also has these standards for all these weird things that nobody ever uses. It's got a standard for the…the Xbox controller…joystick[s]. It's got standards for what should the controls look like, what the data should look like. For a gun, this would be a trigger. This would be a bolt…. [The USB] got things for a periscope on a submarine. People at the USB consortium came together [and stated that] "these are the sort of data that you should send over this." This the sort of thing that you would generally use. Nobody ever uses them because they're just so wild, and it's like never been touched. But that's something we looked into early on and the way we kind of looked at it was "Okay," in a similar vein, "what is the sort of data that you really want from the gun?" Do you care about how far you pull back the trigger? Early only, we said, "No," but later on we went "Maybe." You might make modifications to your gun when you change the sensitivity. There's a hair trigger. You're going to want some magazine stuff. What are the different ways that we can represent magazine data? You can represent it as a position. Maybe you have a track magazine that you actually physically put in. You can represent it as a distance from the magazine well. You can represent it as "press the button." Is it released or is it not? That sort of stuff. The slide can have multiple things. Safety is a big one, so we look at all this sort of data, and we say how do we want to standardize? What's the experience look like? These are 15 different things that you want on every gun, or you want to be possible on every gun potentially, and how are we going to represent data? We made the software platform to handle a lot of that. A big thing that we spent a lot of time on [was] our second developer kit and our Kay Product was in modularization, so we looked at, "Okay, if you're going to want a gun, while theoretically possible, you're going to want a scope. What kind of data with a scope put across? You can adjust the optics of a scope. You can adjust zeroing, you can adjust windage, stuff like that, so maybe we're going to need some variables for…some scopes you can turn on night vision. You can do this sort of stuff…these sorts of data we can put in. Maybe for this gun, you got to want an under-barrel grenade launcher. What does that look like? A lot of under-barrel grenade launchers have a pump that you pull out you, put a shell in, and then you pump it back, and it has its own separate trigger, so you're looking at a slide, a button to press in there, and then another trigger. That's the sort of stuff we looked at. And then at a hardware level, we looked at "How do we modularize that, so that we can make one product, and then later down the line, we can release the scope for it. We can release an under-barrel grenade launcher. We can release under-barrel shotgun. We can release all this sort of stuff, because that continues with the kind of revenue model there. Like the [Nintendo Wii], you buy the Wii. You could also buy the little gun zapper for it. You can buy the tennis racket adapter, and those are sources of income regularly with not so much effort, not so much production cost, but especially if you spend the time where we want to make sure the system supports it. But a huge boom to the experience…if someone makes a game that's just for snipers, you're going to want to really make sure that those dials do everything that you going to do. You want to be able to make sure that you can zero it in. You want to be able to make sure you can move it, and we have one company [that was] working on a sniper game, so if they're going to simulate everything on the software level really well, we need to match up with it. We need to do as much as we can to help inform that interface in that experience.

45:09

JC: When it comes to a rifle as an input device…in one hand it's restricted or constrained to a very particular genre of VR. But, on the other hand, it could be designed to have a lot of utility. Do you think there's any other peripherals that might benefit from a similar approach? [A] standard peripheral that can address maybe one genre or one type of experience, but has a lot of utility? **45:54**

SS: One thing we talked about the glove…I don't think that necessarily fits in one genre, but I think it has a great deal of utility. One of the products that we were looking at developing was actually a vest. You would be able to give you haptic feedback. It has some sort of—not a crazy good resolution—but it's got your shoulder, your left chest, right chest…your back. Being able to give you feedback on damage or that sort of thing. There's a company that does that now. We were talking to for a little bit because it's such an interesting side of things. Because your making your hands feels one thing, but you got this whole body. And there's all these sorts of experiences that you can have act on that body. To not represent them would suck. The interesting thing about that is you don't just have the haptic that happens to you, but also you can do things that happen to it. You always see these in *Onward*…. What's to prevent you from putting a small switch or something in there when you actually reach into the pocket, or something like that? Those sort of experiences. Early on at Ilium, we developed this technology, and then we didn't end up using it for any commercial products. But I always really liked it, which was the magazine was removable, and it had an RFID-based technology in it. And so what you would do is, you have in your pockets or in your vest or wherever, put these RFID tags, so you can pull the magazine out, bring it to whatever tag that you want, it would scan it. This is where you keep your explosive ammunition. This is where you keep your health. Bring all those in. The tags and everything knows you only got 30 rounds of this left. You've only got or get this how many magazines that you bring. Those are sort of things that you could potentially do beyond just being interacted on. The way I think about it is, if you're going to make a visible, physical product in virtual reality, it needs to act on you, and you need to act on it. [The] keyboard is one that's hard because a lot of people have the problem…can't touch type or other things like that, so the finger tracking is important to that. That's something I think Leap Motion, or there's been some stuff about Leap Motion. I think that there is probably capacity for swords. I think the sword scales to tennis rackets, to baseball bats, to all these sorts of things. The idea would be—there's a company that's working on this to some extent. Not so generalized, but the idea is [that] you got a controller, and you can smack it, and if it hits something imparts some sort of mechanical force that's controlled, that makes you feel as if you are being hit back or had hit something. You get into all these sorts of larger, more expensive things, which have been doing this for years, like simulators, car stuff. I think there's a big potential to move from flight simulators and cars into this mechanical, like the mech sort of thing, where you got sticks and other things to control mechanical walking. Things like *Titanfall*. But the other thing that we actually looked into a lot—I've had some personal projects, things like that—to this is…have you ever played *Kerbal Space Program*? Do you know about it? I had project that I worked on, which is a panel. A physical panel that hit the switch and it turns on SAS, or you hit the button that launches the next stage, or whatever. There's no reason that you can't make a panel or user interface that matches physically exactly what's in the game. You track your hand and physically hit it. Not only are you actually actuating those things in the game, but you're *feeling* yourself do it. You're watching yourself do it. You've got all levels of the feedback loop to have that. That goes from something like flight simulator to not just gaming but training. Say, you work in nuclear plant. Why would you let a training work on a $2,000,000 console that could affect a nuclear thing when you can put them in a virtual world? Hit all the switches. It will virtually simulate whatever meltdown or whatever would happen. But it's going to be the exact same piece of hardware they're training on the exact same thing…. It's showing exactly what it would like in virtual reality.

50:55

JC: You bring up a couple of interesting points. I think of…maybe you've seen them…they're like toys that very young children play with. They just have a bunch of things you can interact with, like meaningless toggles and things like that. It sounds like…one of the immersive or one of the presence-inducing features is the ability to do things with your hand. You feel real things. You feel resistance of a toggle. I think there's something to be said about the joy of just flipping switches and turning knobs. There's something fun about it when it's done right. You just flipping things. To go back early, you mentioned some of the hand presence. I've played a little around with Leap Motion…you mentioned earlier that a lot of people would [ask], "Where my hands?" or something like that. How much of a role do you think that is in interacting with, say, a rifle, or any of these other peripherals. What's the point where we do need hands, or another point where maybe we don't need to actually render the hands with as much accuracy? Do you think it's like a continuum? **52:16**

SS: When you talk about, say, let's go all the way on the other end, the panels. You 100% need to see where your hands are, so you can actually see the thing. Fine tracking on the fingers is really important. Or, if you were to do some sort of writing app where you hold a virtual pencil, and it needs to be able to…to actually write in a fine way, they would need very fine tracking for that. But, for the gun, you want hand tracking for any action that you're doing that's you not holding a gun. Anytime that your hands move away from the gun, you actually care about it. And anytime [the hands are] on the gun, it doesn't matter because, for the most part, they're going to be fixed. If you're going to move them somewhere, like where you put your hand on the gun doesn't actually end up mattering…it doesn't have any impact anywhere, but you need to be able to see your hands. We demoed these using these products. We had a muscle memory. I wouldn't need the Leap Motion to pull the slide. But, early on, you're going to want to be able to see your hand, and so that you can go, "This is my hand. I'm moving it towards the bolt, the slide, and pulling them back. Manually change the style. But, I mean the Leap Motion was the way we do that. As soon as you put your hand on the controller, it loses track. It doesn't have any ability. Actually, there's some cases with this…you can actually hold the trigger grouping, the handle, and look at your hand, and you will see it. But for the most part, if you're looking down the barrel, the Leap Motion doesn't have the ability to see anything that it thinks is a hand and can't guess it. It doesn't really affect your experience because it's not what you're paying attention to. When you're paying attention to what your hand is doing, that's when it actually matters. Because, like I said other day, the cycle that you go through is you make a motion, and it interacts with something, and you get feedback from it. Like you're talking about with little kids with [interactive playsets]. The reason they do the same thing over and over and over again is because there's a power in doing something, and have it reliably give you feedback that it's happening and all sort of stuff. That's where a lot of virtual reality experience lose it. Where you [are] doing the thing that should do the thing, but it doesn't work. I'm doing this sort of action but its having no effect, or it's not having the effect that I would like it to have. Then you get into something, like a racing wheel. If your hands are going to be on the wheel 100% of the time, you probably don't need a tracker. It really depends on how much your hands are operating *outside* of the object. That's the kind of scale…I would put the gun in the middle, the consul on one end, and racing wheel on the other. **55:08**

JC: Have you had a chance to use the PlayStation Aim controller?

SS: I tried it once, yeah.

JC: It is designed, of course, to be, well, ambidextrous actually, and it's abstracted out…. Do you have any comments about the design? **55:33**

SS: The general idea behind this is pretty sound. If you look at it from a holistic point-of-view, you've got the technical capacity. It's got a pretty low technical investment into it. They already use the tracking they already have. They put trigger on it, and put it into shape of a gun. It's very accessible. You don't have to know much about guns to use it. Just point and shoot. It's got the physical aspects we talked about. Being able to pull it against and aim with it and have an object that you can do. It satisfies all those requirements. I think that when you look at what we worked on at Ilium, [the gun peripheral] actually sits in the middle on this scale here. If you got PlayStation VR on one end—less immersive, technically gun-shaped, and even before that you've got the two Oculus controllers trying to be a rifle. Oculus controllers, PlayStation VR, and you got Ilium, and then you've got companies that are making the most highly realistic recoil, so much so that's a punishing experience. That's not what we're shooting for. What you miss out on, the benefit you get, is all that you get is the genericness of the touch controllers, but with the physical presence that you get from a physical gun shape, so that it solves a lot of these problems. The thing that it doesn't provide—these are necessarily problems—it's kind of like an addition that you can have…the sort of thing that we did was about actually interacting with that object. The only interaction that you have, the only measured interaction that you have with the Aim, is the trigger. Whereas there are so many other actions that will do with a controller, or with a gun. The trigger is, while a very important part, one of the actual smallest parts. And when it comes to simulating to a certain realism, the experience of combat, pulling the trigger is like the least important part actually. When you pull the trigger, yes, the bullet has to go out of it. But, that's the bare minimum. Every gun does that. The magazine…how many times in *Hotdogs, Horseshoes, and Hand Grenades.* Reloading is actually painfully difficult in that game because it's the gestures of it don't work that well. Reloading *is* difficult. You're going to be in a firefight in a virtual game, and you're going to pull the magazine out, and you're going to fumble it sometimes. Real people fumble. Eventually, we get better and better and better. You're going to stop fumbling, and then that's your kind of training kicking in. That's an experience that you're not going to get with the Aim. Pulling back the bolt. Some people are going to expand their entire magazine, reload, and then try to fire, and it's going to dry fire. There's going to be nothing in the chamber. That's going to be a failure in something you do that could cost them the game, or they could recover from it quickly, and that was a fun experience into itself. So, adding more of those things that you can interact with, prevents it from being just pointing in a direction when pulling the trigger.

58:57

JC: I noticed that when, let's say in *Onward*, the interaction between the players—I was a big *Call of Duty* fan for a long time, and my interactions would last usually less than one second. You see someone, and then everything is decided usually like 0.7 seconds. It's really no option but to kill the other person or shoot at them. But [with] VR, even the act of reloading—I don't know how many times I've dropped my gun or dumped a magazine out of panic. Or trying to do something and just fumble it, or had the dead man's click. I forgot to load the chamber and lost a game this way before. It seems that these input devices, as you mentioned before, kind of open the door to what have conventionally been a single-button action, and you can have a multitude of different encounters and expressions of this. Coupled with VR, the very fact that you can hold a controller—I don't have if you have ever done this in *Onward*—taken prisoners? People drop the weapon; they hold their hands up at me like that's the international sign to give up. Of course, you can't do that in *Call of Duty*, but just the ability *not* to fire suddenly becomes meaningful. You can do other things, but it doesn't have to be shoot. I got one more question for you as we wrap up. I think we covered most the other ones, so let's go back to the force feedback. Now, the only other controllers that I can pick up, besides VR weapons and whatnot that have force feedback, are steering controls. It's been the only iteration of force feedback, I think, that's been around for at least a decade or 20 years or so. There's really no other version of it. And now we have these peripherals coming out that are using force feedback. Do you think force feedback, or some iteration of it, will have a large role in the future? Do you think it has a lot to contribute? Could there be other peripherals with force feedback? **1:01:06**

SS: Yeah, I think really one of the big parts that you miss out on a lot of experience is not having that that force feedback because that gives you…not only is it something that just makes the experience better, it's also something that gives you information. When you are, say with the car, when you are turning, and you're getting resistance, you know that you slide. You don't just have the visual aspect of it. You have a physical thing that you understand. When I drive, to a certain extent, I can close my eyes when I'm doing a turn because I can feel the car trying to correct itself. That's information that's important to the actual operation of it, so a gun controller…say you're in a game in your weapon is silent, so audio is not a huge factor. For the most part, you can't really see, especially if it's silenced and you can't clearly see the explosion. That force feedback is information telling you that you have ammunition that's firing or you don't. Depending on what it is, you can kind of get a sense of, "Okay, am I having a malfunction? Did I just run out of ammo? What's happening?" That's information I can help you in this situation. When it comes to other applications, I think that there is an opportunity for the same sort of thing that you see in racing controllers. I think you can see that my flight sticks where sometimes when you pull up, you're going to feel that that aileron, or whatever, all the resistance it is giving you, and you're going to know it's going to give you information about how difficult or how you should adjust other things like that. Force feedback with the hand in general…there's just so many examples of how much that can really help you, especially when…for example, sculpting. How much of those fingertips are used in that process of crafting a piece of clay. Say, a tennis racket. A big portion of—or baseball—it's not like I see the ball and hit it, and that's it. The way that you feel the ball hitting, and where you feel that it hit, informs your follow through, and other stuff like that. And it also lets you know if you actually hit the thing, or if you straight up missed it. But…there was a contract that we were going to do but fell through for various reasons, for a baseball they were going to use. They wanted us to make a baseball bat with haptic feedback to train little leaguers. Attach a Vive Tracker to it. That's an important piece of information. For the most part, like for a baseball, a much better example than the tennis one. You can feel when, in real life, when a ball just slips over the top of the bat. Or just hits the end. It's not going in the right direction. And along with that, if you were to close your eyes and you did hit the ball, you could probably feel where you think the malls going to go. That's information you can use. In that split second a baseball player hits it, they can feel where it's going to go, and they know [that] this is the base that I'm going to run to, this is how far I'm going to run. Or, this is going to be foul, I should stay. I think that all the haptic feedback just gives as much information as probably can and for some things, that's really, really important to the experience you're trying to…. The furthest extent you could have in any of this is training. Trying to train someone to be better at the real thing. You always want to be as realistic as possible, so that's why I use that as a lot of examples because, at the end of the day, anything that we did before that, is just dumbing down training. We're starting at "this is where real life is." Real life is the training part is that the ideal is 100% matching it, and we're just dumbing down, "We can't do this for technical reasons." We don't want to do this because it's going to hurt. That sort of stuff. That's the way I think of it.

01:05:29

[*End of interview.*]

A.5 Transcript of Interview with Donn DeLane

Interview with Donn DeLane and Employee
Owner, Toxic VR Lounge
February 16, 2018

Participants

Jason Coley	JC
Donn DeLane	DD
Employee	EM

00:01

JC: Let's continue with the escape rooms. Let's talk a little bit about that. You mentioned about not breaking immersion by coding or giving hints. Can you talk a little more about that?

DD: Well, that's it. Once the people—it's funny. I was just talking to the mall guy, and we're trying to think of what to do with these windows, and he said, "Well, why don't you just get black vinyl, and you could black vinyl them," and this and that. I said, "Yeah, but it doesn't fit the theme of the room." I said, "I would rather spend the extra two hours or three hours, close it up, sheetrock it, spackle it. This way you're not just having things that are random in a room." He said, "Well, you get it done faster, and it's cheaper." Fast and cheap doesn't matter to me, if I'm ruining somebody's experience. I want to make it like we've got the serial killer room in Rotterdam. I built a basement. It looks like basement walls, basement floor. There's actually fake basement stairs going up into the ceiling because you really want to make it where when they're in the room, they're in whatever theme that they've picked. We try not to come into the room at any point, so this way once they go in that room, they're for the duration. Your immersing them into the theme. We could just go into a room and put stickers on a wall and stuff and make that the theme. It just doesn't…it's not what people want. People want to be part of the story, and they're in the story, and that's what we tell them. Our Missing Starlet room: you go into the dressing room with the missing starlet, and it's set just like a movie set. It looks like the dressing room in the missing starlet with her make up thing, and her jewelry, and her trunk, So, you try and get all those things. This way, they're in the story. They're set for the 60 minutes they're in there.

02:11

JC: Let's focus more on the VR. Tell me little bit about some of your VR experiences here. Especially as they pertain to team building.

DD: These team building…when it comes to team building, to me, there's two schools of thought on team building. There's the one school of thought where you're going and you actively want to work together, and you're doing something together as a team. That's more the escape rooms. But also with team building, what team building has kind of turned into, is they just want to go out as a team and go out and have fun as a team. They go bowling. They go to mini-golf. They go to different events like that. Running out of stuff to do. That's why the escape rooms are popular. This way they are working together, but they're also having a good time. The VR…I would say most of that is people just coming together and having a good time together. We set the place up. Our thought was setting it up as a lounge with all the screens, so you could see what they see in VR, and you do get a lot of communication back. The Keep Talking game [*Keep Talking and Nobody Explodes*] is all about to me teamwork and working together because that's…. You can see the dynamics of when people get hot and excited in there, and it puts pressure on them because they've got five minutes to defuse the bomb.

03:44

EM: Yeah, I'd say that the two teambuilding, in the traditional sense of working together to accomplish goals by experience, that we have right now are *Keep Talking and Nobody Explodes,* where one person is diffusing the bomb and the rest of them have a manual to the bomb, and the rest of them get to talk to the person who's trying to defuse the bomb about how to defuse the bomb, and yelling and shouting and laughing usually ensue. And then we also have *Arizona Sunshine*, which just has four-player cooperative play. In their horde mode, you are in a small area. Each of you has a gun. There are zombies coming at you. Do not die. You can cooperate together in that game by, let's say, one of your friends run out of ammunition. You can eject the magazine from your gun and throw it to your friends, so that they can have more ammunition. Well, let's say, somebody's low on health. You can chunk the, a cheeseburger, and then they'll be back up to a higher thing. It's all about communication.

04:42

DD: In that game your searching for things, too. You're looking for keys….

EM: One of the levels in it is actually more of…it's kind of an escape room because you have to progress through the thing and actually get different keys and stuff to continue on get more weaponry and stuff.

[*Customer enters the lounge*.]

07:03

JC: So, actually, tell me about some of the customers that come in here?

DD: It's funny. We get it we get them in anywhere from 8 years old to….

EM: We had an 87-year-old man sitting in this swivel chair on Google Earth telling us his life story as he travel the world. We were watching through his eyes up on the screen on Google Earth. We were watching what he was seeing, and he was telling us about what he's done in these locations. He was telling us about cool things he's seen and in places he's been. It was magical.

DD: So, it's amazing. Everybody always asks me, "What is your marketing demographic?" and I'd say our demographic is probably…most of our customers are younger kids. Twenty and under, but everybody enjoys it. It's one of those things.

[*Customer interjected.*]

08:21

JC: What are some of the reactions and misconceptions and first response people have when they come and tried VR? How many of them, maybe their first time? Maybe some of them are old hats?

DD: A lot of them are first time, or they've done the phone. Almost when anybody gets in there, and you put him in the good VR, everybody seems blown away.

EM: I usually have either two reactions when I take the headset off. Either…or…. I know that doesn't translate well on audio. It's either a disgusted look at the real world, or a really excited look. "I want to go again!"

09:01

DD: A lot of people think they're going to get motion sickness from it, and I'll actually just take the headset, put it in front of their face where they're holding it, just so they could see. Because if you've got good equipment, and you don't get what's called kind of lag, and we get very few people who in the Vives get motion sick or anything. People don't…you see on

YouTube videos and stuff that people just fallen over. We've had two, I think. We've been open a year and we had maybe two people fall.

EM: I can think of two instances…well, there was one guy that was playing. He got so immersed in it, and he was playing a [inaudible], which is like a dungeon-crawler type thing where you're fighting skeletons, and you have sword and shield. And he's fighting this skeleton, and he *dove* out of the booth while playing it. He dove clear across the store. He snapped one of our Bungie cable things, but that's no worry because it's just a cable. He got so into it. He dove to dodge out of the way of a skeleton's sword, he was actually fighting the skeleton. That was beautiful. I'm not going to lie.

10:17

DD: Some of it could be a little disorientated. Most of it is, just, it's like your wherever you are, whatever game you pick, whatever experience you pick, whatever you do you're there.

10:30

JC: Are some experiences more popular than others?

DD: First person shooters are by *far* the most popular experiences. Everybody wants to play that. We've got one, it's called *Bullet Sorrow*, is a nice easy one to get into. Does not picking guns and doing this because a lot of people, too, when they first try…just pay for 15 minutes and you don't want to get into a big game that takes long time to load, takes time to pick guns, and there's a big learning curve for some of them. There's learning cards how to reload, what to do, where to get ammunition, which buttons….

EM: Two buttons and two triggers and that is literally all you need to play the game.

11:11

DD: The reason we started this was, we owned the escape rooms, and I knew they had escape games for VR. So, up in our Queensbury location, we got a big back area that we're not using it. And I said, "Let's get it. We'll set up a booth. People want to do a little add on or something, will make it for that. You do escape games in it. As soon as we got it, we started playing some of the games and saw what was out there. I used to enjoy games when I was young. I'm 52 now. And I used to enjoy games when I was young, and now with the controllers and stuff, you got to press 17 buttons to do something, and I just don't have the time to sit there and learn how to do it all. It's not fun for me. [VR games] so easy to do and they're so intuitive that you can get in a game with you're playing seconds and just having a ball.

12:04

EM: Partially due to the motion controls as well, because [inaudible] is a foreign concept to you. Usually anybody who hasn't played a video game before. But being able to swing a sword and shoot a bow and arrow…pullback like that.

DD: Once we did it, we said, "You know, we got to do something else. And then we looked into getting space and doing the whole thing. That's how this was born.

12:36

JC: So, let's talk about how this came into being. Maybe from initial conception to where we are today.

DD: That was basically it. We basically just set it up as one booth up in Queensbury, and then we decided to do more, and then we started doing just some of the thinking about it. What it would cost us, and what the monthly expenses would be. How many booths do we need to even try and get to a breakeven point? We opened with…I had four booths, but I had three headsets setup, and then we bought a fourth headset. We bought PlayStation just as a kind of add-on thing while we were there. Then we basically just opened it up, marketed like everything else we do. Me and my partner basically when we first started, we just ran it ourselves…and then [motions to employee] walked past…. We've just been kind of chugging along and trying to figure out, and then we really…when this space became available, we wanted to open our escape rooms also, and they already had all these pre-built out rooms, so it's just a perfect thing. The VR was doing good enough to just keep it going and move it over here. But it's been a year now, we're paying our bills.

14:15

EM: Yeah, February, it's been a year.

DD: Next week is actually are…we opened February break last year.

14:23

JC: So, have you tried VR before all this? So how did--?

DD: I've never tried I tried it before I put the headset on. We just don't…that's typically how I do things…I figured marketing-wise we're going to…I read all good things about it, so I wasn't afraid that. I said it was just doing it on a smaller scale. Even if I spend $1000, it didn't get it back or something, *c'est la vie*. But, it was good. It far exceeded what I thought it was going to be.

15:08

JC: Can you explain that? Tell me more about that.

DD: Well, when I got it, I thought we were going to do just simple escape games and stuff, and we got in there and realized how much they had. How many different things you had. How much actually just fun it was. That's what we decided we really got to do something bigger. Then I started doing research for VR arcades out there in the world. Big in China and Japan. People are doing it, so let's jump in and try it.

JC: Was there anything thing that you learned from working with the escape rooms that you were able to carry over to running in the arcade space?

15:49

DD: Just basic customer servicey That's really…you're making experience about the customer. And you're doing everything you can just to keep their experience and make sure they're having fun. If they have fun, they want to come back. But they come back then we're doing our job and we're making money. That's really probably…the only thing. Just the customer service of what…and I knew from the escape rooms, people will look into something different to do. People would come in all the time just say, "Thanks for opening this"—the VR, too—the escape room when I first opened. People are just dying for something new to do and just go out and have different experiences. And [VR] gives you unlimited experiences.

16:40

JC: Let's talk a little bit about *presence*. What does that word mean to you? Are you familiar with that term?

DD: No.

JC: So, *presence* in lot of academic circles, is this idea that VR can make you feel like you're in some other place.

DD: Oh, that's what it is. It's 100%. Literally, when we put you in there, and I always say that it's. Google Earth. You feel like you, wherever you're going, you feel like you're there. It's you losing track. People come out, we take the goggles off of them, and they go, "Oh my God! I didn't know I was here in the booth. I didn't know. I almost forgot I was there in a mall." Especially now that we got the glass there. I always try to put people in those front two booths, so everybody sees them from the outside. I call it our money shot. And from there, people are saying, "I don't want to be in front of everybody," and I say, "Give it 30 seconds." And I said, "You will forget that anybody is out there." I said, "You could have a crowd of people standing there, and you'll forget they're out there." You are wherever you go, and that's—good or bad—they've got some horror, terror games that are brutally realistic and stuff. It's just affected…*The Manner* [a VR horror game]. I was just playing that the other day. We just didn't…we belong to SpringboardVR [a distributor and content provider for location-based VR arcades], and they do…through them, we can do commercial licenses for games, so we just went nuts, and they've got over 100 games. So, now we're just loading up all the games and stuff from them. This way, it's easy that we pay per minute for the licensing and stuff for it, and they keep track of everything. So, it's nice for us, and just gives us huge offering now. We weren't able to do that before.

18:32

JC: You have 55 games. Are these different games than you would find on Steam, or are these on other platforms?

DD: Some of them are. Some of them they're making just for arcades. Now, most of them are on Steam. So, you could buy a Vive, get a computer that will run it at home, and have it at home. The big advantages here are [that] you don't have to buy the games, you don't have to buy the Vive. We take care of everything. We have dedicated space for it, but that's why there's a lot of people go, "We got to move a couch, we've got to move the two tables." We've got a cable management system that keeps the cables out of your way, not trip. At one point, I think we had a couple, and I set one up at my house. If I was just find buying it for home use, I'd probably would've gotten rid of it because I was tripping over the table all the time. I'm downstairs in the basement…the only space big enough to use it all the time. We were whacking the controller into the ceiling. And here it's nice setup to use it, enjoy it the way it was meant to be. So, that hat's not part of it. The presence is…it is…you are wherever you are. When we walk up to a ledge and look over a ledge, and you get…target example is a game that you get into an elevator, and you go down into Batman's cave. Literally, the first time I got into the elevator, I got the feeling in my stomach like when you go in an elevator and your stomach drops. I got that feeling. Now, I'm standing on a cement floor. The cement floor is not moving. I know that. But I swear because of what you see, my body reacted to it and gave me that feeling—almost like it knew that's what it was supposed to feel. That's how immersive that experience is. That is deeply immersive.

20:32

JC: What are some things that make something more immersive, or work toward making this a more powerful experience you think?

DD: Probably the graphics. The graphics definitely make it much more…you can even play games that are…if you look at this game. That's a fun game…the kids love this game, but to me, it's not. I don't know if it would be super immersive. You go into Google Earth, and its actual, almost video quality around you. It doesn't look cartoon. It's still graphics and all that, but some of the stuff is so realistic. I think the realism in the graphics and everything is what makes it very immersive.

21:34

JC: How about some of the controllers? As far as…you mentioned that there's too many buttons…it could break the immersion?

DD: Absolutely. The controllers that they have now, I would say, are real close to being good. A lot of the games they have are shooting games and stuff, so, you know, you've got triggers on the controller, and the trigger is where you would use a normal trigger. But I'd say the control is really aid in the immersion more than taking away. It's got grip buttons on the sides of it, so when you go to pick something up, you actually grip the controller. It's almost like you're actually picking it up, so that's…I'd say to control is definitely a big level to immersion.

22:22

JC: I noticed that when, say VR shooters for example. What traditionally has been like "Press X to reload" now becomes a three-stage process. Pulling it out, putting it in.

DD: Sometimes. You got the one, *Arizona Sunshine*. You got to touch your side where you would grab a magazine from, and then you just click a button.

EM: Then you push the—*Containment Initiative* [VR shooter]—that's the one.

DD: That's the one you got to grab it. You got to actually put it in, and then hit the slide. There is a…pull the slides back. To me it's really more like an actual gun.

EM: Same thing with *Bullets and More*. *Bullets and More* you have to do the same thing. You actually have to know how to operate the gun. You know where the slide is. You have to know how to eject the magazine, put the magazine in the right spot, pull the slide back and hold it the way you really would.

DD: Typically, much more immersive than your typical video games.

[*Speaks to customer*]

23:28

JC: What about these social experiences? *Arizona Sunshine*, four people playing….

EM: I could talk about the social experience when it comes to VR. I play this game called *Rec Room* by a great company from Seattle called Against Gravity. They're awesome. I'm actually friends with several of the developers there through playing their game. I started playing this game on a whim. I was like, "Wow, that looks cool." Started playing paintball and stuff, and I started meeting people in game, like talking to them, and then we just kind of meet up in game and not do anything and just hang out in public or areas. They added private areas. We go there. We hang out, and we'd play Dungeons & Dragons. And we have a weekly cocktail club meet-up where people learn like different cocktails and stuff.

DD: That's why would I thought it would be good if he were here.

EM: Every once in a while, it's like, we'll meet up together, and we'll play laser tag with a team of six. I have more friends now than ever because of virtual reality. I've met people from California, Georgia, Charlotte, Boston—all the way out in LA—and we can meet up at anytime, and actually physically hang out together because we're able to be in the same virtual-physical space, which is super cool.

24:50

JC: You mentioned basically meeting people and making friends. So, what is it—if we can pinpoint this down—what is it in VR that fosters this, and maybe normal gaming or Reddit chat room may not? What is it particularly you think about this?

EM: I think it might be the physicality of it. Because being able to be within the same virtual-physical proximity of somebody and actually seeing them in front of you, hearing their voice come out of their avatar, seeing their hands move the way that their hands are actually moving, and being able to go up to somebody and high-five them, being able to throw something for somebody and them catching it, or being able to let go up to somebody and shooting them…. Even that is so much different than actually playing it online because if you're playing online, you're not actually interacting with that person. You're interacting with their character that they're playing. In VR, it's different because you're not just looking at the character or not just looking through the eyes of the character. You're *in* the character that you've made in VR. So, it's more you then it would be if you were playing on an Xbox, C*all of Duty*, or something like that.

26:07

JC: I have a lot of similar sentiments. I play…I like *Rec Room* a lot. I also go to *VRChat*….

EM: I try to stay out of *VRChat*. That place scares me.

JC: Let's talk a little bit about some of the equipment you have here. I see the different cockpits. They look like they're probably for different experiences. You mentioned the pods up front. You said that are [for VR] helicopter rides, roller coasters…?

EM: They are a machine called the VR Eggs, I believe. What they are is basically a roller coaster-type ride thing. They're less of a virtual reality game and more virtual reality experience. Let's say you go to Universal Studios. You go on one of their virtual roller coaster ride-things, and they put you on a huge platform that moves the groups around, and they play a video around you, and it feels like you're actually on a rollercoaster. Like that, but on a smaller scale. You're putting on the headset, and the headset doesn't have positional tracking, but it does have rotational tracking, so you can put it on, you can look around and see the surroundings that you're on, and the machine itself is synced up with the video in such a way that it moves you at the same angle at the same time as the roller coaster or helicopter ride or swing pirate ship or boat ride or skiing trip or whatever you're on moves. It makes you feel more connected with the motion and the actions that are happening on the screen because there's actually a physical jostling or what have you of your own personal body, which is pretty good.

27:45

DD: VR itself isn't the quality of other stuff.

EM: It's a lower grade VR headset called the Pimax 4K. Doesn't have positional tracking at all, and the screens aren't great, but it does the job.

DD: But with that, you get the movement….

EM: That is the only thing that's ever made me nauseous in VR only because I get really nauseous on swinging pirate ship rides in real life. I did the swinging pirate ship in there, and I wanted to throw up because it felt like I was actually on swinging pirate ship ride. That's how good it was. I have no idea how they manage to convey the most horrible feeling. I think it was horrible in a cool way. I love that I hated it…because it makes me feel like I was actually there, which is really cool.

28:40

JC: Where do you think the direction of VR arcades might be heading, and what do you think, for example, will people [pine for] experiences with more users? Or, do you think it may gravitate toward guns and more of those active, very active, kind of games where you're ducking…?

DD: I think where the entertainment industry overall and VR are going, backpack computers, or cordless headsets, where all you have to do is put a headset, and you're all in a room together. Zero Latency, what they're doing, that's going to be the future. I wish we could somehow get more into that because I think it's limitless what you could do with it, and what situations you could put people into safely. Because with the escape rooms and stuff, I can't have knives in an escape room. In VR, I could have them on a narrow bridge crossing a gorge if I have to.

EM: They just announced a wireless add-on for their headset, and they actually just announced a new version of their tracking hardware that will allow people to be tracked within a 75 by 75 foot area and come back with the wireless headset add on, you could have a huge amount of people in one spot all working together to do a common goal.

DD: That's where it should…I think it's enormously cool. After doing VR, and also having escape games, my brain just starts rolling with ideas and stuff that you could do. Just have a physical wall, so when somebody actually walks up, there is a physical wall there, but it will look like—in there, it'll look like a castle wall with vines growing down it. You can…it's just amazing what the possibilities are.

30:48

JC: I imagine with, especially when it's more wireless, and you don't have to worry about people tripping over them, I think that's the very thing that some people are, like designers and developers these spaces, are considering the floor more as part of the experience, such as having players jumping or hopping over things that to [the players] would look like a chasm or something like the bridge, or even the idea that you know because I can touch this, I can feel it back. That we can somehow use this as part of the game, like having a player lean on their back or laying down to look up to see something.

DD: One of the games I saw they have that had a…looked like a 6 by 6 coming up, and they actually had to get something and put it, I think two players had to get something and insert it into their the thing there. It was a physical thing they actually had to pick up, but it also was a physical thing that they put it into, but it looked nothing like…it didn't *look* like a 6 by 6. It was some kind of control that they were putting it in. So, it's…that's where I think the whole thing is going to go, and it's going to get crazy.

32:05

JC: So, if I am understanding you right, there might be more of a tactile element as we move forward these VR arcades?

DD: I could see it. Everybody wants real guns to hold. We had guys come. They're are the guys over in Troy. They brought one of them…I should remember the name of it…you know thing that you walk in? Has a belt on so you could walk in VR, and you put the special shoes on? The Omni treadmill….

[*Phone rings*]

35:22

JC: I may have touched of this one already, but what are some of the common misconceptions about VR? When people come here, what expectations, or have they heard something that is not quite [accurate]?

DD: The common thing that we hear [are] "It's going to make a sick." They think it's like the phone VR. They don't realize how actually immersive and how good VR is to come because everybody—even in the chat rooms and stuff. You see the guys all time, "I'm waiting until they get this straighten out" and "I'm waiting until they get that straightened out," and I think it's a worthwhile experience already. I don't know if purchasing for house. Like I told you, I think there's more to come with that, and I think it's also changing so much.

[*Tangential discussion about HTC*]

37:16

JC: What are some of the best practices for creating the most immersive experiences in VR? If [someone] wanted to run a VR arcade, do you got some advice?

DD: I guess just having them in their own space. It's the experiences is so immersive on its own. You put the headsets on and headphones, and you can really just be…there's not much almost that I could do to make it more your thing other than just your own space and just letting you go. Right now, I wouldn't say it as much so we can do to add to the immersion of it.

38:16

JC: The product sells itself?

DD: It's really immersive. That's the whole basis of that is that it is, to me, is that it is an immersive experience just in itself, rather than us trying. Escape rooms [are] different. We work to try and create the immersion. We've got videos that a lot of times we play just before [the participants enter the escape room]. You're the detective when you're in here. You're in the basement of the serial killer. Our serial killer room we have. We just use Velcro straps, but we handcuff people together. Two people get shackled together. The leg shackles get locked to the wall inside. Everybody is hooded before—we actually put like a T-shirt, and I cut the sleeves off, and sewed up the top, and we put hoods on everybody, then bring him into the room. This way, when they remove the hood, the go from being in a mall to being in the basement of a serial killer. That's creating the immersion in that. [VR] is put on the headset, click play, and you're in the immersion. Actually, don't have to click play. Even just being in the game launcher. Have you ever seen Springboard or anything?

39:27

JC: I don't think I have.

DD: SpringboardVR is our game launcher. They're probably, I would say, probably one of the big guns in VR arcades. Have you seen their videos on YouTube? We found them actually helpful when I was looking at them. Springboard put out a whole series, anywhere from marketing your VR arcade and setting it up to how they run. And they're just on YouTube. It's nothing special you have to do. I find them interesting, and I like also the business [videos].

[*Tangential conversation about dissertation research*]

41:32

DD: That's really what makes it…like when you talk about the social end of it. It's one thing when you chat with somebody online, and it's another thing when you're…sitting at a table across from them. It's almost like Facetime compared with texting somebody…. But it's another thing when you Facetime and you feel like you're together at the same place. Even just a phone call, a phone conference compared to Facetime and actually seeing each other. It's a different experience. It's your avatar, but it's still just seeing the motion of another. Because it still is…it's a human making those motions and stuff, yet so digitally enhanced, but that's kind of the interesting. I think that makes it more…thinking back, the very first time I was in it, I got into, and I think it was *Bullets and More* when it was, and, this is going back a little over a year ago, is probably last January, and somehow I got…I didn't realize I was in the online mode and all of a sudden the guy starts talking to me, and I'm like I guess we're playing together, and he's like, "Yeah, right, you better duck," and I turn and there he was standing right there, and it was a really deep inside creepy feeling. This guy was right here.

43:16

[*Batteries expired: Second Recording. Recording begins during the tour of escape rooms.*]

00:01

DD: How would you do a room with this box? But, immediately I thought I'd heard of a puzzle. It's a Braille puzzle. So, what I'm going to do is I'm going to put a top on this with a hole in it. I'm going to put—see I got the Braille? I'm going to put Braille letters on the inside. That'll be on the outside, so you know you're looking for something Braille. You're going to have to reach in. You're not going to be able to see it. You're going to have to feel the Braille to get the code…. And it's all just stuff like that. A friend on Facebook was selling this. You know this is escape room gold. It's got numbers on it. It's immersive. It's actually from the National Bank. It's got a key to lock. It's got you…until somebody destroys this, because people are brutal in the escape rooms. Stuff like that. And it's cost me $5. I found these. And that's all stuff just to add to the immersion because you want to make it. I got this Sherlock Holmes [holds up a calabash pipe]. I can use probably the pipe, and I'll probably repaint the pipe to make it look less. But when I saw it on Amazon, I thought it looked great, and then I got the hat. Then I thought, "I can't use that. It's ridiculous." I waste some money on stuff too but…

01:35

JC: If I understood right, you think of a theme for room, and the theme really shapes the nature of the puzzle or shapes the experience?

DD: You try, and you don't want to have stuff that's completely out of theme. If I'm doing the Missing Starlit room, and it's supposed to be like a 50's starlit. I don't want to take and put a cell phone in that room that they have to break a code or a computer in that room that they have to break a code. I have a seal team room, and we use a USB. They have USB's that you have to put a code in to use. We have that hidden somewhere in the room. They've got to do this whole puzzle to get it out, and then they have to plug it in. They have to put the password in, and then they get another clue. I couldn't put something like that in my Missing Starlit or my Sherlock Holmes room or something because it just breaks out of what…so you want to keep it immersive to what you're doing and try and tie the—some people are better at this than others—but you even want to tie…. You don't want to just do a puzzle in for no reason. There's people who put crossword puzzles and games, and actually in my Murder Mystery room up in Queensbury, it's a straight murder mystery. You go into an apartment. There's a whole backstory to it. I've got a crossword puzzle in it. Some people would say that's a horrible thing to do because why do you have to solve this puzzle or anything? But we find that people like to play puzzles, and they like to do stuff like that, so breaking immersion once in a while with stuff like that. And black lights…because it's magic. You look at this wall. You don't see anything. Then all of a sudden you take a black light and you put it on it, you see stuff…its invisible. Use invisible paint, marker or whatever, and it shows up with a black light. You got to hear the hooting in the hollering in the rooms when they find something like that. Almost every escape room you'll ever go in has some kind of blacklight there at some point. Because people love it. Except for the real enthusiasts, the ones who have done [a] 100 rooms. They hate black lights.

04:05

JC: This has been very informative because the escape room is a good way—from an academic perspective—is a good complement to talk about VR.

DD: I think the two of them are very tied together. I think you're going to see a lot more escape room owners bringing VR into [the business]. Because immediately what I think of is what I can do with the escape rooms with VR when it gets to that point where it's good, but it's got to be wireless, it's got to be…when they get the gloves. They work properly and everything. Where you're actually feeling things and that your controller. That's going to be [a] game changer.

04:49

JC: Do escape rooms offer a kind of unparallel tactility to the experience? What you're describing right there, that's something you could only do an escape room.

DD: Yes, because you never feel that. So, I don't think it's not going to replace these. I think you're going to add rooms and have VR rooms. Because people like puzzles…people like it and they've got to really figure things out.

05:22

JC: I think you you're definitely right. Say, taking an object, and for the user—let's say using VR—they would pick it up and would have weight, but maybe [inaudible] would look different aesthetically based on whatever theme you might have.

DD: Yes, and that's where you could—like I say, you can have where you're walking pass something, and then there's a dragon outside a window. You just can't do in real life. If I have a video screen. You can set it up where it looks like a window, and you can play whatever you want on it outside. But you still know it's different. It's got its limitations.

[*End of interview*]

A.6 List of Virtual Reality Applications Explored in This Research

The following list identifies the wide range of virtual reality and immersive applications investigated for this doctoral research, along with their studios, release dates, and platforms.

Title	Developer/Studio	Date	Hardware
A Fear of Heights, and Other Things	Fulby Technologies	2016	HTC Vive
A Fisherman's Tale	Innerspace VR	2019	HTC Vive
Aces High	HiTech Creations	2017	Oculus Rift
Adventures in Space: Black Holes and Beyond	VictoryVR	2018	Oculus Rift
Affected: The Manor	Fallen Planet Studios	2016	Gear VR
Aircar	Giant Form Entertainment	2017	Oculus Rift
Allumette	Penrose Studios	2016	PlayStationVR
AltspaceVR	AltspaceVR, Inc.	2016	Oculus Rift
AltspaceVR	AltspaceVR	2016	Gear VR
Anne Frank House VR	Force Field	2018	Oculus Rift
Archange Hellfire Free	Skydance Interactive	2018	Oculus Rift
Arizona Sunshine	Vertigo Games, Jaywalkers Interactive	2016	HTC Vive
Audio Drive Neon	2-Volt Games	2017	HTC Vive
Audioshield	Dylan Fitterer	2016	HTC Vive
Base Blitz	Petroglyph Games	2017	Oculus Rift
Batman: Arkham VR	Rocksteady Studios	2016	PlayStationVR
Battle Dome	QuinnTeq	2016	HTC Vive
Bazaar	Temple Gates Games	2015	Gear VR
Beat Saber	Beat Games	2019	HTC Vive
Big screen Beta	BigScreen, Inc.	2016	HTC Vive
Big screen Beta	BigScreen, Inc.	2016	Oculus Rift
Blade and Sorcery	WarpFrog	2019	HTC Vive
Blade Runner 2049: Memory Lab	Alcon Interactive Group, LLC	2017	Oculus Rift
BLARP!	Isaac Cohen	2016	HTC Vive
Blood & Truth	Sony London Studio	2019	PlayStationVR
BombSquad	Eric Froemling	2015	Gear VR
Boulevard	WoofbertVR	2015	Gear VR
Breach It	Domas Sabockis	2017	HTC Vive
Budget Cuts	Neat Corporation	2018	HTC Vive
Bullet Train	Epic Games	2016	Oculus Rift
Bullets and More VR: BAM VR	Koenigz	2018	HTC Vive
Calcflow	Nanome	2016	Oculus Rift
Castaway VR	MC Games	2018	HTC Vive
Cerevrum Game	Cerevrum, Inc.	2016	Gear VR
Chroma Lab	Sean Tann	2017	HTC Vive
Cirque du Soleil's Zarkana	Felix and Paul Studios	2015	Gear VR
Cityscape Repairman	Khora ApS	2015	Gear VR
Climbey	Brian Lindenhof	2016	HTC Vive

Coco VR	Magnopus, Walt Disney Studios	2017	Oculus Rift
Colopl VR Garage	COLOPL, Inc.	2017	Oculus Rift
Colosse	ColosseTeam	2015	Gear VR
Contractors	Caveman Studio	2018	HTC Vive
Cosmos Warfare	Artfire Games	2016	Gear VR
Crooked Waters	Craft Game Studio	2018	HTC Vive
Crypt Hunter	Robot Games	2017	HTC Vive
Cyber Cook Taster	Starship (UK) Ltd.	2015	Gear VR
CyubeVR	Stonebrick Studios UG	2018	HTC Vive
Darkest Dungeon	Red Hook Studios	2016	HTC Vive
Dead and Buried	Oculus	2016	Oculus Rift
Dead Hungry	Q-Games Ltd.	2016	HTC Vive
Dead Secret	Robot Invader	2015	Gear VR
Deadeye Dungeon	Flávio Miyamaru	2017	HTC Vive
Demon Blade VR	Monkeys Crowd Entertainment	2017	HTC Vive
Deus Vult	Raptor Lab	2017	HTC Vive
Dim Light	Sanbae	2016	Gear VR
Disney Movies VR	Disney Online	2017	Gear VR
Dispatch	Here Be Dragons, LLC	2017	Oculus Rift
Dodge This VR Demo	IMGNATION Studios	2015	Gear VR
Dreadhalls	White Door Games	2017	HTC Vive
Dreadhalls	White Door Games	2015	Gear VR
Drunkn Bar Fight	The Munky	2016	HTC Vive
Duck Season	Stress Level Zero	2017	HTC Vive
Echo Grotto	Gaugepunk Games	2017	HTC Vive
Echo VR/Echo Combat	Ready At Dawn	2017	Oculus Rift
Element Engine	Seismic Games	2015	Gear VR
Face Your Fears	Turtle Rock Studios	2017	Oculus Rift
Face Your Fears	Turtle Rock Studios	2016	Gear VR
Fallout 4 VR	Bethesda Games Studios	2017	HTC Vive
Fantastic Contraption	Northway Games	2016	HTC Vive
Fantasynth: Chez Nous	HelloEnjoy	2017	Oculus Rift
Farlands	Oculus	2016	Oculus Rift
Farpoint	Impulse Gear	2017	PlayStationVR
FindingVR	The Vision Raiders	2015	Gear VR
Fine China	Fine China Games	2017	HTC Vive
Flappy Arms	Improbable Industries	2018	HTC Vive
Flickr VR	Flickr	2015	Gear VR
From Other Suns	Gunfire Games LLC	2017	Oculus Rift
Front Defense Heroes	Fantahorn Studio	2017	HTC Vive
Frontier VR	Gaugepunk Games	2017	HTC Vive
Fruit Ninja VR	Halfbrick Studios	2016	HTC Vive
Fruit Ninja VR	Halfbrick Studios	2016	PlayStationVR
Furious Seas	Future Immersive	2018	HTC Vive
Ghost In The Shell	Here Be Dragons	2017	Oculus Rift

Google Earth VR	Google Inc.	2017	Oculus Rift
GORN	Free Lives	2017	HTC Vive
GrooVR	Presence Labs	2015	Gear VR
Gunjack	CCPGamesShanghai	2015	Gear VR
Heart of the Emberstone: Coliseum	Cloudhead Games, Ltd.	2017	Oculus Rift
Hehu and the Taniwha	Mohsin Ali	2018	Oculus Rift
Henry	Oculus	2016	Oculus Rift
Herobound Gladiators	Escalation Studios	2016	Gear VR
Herobound: First Steps	Oculus	2015	Gear VR
Herobound: Spirit Champion	Gunfire Games LLC	2015	Gear VR
Hidden Temple: VR Adventure	www.handy-games.com GmbH	2016	Gear VR
Hide N Seek VR	Antoine Rigitano, Serge Sentis	2017	HTC Vive
Hold My Beer	Lord of the Stack	2017	HTC Vive
Hot Dogs, Horseshoes, & Hand Grenades	Rust	2016	HTC Vive
Hover Junkers	Stress Level Zero	2016	HTC Vive
I Expect You to Die	Schell Games	2017	PlayStationVR
Ice Lakes	Iceflake Studios	2016	HTC Vive
im360VR	Immersive Media	2015	Gear VR
Imageen Tarraco VR	Imageen	2015	Gear VR
InDeath	Sólfar Studios	2018	HTC Vive
Into the Dead	PikPok	2015	Gear VR
Introduction to Virtual Reality	Felix & Paul Studios	2016	Oculus Rift
Invasion!	Baobab Studios Inc.	2016	PlayStationVR
IronWolf VR	Ionized Studios	2017	HTC Vive
Island 359	CloudGate Studio, Inc.	2018	HTC Vive
Jake and Tess' Finding Monsters Adventure	Black River Studios	2015	Gear VR
Jet Island	Master Indie	2018	HTC Vive
Job Simulator	Owlchemy Labs	2016	PlayStationVR
Jupiteration	Bartoš Studio s.r.o.	2017	HTC Vive
Jurassic World: Apatosaurus	Felix and Paul Studios	2015	Gear VR
Juventus VR	Juventus FC	2017	Oculus Rift
Keep Talking and Nobody Explodes	Steel Crate Games	2015	Gear VR
KFC The Hard Way	W+K Lodge	2017	Oculus Rift
Knockout League	Grab Games	2018	HTC Vive
L.A. Noire: The VR Case Files	Team Bondi/Rockstar Games	2017	HTC Vive
Land's End	Ustwo Games	2015	Gear VR
Lightblade VR	Andreas Hager Gaming	2016	HTC Vive
Littlstar VR Cinema	Little Star Media Inc.	2017	Oculus Rift
Littlstar VR Cinema	Little Star Media Inc.	2017	PlayStationVR
Littlstar VR Cinema	Little Star Media Inc.	2017	Gear VR
Lone Echo	Ready At Dawn	2017	Oculus Rift
Long March Space Project	Mandrill VR Co., Ltd	2016	Gear VR
Look Both Ways	Stress Level Zero	2015	Gear VR

Lost	Oculus	2016	Oculus Rift
Lunasee	Iridium Studios	2015	Gear VR
Magic Table Chess	Experiment 7	2017	Oculus Rift
Marvel Powers United VR	Sanzaru	2018	Oculus Rift
MasterWorks: Journey Through History	FarBridge	2018	Oculus Rift
Maze Run VR	Vice Age	2017	HTC Vive
Minecraft VR	Mojang AB	2016	Oculus Rift
Minecraf VRt	Mojang AB	2016	Gear VR
Mission: ISS	Magnopus	2017	Oculus Rift
Miyubi	Felix and Paul Studios	2017	Oculus Rift
Moss	Polyarc Games	2018	PlayStationVR
Music box	Unwise Studio	2017	Oculus Rift
Netflix	Netflix	2015	Gear VR
New Retro Arcade Neon	Digital Cybercherries	2016	HTC Vive
Night Drive VR	AntiAnti	2018	HTC Vive
Ocean Rift Demo	Llyr ap Cenydd	2015	Gear VR
Oculus 360 Photos	Oculus	2016	Oculus Rift
Oculus 360 Photos	Oculus	2015	Gear VR
Oculus Arcade	Oculus	2015	Gear VR
Oculus Avatar Editor	Oculus	2015	Gear VR
Oculus Browser	Oculus	2016	Gear VR
Oculus Dreamdeck	Oculus	2016	Oculus Rift
Oculus First Contact	Oculus	2016	Oculus Rift
Oculus Medium	Oculus	2016	Oculus Rift
Oculus Prologue	Oculus	2016	Gear VR
Oculus Rooms	Oculus	2016	Gear VR
Oculus Venues	Oculus	2018	Gear VR
Oculus Video	Oculus Team	2016	Oculus Rift
Oculus Video	Oculus	2015	Gear VR
Offscreen Colonies: VR edition	Conspiracy	2017	Oculus Rift
Onward	Downpour Interactive	2016	HTC Vive
OrbusVR	Orbus Online, LLC	2019	HTC Vive
ORBX Media Player	OTOY Inc.	2015	Gear VR
Orion Trail VR	Schell Games	2015	Gear VR
Pavlov VR	davevillz	2017	HTC Vive
Phantom: Lost	Zebracolor	2018	Oculus Rift
Phone of the Wind	YesPleaseThankYou	2017	Oculus Rift
Pierhead Arcade	Mechabit Ltd.	2016	HTC Vive
Pinball FX2 VR	Zen Studios	2016	PlayStationVR
Pixel Ripped 1989	ARVORE Immersive Games Inc.	2018	HTC Vive
PlayStation VR Demo	Sony Interactive Ent.	2016	PlayStationVR
PolyRunner VR	Lucid Sight, Inc.	2016	Gear VR
ProjectM : Dream	EVR Studio	2017	Oculus Rift
Puzzle Blocks	Ayy Caramba Games	2016	Oculus Rift

Qbike: Cyberpunk Motorcycles	GexagonVR	2017	HTC Vive
Quill	Facebook	2016	Oculus Rift
Raw Data	Survios	2016	HTC Vive
Rec Room	Against Gravity	2016	HTC Vive
Rec Room	Against Gravity	2016	Oculus Rift
Rec Room	Against Gravity	2017	PlayStationVR
RelayCars	RelayCars LLC	2015	Gear VR
Resident Evil &: Biohazard	Capcom	2017	PlayStationVR
Reveries: Dream Flight	Multiverse	2016	Gear VR
Richie's Plank Experience	Richard Eastes, Toni Eastes, Daniel Todorov	2017	HTC Vive
Rick and Morty: Virtual Rick-ality	Owlchemy Labs	2017	HTC Vive
Rilix VR	Rilix	2016	Gear VR
Ripcoil	Sanzaru Games, Inc.	2016	Oculus Rift
Robo Recall	Epic Games	2017	Oculus Rift
Room 202	Play Nicely Ltd	2016	Oculus Rift
Rose	Penrose	2015	Gear VR
Samsung Gallery	Samsung Electronics Co., Ltd	2016	Gear VR
Samsung Internet	Samsung Electronics Co.	2015	Gear VR
Samsung VR: Videos	Samsung Electronics America	2018	Oculus Rift
Samsung VR: Videos	Samsung Electronics	2015	Gear VR
San Base Travel	San Base	2017	Oculus Rift
Scanner Sombre	Introversion Software	2017	HTC Vive
Shadow Legend VR	VitruviusVR	2019	HTC Vive
Sharecare VR	Sharecare, Inc.	2017	Oculus Rift
Shironeko VR Project	COLOPL, Inc.	2015	Gear VR
Shooting Showdown 2 VR	Naquatic LLC	2015	Gear VR
Showdown	Epic Games	2016	Oculus Rift
Silicon Valley: Inside the Hacker Hostel	HBO	2018	Oculus Rift
Sisters: A VR Ghost Story	Otherworld Interactive	2015	Gear VR
Skybox VR Video Player	Skybox Studio	2017	Oculus Rift
Smash Hit	Mediocre	2015	Gear VR
Solitaire Jester	Resolution Games	2015	Gear VR
Solitaire VR by Tripp	Tripp Inc	2016	Oculus Rift
Space Dream VR Demo	Davis3D	2017	Oculus Rift
Space Pirate Trainer	I-Illusions	2016	HTC Vive
Space, VR!	James Nye, Copeland Williams	2016	HTC Vive
Spartan VR	Immergity	2017	HTC Vive
Spheres	Novelab	2018	Oculus Rift
Spider-Man: Homecoming-Virtual Reality Experience	Sony Pictures Virtual Reality	2017	Oculus Rift
Spider-Man: Homecoming–Virtual Reality Experience	Sony Pictures Virtual Reality	2017	PlayStationVR
Sports Bar VR Hangout	Cherry Pop Games	2016	PlayStationVR
Sprint Vector	Survios	2017	HTC Vive

Stand Out: VR Battle Royale	Raptor Lab	2019	HTC Vive
Star Shelter	Overflow	2017	HTC Vive
Star Trek: Bridge Crew	Red Storm Entertainment	2017	HTC Vive
Star Wars Battlefront Rogue One: VR Mission	Criterion Games	2016	PlayStationVR
Stolen Steel VR	Impromptu Games	2017	HTC Vive
Strangers with Patrick Watson	Felix and Paul Studios	2015	Gear VR
Superhot VR	SUPERHOT Team	2017	HTC Vive
Surge	arjanM2	2016	Oculus Rift
Sword Master VR	Master Indie	2016	HTC Vive
Tabletop Simulator	Berserk Games	2016	HTC Vive
Tales of Glory	BlackTale Games	2017	HTC Vive
Temple Run VR	Imangi Studios, LLC	2015	Gear VR
That Dragon, Cancer: I’m Sorry Guys, It’s Not Good	Numinous Games	2016	Gear VR
The Body VR	Moshe Ben-Zacharia	2016	Oculus Rift
The Box	8ninths	2015	Gear VR
The Cavern	Space Paw Studios	2017	HTC Vive
The Elder Scrolls V: Skyrim VR	Bethesda Game Studios	2017	PlayStationVR
The Elder Scrolls V: Skyrim VR	Bethesda Game Studios	2018	HTC Vive
The Forest	Endnight Games Ltd	2018	HTC Vive
The Gallery-Episode 1: Call of the Starseed	Cloudhead Games	2016	HTC Vive
The Gallery-Episode 1: Call of the Starseed	Cloudhead Games	2016	Oculus Rift
The Lab	Valve	2016	HTC Vive
The People's House	Felix and Paul Studios	2017	Oculus Rift
The Playroom VR	SIE Japan Studio	2016	PlayStationVR
The Thrill of the Fight	Ian Fitz	2016	HTC Vive
theBlu	WEVR Inc.	2016	HTC Vive
Theta S VR	XVI Inc.	2015	Gear VR
Tilt Brush	Google	2016	HTC Vive
Titans of Space 2.0	DrashVR LLC	2016	HTC Vive
Tomb of the Golems	GREE, Inc.	2016	Gear VR
Tornuffalo	RealityRig	2016	HTC Vive
Totems In Dreamland	Mandrill VR Co., Ltd	2015	Gear VR
Tower Ascent	KitTheNinja, Ate134, FFTG - Nate	2017	HTC Vive
Toybox	Cloudgine	2016	Oculus Rift
Transition	Mike von Rotz & Joost Jordens	2017	Oculus Rift
Travel VR	Little Maxima LLC	2017	Oculus Rift
Trickster VR: Co-op Dungeon Crawler	Trickster Games	2019	HTC Vive
Ultrawings	Bit Planet Games, LLC	2017	HTC Vive
Undead Development	Masterstrike, LadrikDev	2017	HTC Vive
Unseen Diplomacy	Triangular Pixels	2016	HTC Vive
Until Dawn: Rush of Blood	Supermassive Games	2016	PlayStationVR
Until None Remain VR	D.W.S.	2018	HTC Vive

Vanishing Realms	Indimo Labs LLC	2016	HTC Vive
VeeR: Video and Movie Platform	Velocious Technologies	2017	Oculus Rift
Virtual Desktop	Guy Godin	2016	HTC Vive
Virtual Space	Virtual Space Inc.	2017	Oculus Rift
Virtual Virtual Reality	Tender Claws	2018	Oculus Rift
VRChat	VRChat Inc.	2017	HTC Vive
VRChat	VRChat Inc.	2017	Oculus Rift
VR Dungeon Knight	Blackjard Softworks	2017	HTC Vive
VR Karts: Sprint	Viewpoint Games Ltd	2015	Gear VR
VR Regatta	MarineVerse	2016	HTC Vive
VRMultigames	Mad Triangles	2016	Oculus Rift
VRZ Torment	StormBringer Studios	2016	HTC Vive
vTime XR	vTime Limited	2015	Gear VR
War Dust	raptor lab	2017	HTC Vive
We Come in Peace….	headgear	2015	Gear VR
Werewolves Within	Red Storm Entertainment	2016	HTC Vive
When We Land	Phenomena Labs INC	2016	Gear VR
Windlands	Psytec Games	2016	PlayStationVR
Windlands 2	Psytec Games	2018	Oculus Rift
Within	Within	2015	Gear VR
Wonderful You	BDH Immersive	2017	Oculus Rift
Wrench: Engine Building Demo	Missing Digit	2018	Oculus Rift
YouTube 360	Google Inc.	2017	PlayStationVR