

Virtual Reality and the Clinic: An Ethnographic Study of the Computer Assisted
Rehabilitation Environment
(The CAREN Research Study)

by

Karen-Marie Elah Perry
M.A. Simon Fraser University, 2010
B.A. Simon Fraser University, 2006

A Dissertation
Submitted in Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY

in the Department of Anthropology

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University of Victoria

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Abstract

At the Ottawa Hospital in Ontario, Canada, clinicians use full body immersion virtual reality to treat a variety of health conditions, including: traumatic brain injuries, post-traumatic stress disorder, acquired brain injuries, complex regional pain syndrome, spinal cord injuries, Guillain-Barré syndrome, and lower limb amputations. The system is shared between military and civilian patient populations. Viewed by clinicians and the system's designers as a value neutral medical technology, clinical virtual reality's sights, sounds, movements, and smells reveal cultural assumptions about universal patient experiences. In this dissertation I draw from reflexive feminist research methodologies, visual anthropology and sensory ethnography in a hospital to centre the body in current debates about digital accessibility in the 21st Century. 40 in-depth interviews with practitioners and patients, 210 clinical observations, and film and photography ground research participant experiences in day-to-day understandings of virtual reality at the hospital. In this dissertation I address an ongoing absence of the body as a site of analytical attention in anthropological studies of virtual reality. While much literature in the social sciences situates virtual reality as a 'post-human' technology, I argue that virtual reality treatments are always experienced, resisted and interpreted through diverse body schemata. Furthermore, virtual reality cannot be decoupled from the sensitivities, socialities and politics of particular bodies in particular places and times. The Ottawa Hospital's Computer Assisted Rehabilitation Environment (CAREN) system features a digitally enhanced walk-in chamber, treadmills on hydraulic pistons, surround sound audio, advanced graphics and user feedback utilizing force plates and a dynamic infrared motion capture system. The CAREN system utilizes hardware and software reliant on specific assumptions about human bodies. For example, these assumptions are echoed in depictions of race, gender, class, and indigeneity. Patients using virtual reality technologies can experience more than one disability or health condition at a time, further disrupting the idea of universal user experiences. As clinicians and patients confront the limitations of body normativity in the CAREN system's interface design, they improvise, resist, and experience virtual reality in ways that defy design agendas, ultimately shaping patient treatments and unique paths to healing and health.

TABLE OF CONTENTS

SUPERVISORY COMMITTEE	ii
ABSTRACT	iii
TABLE OF CONTENTS	iv
LIST OF FIGURES	vi
LIST OF TABLES	vii
DEDICATION	viii
ACKNOWLEDGEMENTS	ix
INTRODUCTION TO THE RESEARCH PROBLEM: CHAPTER ONE	1
STATEMENT OF THE RESEARCH PROBLEM	4
RESEARCH QUESTIONS	5
RATIONALE FOR STUDY	7
RATIONALE FOR SENSORY ETHNOGRAPHY	8
GUIDING CONCEPTUAL FRAMEWORKS AND KEY THEORETICAL ORIENTATIONS	9
DISCUSSION	23
STRUCTURE OF DISSERTATION	24
LITERATURE REVIEW: CHAPTER TWO	28
ANTHROPOLOGICAL ACCOUNTS OF THE BODY AND VIRTUAL REALITY	28
MULTI-SENSORY RESEARCH ON VIRTUAL REALITY	35
DISCUSSION	40
METHODOLOGY: CHAPTER THREE	43
INTRODUCING THE CAREN SYSTEM	43
STUDY GROUPS	49
RECRUITMENT AND ELIGIBILITY	51
DATA COLLECTION	51
FIELDSITE	58
DATA ANALYSIS	66
ETHNOGRAPHIC ETHICS AND PRACTITIONER ENGAGEMENT	68
RESEARCH DISSEMINATION	78
STUDY LIMITATIONS	79
CONCLUSION	80
MOVEMENT: CHAPTER FOUR	82
PREPARING TO MOVE	83
FUTURE MEDICINE NOW	93
CLINICAL STRATEGIES	100
WHEN VIDEO GAMES BECOME MEDICINE	107
LEARNING TO MOVE IN MULTISENSORY VIRTUAL REALITY	112
AFTER EFFECTS	117
CONCLUSION	122
PERSPECTIVE: CHAPTER FIVE	123
SENSATION, MEDICINE AND VIRTUAL REALITY	124
BODYSCAPES AND ESSENTIALIZED BODIES IN MEDICINE	125
LIVING WITH PAINS AND DISABILITIES	126
EMOTION AND THE MACHINE	138

HUMAN CREATIVITY, CONFRONTING THE INTERFACE.....	149
CONCLUSION	150
REPRESENTATION: CHAPTER SIX.....	152
ADVERTISING	153
REPRESENTATIONS OF WAR TRAUMA	160
DISRUPTIVE BODIES	173
THE SIMULACRA.....	184
CONCLUSION	189
SIGNIFICANCE OF RESEARCH: CHAPTER SEVEN	190
VIRTUAL REALITY AND POWER.....	191
EMBODIED RESEARCH AS RESISTANCE.....	193
PERSPECTIVE(S) ON VIRTUAL REALIT(IES)	195
UNSETTLING SENSATIONS.....	197
TOWARDS MULTISENSORY BODYSCAPES.....	199
SENSITIZING PATIENTS TO VIRTUAL REALITY.....	200
EMBODIED METHODOLOGIES IN DISEMBODIED CYBERSPACES	201
TROUBLING ‘THE’ INTERFACE.....	202
FROM HERE TO THERE	205
BIBLIOGRAPHY	208
APPENDICES	245
Appendix A: Semi-Structured Interviews with CAREN Patients	245
Appendix B: Semi-Structured Interviews with CAREN Practitioners.....	246

LIST OF FIGURES

Figure 1: The Ethnographer Entering the CAREN System.....	1
Figure 2: Standardized Dimensions of the Body in CAREN Interface Design.....	5
Figure 3: The Ottawa Hospital's CAREN System.....	45
Figure 4: Ethnographer in "the Pit" Beneath the System	46
Figure 5: Close-Up of System Hydraulics.....	46
Figure 6: Close-Up of the Curved Screen from Below	47
Figure 7: Motion Capture Devices (Foreground/Background)	47
Figure 8: Platform and Dual Treadmills Where the Force Plates are also Located	47
Figure 9: System Projectors and Motion Capture Devices Mounted Above the System..	48
Figure 10: CAREN Technician's Station Behind the Machine	49
Figure 11: The Ottawa Hospital's Virtual Reality Lab.....	58
Figure 12: Hospital ID.....	59
Figure 13: CAREN System Body Markers for Tracking Patient Movements	59
Figure 14: Screen Capture of Reproduction of the Ethnographer's Skeleton.....	60
Figure 15: Research Dissemination Process.....	78
Figure 16: Paddleboard Application with Kayak Paddle and Resistance Bands	85
Figure 17: The CAREN System as Futuristic Healthcare	94
Figure 18: Ethnographer Photo.....	97
Figure 19: Science Fiction Aesthetics and Clinical Virtual Reality	97
Figure 20: Therapeutic Robots	98
Figure 21: Figures from Clinical Observations	100
Figure 22: The Train Application.....	108
Figure 23: Breakout Application Modeled After Pong (Atari 1972)	111
Figure 24: Alternative V Shaped Harness Configuration to Avoid Sensory "Cheating"	115
Figure 25: Optokinetic Stimulation	120
Figure 26: Rope Bridge with Fire and Lava Additions for a Firefighter's PTSD.....	135
Figure 27: CAREN'S Nooselike Harness Ropes	146
Figure 28: A Trio of Seagulls Appears in the MM Boat Application	147
Figure 29: MM City Ride Application	154
Figure 30: 3MDR PTSD Escalation Phase.....	162
Figure 31: 3MDR PTSD Trauma Exposure	163
Figure 32: 3MDR PTSD De-escalation Phase	163
Figure 33: Eye Movement Desensitization and Reprocessing Therapy in 3MDR.....	166
Figure 34: The CAREN System Rifle	170
Figure 35: 3MDR's Spaceship Like Corridors	172
Figure 36: Racist Sports Team Logos in Clinical Virtual Reality.....	177
Figure 37: Decorating a Christmas Tree as Physiotherapy in MM Christmas 2011	178
Figure 38: "European Woman," "Asian Woman," and "African Woman" Templates....	180
Figure 39: "European Man," "Asian Man," and "African Man" Templates.....	180
Figure 40: A Walk by Ottawa's Virtual Parliament Buildings	184
Figure 41: The Park Application	187

LIST OF TABLES

Table 1: 40 Qualitative Interviews	52
Table 2: Primary Reason for CAREN Clinical Use	56
Table 3: Examples of Patient Accommodations.....	132

DEDICATION

To my wife Andrina Perry.

“The learning process is something you can incite, literally incite, like a riot.”
- Audre Lorde

ACKNOWLEDGEMENTS

This research was conducted on the traditional unceded and unsundered territories of the Algonquin Anishnaabeg Peoples. However, it takes so much more than an acknowledgement to enact change. It takes the clarity and courage to recognize our own role in ongoing systems of colonization and to push for change, especially when it is difficult to do so.

I would like to thank the practitioners and patients at the Ottawa Hospital, without whom my work would not have been possible. A special thank you to Dorothyann Curran, Courtney Bridgewater and Sandy MacLeod. By working across disciplinary boundaries we can improve healthcare.

Thank you to Dr. Lisa Mitchell, Dr. Arthur Kroker and Dr. Alexandrine Boudreault-Fournier for the guidance throughout the PhD process. It's done!

Thank you to Dr. Sarah Wright Cardinal. You know too well that statistics look tidy on paper but that there is no greater joy than foiling statistics. We exist and persist. Marginality can bring unique strengths.

I would like to thank Lily Crist and Dr. Eric Spalding for assistance with French translation for the project. Thank you Chelsea Maija, Suzie Dunn, and Rika Moorhouse for help with living arrangements and logistics surrounding the move to Ottawa. Dr. Françoise Claire Guigné and Arun Andre Pant, thank you for making Ottawa feel like home.

To Marcy Cohen, Susan Pinkus, Ana Policzer, Leila Bell, Avril Orloff, Zev Tiefenbach and Mia Brooks, thank you for the morale boosting visits back home in East Van. This kept me going.

חזק חזק ונתחזק

To Ted Perry and Corinne Perry, thank you for your unwavering support of our family's attempt to do two graduate degrees at once. We did it!

Thank you to Maëve Leduc for being the ultimate research assistant and Leah Handler for the transcription services.

Finally, a big thank you to baristas Naomi Amren and Kat Beckwith at Turk's Coffee House, my favourite place to write on Commercial Drive.

This dissertation would not have been written without the love and support of my family (particularly Andrina Perry) and East Van community.

INTRODUCTION TO THE RESEARCH PROBLEM: CHAPTER ONE

Figure 1: The Ethnographer Entering the CAREN System



When I first saw the machine I didn't know what to think. As an ethnographer should I consider the Computer Assisted Rehabilitation Environment (CAREN) a video game or medicine, a technology or a place? With over forty digital environments for patients to use as part of their treatments, I wanted to know what kinds of worlds they occupied and how they felt about it. Elves, robots, and UFOs; oceans, cityscapes, forests and games; hissing pistons and roaring treadmills; blinking green lights; the sharp smell of copper wire – all flood the senses with awareness this is not a typical hospital experience. Reporters compare encountering the CAREN system to entering a spaceship (Parry 2015). In the Virtual Reality Lab, movements, perspectives and representations are carefully crafted to meet clinical needs. However, they are also built on assumptions about humans, how they look, how they feel, and what they should or should not do.

In Canada today digital interfaces have grown increasingly immersive. 3D visors, treadmills, domed screens, and tracking devices that project user images into responsive interactive worlds provide new opportunities for experiencing digital technologies.

Within these diverse digital interfaces, virtual reality refers to the “computer graphics creation of an environment that allows its participants to physically enter within and interact by moving around or changing some aspect of that electronic environment” (Brill 1993: q). Virtual reality is not one technology; rather, it represents a diversity of applications.

Early virtual reality techniques were relatively limited in their ability to perceptually envelope users. The ‘hype’ often outweighed the effectiveness of associated applications to engage the senses (Sutcliffe 2003: 2). However, advanced electronic techniques have created the ability to change the user’s feeling of textures, to center user movement along lateral, vertical, and longitudinal axes, and they feature enhanced graphics and haptics (Bau et al. 2013; Motek Medical 2015). Sight, sound, touch, smell, and sensations of balance, acceleration and kinetics are heightened in emerging interfaces. As these technologies have grown more immersive, their applications have proliferated. For example, immersive virtual reality applications are being standardized in mining, health care, education, communications, architecture, gaming and commerce in many Canadian urban centers (Government of British Columbia 2012; Government of Ontario 2012; Government of Quebec 2012; Government of Saskatchewan 2006; National Research Council Canada 2009; Nova Scotia Research and Innovation Trust 2012). Declining costs and accelerated developments in computing have impacted the current uptake of these technologies (Gallace et al. 2012). Within applied contexts the healthcare sector has been particularly responsive to immersive virtual reality for physiotherapy, psychotherapy, and the education of medical professionals. For example, Canada’s most advanced virtual reality systems featuring walk in digital chambers,

responsive treadmills, and surround sound systems are found in rehabilitation hospitals and at the University of Quebec's Cyber-Psychology Laboratory (Alberta Health Services 2011; Cyber-psychology Lab of the University of Quebec 2014; Ottawa Hospital 2014a). The Government of Canada has invested millions in funding for virtual reality technologies targeting healthcare (Government of Canada 2014).

As these technologies have grown more pervasive they have reshaped our relationship to the human body, while remaining firmly rooted in corporeal assumptions of the past (Csordas 2002). Furthermore, access to digital technologies continues to be mediated by social inequalities (Kroker and Weinstein 1994; Haraway 1997). Critically, virtual reality technologies account for some bodies at the expense of others. This is not just a question of who has access to new technologies and why, but whose bodies are depicted and accommodated perceptually in immersive digital applications.

Exclusion can be a multi-sensory experience. Applied studies on immersive virtual reality reveal a startlingly flattened corporeal plane offered to users. Disabilities are accommodated, but there are no representations of persons with disabilities. Gender is invoked, but with no space for Queer and Trans identities.¹ People of Colour² occupy the margins of digital representation and the aesthetics of class betray a focus on Middle Class digital worlds, as if mimicking the very environments where virtual reality applications are created. We do not yet know the full implications of the perceptual shift in virtual reality and its relationship to social inequality. To date the type of bodies

¹ "Queer" is a pejorative term that has been reclaimed in Canada and refers to a spectrum of people who do not conform to dominant understandings of gender and sexuality. "Trans" refers to transgender, encompassing people who do not identify with the sex they were assigned at birth. This can be both binary (i.e. assigned male at birth now identifies as female) and non-binary (i.e. identifies somewhere in between male and female or experiences identity as fluid).

² Anti-racist action groups often use this term in Canada to refer to people who are racialized. For example, the University of Victoria's Students of Colour Collective.

evident in applied virtual reality applications are relatively homogenous. This study explores that phenomenon.

Anthropology, including sensory ethnography, is uniquely situated to address corporeal normativity and new technologies. For over three decades, anthropologists have produced robust ethnographic explorations of techno-science. From accounts of fetal ultrasound imaging (Mitchell 2001) to day-to-day life in digital worlds (Boellstorff 2008) and brains scans and biomedical identity (Dumit 2004), these studies offer unique insights into technology's role in reshaping, and perpetuating, corporeal norms. Less explored in anthropology has been the question of multi-sensory perception, digital technologies, and corporeal norms. For example, the perspectives, movements and representations of the human form offered to virtual reality users reflect social values. Sensory ethnography has the capacity to draw attention to these features in its "rethinking" of "ethnography through the senses" (Pink 2009: 5). Further, anthropologist Thomas Csordas (1997) has explicitly called for embodied accounts of virtual reality. Much of the literature to date has focused on vision and virtual reality, not the multi-sensory features of digital interfaces. Drawing from sensory ethnography, this study, therefore, addresses several critical gaps in the literature.

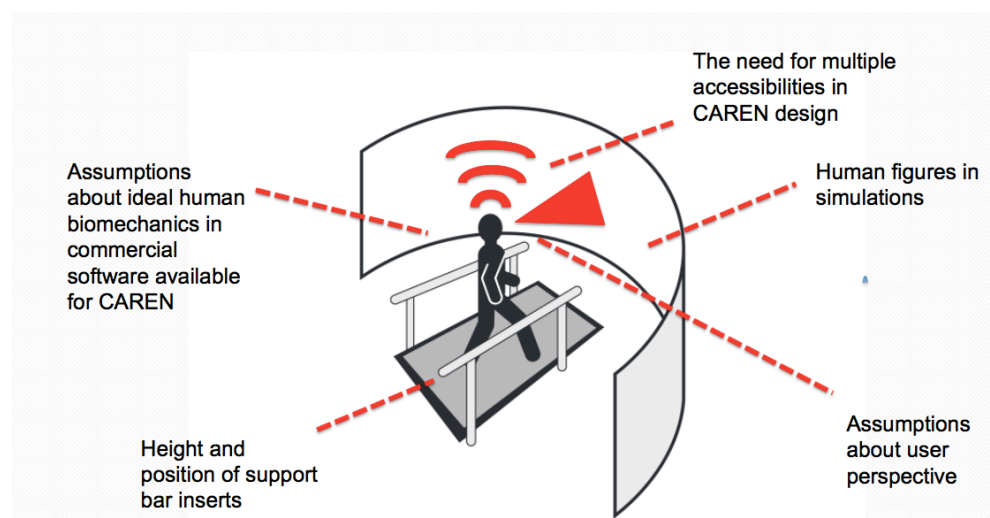
STATEMENT OF THE RESEARCH PROBLEM

From "user-friendly" touch screen interfaces (Fernandes 2011: 35) to the "World Wide Web" (Berners-Lee et al. 1992: 52), new technologies invite us to consider a world of democratized digital spaces. However, the discourse of digital accessibility obscures ongoing inequalities tied to emerging technologies, this has implications not only in terms of direct access to digital technologies, but also in terms of who is represented and

accommodated in digital interfaces. Currently, a startlingly flattened corporeal plane is offered to users in applied virtual reality. Associated perspectives, movements and representations of the human form reflect a limited conceptualization of the body, a conceptualization that has little in common with the diverse bodies and nuanced identities people occupy in their day-to-day lives. Given the increasing standardization of immersive virtual reality in applied Canadian medical contexts, and calls for anthropological studies of virtual reality that address embodied experiences of virtual reality, it is necessary to expand the scope of anthropological research on digital technologies. Applied research on multi-sensory virtual reality also draws a strong connection between user identification and efficacy, further highlighting the need for this work.

RESEARCH QUESTIONS

Figure 2: Standardized Dimensions of the Body in CAREN Interface Design



This study addresses the central research question: *in what ways is virtual reality based on assumptions about the normative body?* The CAREN system features a digitally enhanced walk-in chamber, treadmills on hydraulic pistons, surround sound audio, advanced graphics and user feedback utilizing force plates and a dynamic infrared motion capture system. Like other virtual reality technologies, the CAREN system utilizes hardware and software reliant on specific assumptions about human bodies. Through mixed qualitative methods, including photography, film, clinical observations and patient and practitioner interviews, I will address several sub-questions. *During the use of the CAREN system, what assumptions are made about movement?* For example, CAREN use can be limited by impaired neck movement and the height of CAREN side support bars is fixed. Adjustable bars would better facilitate more diverse body types. *What assumptions are made about perspective, or how the user can see, hear and feel?* For example, users may experience multiple disabilities at the same time. A concussive blast resulting in traumatic amputation of a leg can also result in associated deafness. CAREN clinical techniques are modified for deaf patients seeking physiotherapy services. Finally, *what assumptions guide the creation of human representations and associated digital environments in the CAREN system?* Previous research has shown that human bodies depicted in digital environments are often highly skewed, either lacking diversity altogether or relaying on racist and sexist tropes (Leonard 2006: 83-88). Commercial software available for the CAREN system, documenting joint rotation, posture and muscle changes, is also based largely on the biometrics of bodies without disabilities.

RATIONALE FOR STUDY

This sensory ethnography is an important contribution to research for several key reasons. First, the study draws attention to exclusion as a multi-sensory experience. While researchers have investigated power, the body, sensation and experiences of class (Rhys-Taylor 2010), gender (Pink 2004) and colonization (Trnka, Dureau and Park 2013), broader theorizing addressing exclusion and sensation is lacking in sensory ethnography. Second, this study pulls intersectional approaches to the body into accounts of immersive digital technologies and sensory ethnography. Intersectional approaches are well suited to examining the multiple accessibilities and exclusions that mark digital technologies in the 21st century. Bodies are hardly as ‘flattened’ as they appear in current representational practices; rather, people occupy multiple social worlds and identities. These experiences are also shaped by imbalances of power. This not only has implications for a critical anthropology of techno-science, but also healthcare practitioners engaged in anti-oppressive work in the clinic. Psychologists and IT specialists working in applied contexts also emphasize that user identification is an important feature of virtual reality efficacy (Takatalo et al. 2008). Third, a related point is that there is an ongoing disconnect between the social sciences and computer scientists and healthcare practitioners actively working with immersive virtual reality. This study undertakes important bridgework. Forth, there are currently calls in anthropology for embodied accounts of virtual reality. This study addresses that gap. It shifts the current ethnographic focus on visualization and virtual reality to perception and multi-sensory experience.

RATIONALE FOR SENSORY ETHNOGRAPHY

Sensory ethnography challenges researchers to remain attentive to multiple sensory modalities (Pink 2009). This has clear benefits in a study centered on the CAREN system, as it encompasses technologies fixated on sensory immersion drawing from a variety of hardware and software set-ups. More broadly, ethnography and the anthropology of embodiment emphasize participant experiences and the relationship of those experiences to broader social values. In anthropology the body and culture are inseparable, the body is interwoven in social practices, corporeal politics and unique individual experiences, multi-sensory and otherwise (Scheper-Hughes and Lock 1987). Narrative based inquiry in conjunction with multi-sensory focused participant observation has the capacity to elucidate the complex ways corporeal norms are experienced, resisted and reproduced. The project's multi-sensory research methods also benefit from photography and film. Photography and film are utilized with an unconventional focus on kinetics and perspective. For example, attention to multiple points of view in camera positioning help the researcher to examine corporeal assumptions CAREN applications make in relationship to user perspective. An emphasis will also be placed on kinetics and movement. Although poorly explored in video ethnography, sight not only bespeaks vision, but it is also a modality of demonstrating movement. For example, a camera can help capture an impression of jarring application movements along lateral, vertical, and longitudinal axes.

GUIDING CONCEPTUAL FRAMEWORKS AND KEY THEORETICAL ORIENTATIONS

This section provides advanced discussion of guiding concepts and key theoretical orientations adopted in my research. It demonstrates how and why the question of immersive virtual reality and corporeal normativity is important. Furthermore, it situates the study within broader theorizing on digital technologies and society, specifically through discussion of digital accessibilities. It highlights the importance of drawing intersectional theorizing on the body into embodied accounts of virtual reality and concludes with discussion of Louis Brill's (1993, 1994a, 1994b, 1994c, 1995) relational typology of virtual reality and multi-sensory interfaces. Critical concepts such as Immersive First Person (IFP), Through the Window (TW), and Mirror World (MW) virtual reality techniques are elucidated, not as authoritative definitions but in terms of how these concepts draw attention to embodiment and virtual reality.

Digital Exclusion

This section explores how a pervasive emphasis on accessibility obscures features of digital life that remain grounded in exclusionary practices. Whether through a limited ability to directly access virtual reality technologies or the corporeal normativity virtual reality reflects, inequalities persist. I explore how exclusion can be a multi-sensory experience and discuss the implications for a sensory ethnography of immersive virtual reality technologies. Tellingly, both sensory ethnography and the anthropology of virtual reality have neglected to account for embodied, multi-sensory experiences of corporeal exclusions in digital scapes.

Unsettling Digital Accessibility

New technologies invite us to consider a world of democratized digital spaces. From “user-friendly” multi-touch screen interfaces (Fernandes 2011: 35), to the “World Wide Web” (Berners-Lee et al. 1992: 52) and “telehealth” at a distance (Koch 2006: 565), accessibility is considered the hallmark of digital design in the 21st Century. It is a world that invokes few geographic boundaries, easy ergonomics and educational, gaming and therapeutic environments that cater to individuals. Yet, inaccessibilities persist. For example, 50% of the global population does not have access to the Internet, despite the myth of the World Wide Web (Kemp 2017) and while the majority of the global population speaks a dialect of Chinese as a first language (Simons and Fennig 2017), the majority of websites are in English (W3Techs 2017). Access to digital scapes is powerfully mediated by socio-economics and proximity. Other forms of exclusions and inclusions are shaped by the way bodies are perceived and encoded into hardware and software options, specifically in the movements, representations and perspectives offered to users.

The pervasive emphasis on accessibility obscures features of digital life that remain grounded in structural inequalities and corporeal assumptions. Like other multi-sensory experiences immersive virtual reality represents an “intricate dialectic between lived experience, ideological formations and political forces within which normative ideologies naturalize particular forms of belonging” (Trnka, Dureau and Park 2013: 1). Digital scholars have also critiqued the technological fetishism inherent in popular narratives of virtual reality since the 1980s (Kroker and Weinstein 1994; Haraway 1997).

Digital Technologies and Exclusion as a Multi-Sensory Experience

Exclusion can be a multi-sensory experience. Yasmin Gunaratnam emphasizes that a “multi-sensory orientation” in research “can uncover often hidden relationships of power” (2008: 113). Early sensory ethnography remained preoccupied with documenting diverse schemata for categorizations of the senses that vary cross-culturally (Classen 1997). More recently, sensory ethnography has turned to questions of power in studies of class (Rhys-Taylor 2010), gender (Pink 2004) and colonization (Trnka, Dureau and Park 2013). However, the question of multi-sensory exclusion has been more implicit than explicit as a decisive line of theoretical inquiry in sensory ethnography. Furthermore, multi-sensory studies of digital technologies by anthropologists have only just begun to emerge. For example, Sarah Pink’s second edition of *Doing Sensory Ethnography* (2015) includes an expanded chapter on digital technologies. Anthropologists have also indicated that embodied accounts of virtual reality are lacking (Csordas 2002). The question of how emerging multi-sensory digital interfaces include some bodies while excluding others remains an open question in anthropology today, at least in terms of embodied accounts of these processes attentive to multi-sensory frameworks. As this study demonstrates, this is also a salient question for practitioners and developers invested in virtual reality.

This study is based on the premise that technologies are always socially contingent (Rapp 2000; Mitchell 2001; Lock 2002; Dumit 2004). It works to disrupt the discourse of digital accessibility because it obscures persistent exclusions. True to a basis in intersectional approaches to the body, the need for practitioners and theorists to remain attentive to accessibilit(ies) is also emphasized. As this study’s literature review

demonstrates, applied virtual reality techniques have flattened the body. For example, in many applied virtual worlds one may be disabled, but not a queer woman of colour at the same time. The corporeal planes presented to users are relatively homogenous. Why should practitioners care? Because even within their own studies user identification with application content has been linked to more effective outcomes in applied contexts. Anti-oppressive approaches to healthcare also call for nuanced accounts of patient experiences and representational practices in medicine.

Intersectional Approaches to ‘the Body’

There is a growing acknowledgement in research that human beings do not experience their bodies or identities in one-dimensional ways. Individuals seeking physical rehabilitation in a CAREN system, for example, may be dealing with more than one disability. The concussive blast resulting in traumatic amputation of a leg can also result in associated deafness. It is also possible to be both a woman and working class. These intersections have a bearing on our experiences of the world, ourselves, and our bodies. Anthropologists also study these distinctions as categories of social significance (Boellstorff 2007). In this sense, there is a strong interplay between culture, identity and sociality (Scheper-Hughes and Lock 1987).

Today many ethnographers explicitly work against reification of ‘the body,’ tracing complexities and multi-vocal accounts of experience (Myers & Dumit 2011: 246). Anthropology’s tendency towards multi-vocality sits well with intersectional approaches to research (McCall 2005: 1778-1782). More specifically, “intersectional” approaches to the body accomplish two things in this study (Crenshaw 1989). First, they draw attention to the impossibility of reducing human “lives to single characteristics” (Hankivsky et. al.

2012: 17). Second, they push researchers to consider multiple levels of exclusion and how exclusions operate in complex and overlapping ways (Varcoe et al. 2011).

As an activist and researcher I acknowledge the way ethnography itself is a situated practice, mediated by each ethnographer's own sense of embodiment, identity and social location (Fischer 2003). Reflexive approaches to fieldwork and sensory ethnography make no claims to authoritative power (Cole and Phillips 1996); rather, "partial and situated" perspectives disrupt the idea of value neutral practice even in anthropology itself (Haraway 1997: 121). Here the intersections of my own life shape the way I experience fieldwork, relationships with my research participants, and clinical virtual reality as a topic of study. Personal narratives enrich debates in the social sciences, medical ethics and social theory (Fischer 2003): what are ethnographers but also people being-in-the-world in all its contestation, nodes of power and liveliness? By giving voice to silences I hope to explore the CAREN system in a more robust and enlivened way – this includes silences that mark my own experiences as an ethnographer during fieldwork. Multisensory approaches to ethnographic research integrate anthropologist's own sensory experiences into research (Pink 2009). My own stories also highlight the relationship of multisensory virtual reality to broader structures of power.

The Legacy of Kimberle Crenshaw

As a paradigm for research and community organizing, intersectionality arose in response to some of the more problematic aspects of identity politics of the 1980s and 90s that disregarded boundary crossing, fluidity and membership in multiple social worlds (Grzanka 2014). Intersectional approaches also emerged in response to dominant practices that have historically flattened difference within and between social groups

(Grzanka 2014). Coined in 1989, by lawyer, activist and scholar Kimberle Crenshaw (1989), intersectionality was first used within the context of examining feminist theorizing and the law. Specifically, Crenshaw calls attention to the “multi-dimensionality of Black women's experience” and how a “single-axis framework distorts these experiences” (1989: 139). For example, socio-economic conditions and sexuality converge with gender and the politics of race in the United States, shaping women’s experiences of the court system (1989: 59-64). Scholars have attempted to operationalize intersectionality in practice, turning to intersectional frameworks for guidance in social work (Murphy et al. 2009), psychology (Cole 2009), the law (Crenshaw 1989), policy development and healthcare (Hankivsky et al. 2012). Queer theorizing, subaltern studies, indigenous methodologies, and critical race theory have all taken up intersectionality, further broadening multi-dimensional accounts of identity in research (Grzanka 2014).

Intersectional Approaches to Embodiment

Paula Villa (2009) notes “intersectionality comes in handy when trying to grapple with the complexity of embodiment.” Little research exists on multi-sensory experience and intersectionality; however, intersectional frameworks have the potential to elucidate the complex ways bodies are included and excluded through subtle and overt assumptions about the body. Understanding ‘accessibility’ itself through a pluralistic lens also draws attention to the importance of multiple accessibilities. For example, virtual reality technologies that provide physiotherapy can accommodate people with neurological disabilities, while fostering other exclusions. If these applications erase racialized and working class bodies, as applied therapeutic applications often do, they fix perspective and the body to very particular ideals. Assumptions, in this sense, are made about those

with neurological disabilities and who exactly is utilizing the technology. This tendency to ‘flatten’ the identities of people with disabilities is also tied to a long history of generalization and paternalism (Frank 2000; Garland-Thomson 2005). There are risks associated with privileging some bodies at the expense of others or assuming that inequalities are mutually exclusive (Ferree 2009).

Resistance

Resistance has preoccupied scholars invested in intersectional approaches to research (Hankivsky et al. 2012: 18). Anthropologists and critical theorists emphasize that it is not enough to map corporeal normativity (Scheper-Hughes and Lock 1987; Butler 1990). The dynamic ways people make sense of their bodies and their cultural-environments is important. In Canada, we do not know how users experience immersive virtual reality’s representations, movements and perspectives because we have not asked, at least not from the standpoint of sensory anthropology. In her original characterization of intersectional theory, Crenshaw (1989) pushes against ‘top down’ approaches to the body as a simple conduit of social norms, emphasizing that this only serves to reproduce the status quo. James Scott (1990) emphasizes the diverse ways bodies can resist norms, even while cultivating an agreeable appearance. Lila Abu-Lughod (1990) also cautions scholars to remain attentive to the oversimplification of resistance, calling for researchers to document how diverse forms of resistance reflect shifting forms of power over time. When it comes to the CAREN system it is important to remain open to user agency. Corporeal norms may be evident in CAREN application content; however, we do not know what users do with that, how they may resist, respond, ignore or re-write social meanings making the CAREN system their own.

Louis Brill's Relational Typology of Virtual Reality and Multi-Sensory Interfaces

Defining virtual reality is not a simple task. Scholars have offered definitions of virtual reality ranging from on-line interactive multi-player worlds (Schaap 2002), to enclosed 'pods' featuring walk-in digital applications (Myers and Dumit 2011). This study remains focused on the CAREN system, an immersive digital technology that augments digital experiences by offering users more than just a desktop, monitor and mouse. Virtual reality is not homogenous in its outcome or in its enrolment of the human body. Different interfaces also feature different vehicles for corporeal normativity. This section provides a brief overview of the concept of virtual reality. Furthermore, it provides discussion of encumbered versus unencumbered interfaces and the salience of user perspective. Immersive First Person (IFP), Through the Window (TW), and Mirror World (MW) techniques will also be discussed in more detail and in relationship to Louis Brill's relational typology of virtual reality and multi-sensory interfaces. These discussions are important to my study in that they not only provide a conceptual framework for virtual reality itself, but also draw attention to shifts in corporeal assumptions inherent in different interfaces.

Virtual Reality

Various definitions of virtual reality have been put forward. Critically the term was coined by digital researcher Jaron Lanier (1988) to refer to the immersive digital technologies that utilized bodysuits, visors, and gloves (Krueger 1991; Schroeder 1993). It is difficult to trace a definitive history of virtual reality, as precursors to today's technologies emerged in waves throughout the 1960s, 1970s and 1980s from a variety of sources, but particularly the military, corporate and arts sectors (Lanier 1988; Krueger

1991; Gray and Driscoll 1992). Museums were also some of the first institutions to adopt virtual reality installations open to the public throughout the late 1980s and early 1990s (Brill 1994b, 1994c, 1995). While many researchers have focused on the physically immersive features of virtual reality (Lanier 1988), others have emphasized networked digital community as a form of social immersion representative of virtual reality (Schaap 2002). Prior to the popularization of the Internet it was often the social features of installations such as the *Networked Virtual Art Museum* (Loeffler 1992) that captivated “virtual reality” users in their ability to interact digitally with others located off site.

Further complicating virtual reality is interchangeable use of other related terms. For example, Myron Krueger’s “artificial reality” (1991) or “digital worlds” (Boellstorff 2008) and “digital environments” (Hill and Hannafin 2001) have also been utilized. “Augmented reality” has grown in use, sometimes positioned as a type of virtual reality (McLellan 1996: 464), at other times seen as a radical departure from virtual reality technologies in its capacity for digital graphic overlays in user’s day-to-day environments (Graham, Zook and Boulton 2012: 476). Local and regional conventions of course also shape use of terms. Louis Brill suggests researchers should remain attentive to the “breadth and width” of immersive digital experiences and to the diversity of virtual reality interfaces (1994a: 30-31). For the purposes of this study, virtual reality is defined as the “computer graphics creation of an environment that allows its participants to physically enter within and interact by moving around or changing some aspect of that electronic environment” (Brill 1993: q). Brill’s framework for virtual reality and associated sub-classifications is useful, largely because his work draws attention to the ways bodies are positioned in diverse digital interfaces. Here, Brill fosters a framework

that allows anthropologists to examine the question of digital technologies, exclusion and the body attentive to multi-sensory interfaces.

In identifying an operating definition of virtual reality this study benefits from the work of Louis Brill (1993, 1994a, 1994b, 1994c, 1995). In the early 1990s Brill developed a framework for thinking about the diverse digital interfaces that were beginning to emerge in the high tech sector. His work remains valuable, not so much as it provides an authoritative definition of virtual reality, but in terms of how his work draws attention to the diverse ways bodies are accommodated in digital interfaces. His typology of virtual reality is relational, emphasizing perception and the dynamic interaction between users and their digital environments. Brill remains attentive to both hardware and software and how different configurations of virtual reality shape perception and user experiences in unique ways. Three variations of Brill's virtual reality interfaces have particular salience for this study in that they have been standardized in applied Canadian medical contexts: 1) Immersive First Person, 2) Through the Window, and 3) Mirror World techniques (1993, 1994a; McLellan 1996).

Encumbered and Unencumbered Virtual Reality and Point of View

First, Brill discusses the idea of encumbered and unencumbered virtual reality technologies. Encumbered technologies require users to manipulate keyboards, data gloves, or wear head-mounted displays. Unencumbered technologies rely on responsive body position tracking devices and projector systems alone, demanding no direct physical contact. Second, Brill emphasizes perspective or point of view, including how equipment positions users in virtual environments. Does the digital application provide a first, second or third person perspective? For example, visors and responsive walk-in

chambers commonly feature a first person perspective. Other technologies project a responsive mirrored image of the user in a digital world, providing a second person perspective. Ultimately Brill offers a comprehensive typology of virtual reality technologies based on functionality, external equipment and communications systems. He emphasizes, the “importance is not so much to label as it is to understand each system’s user dynamics and also how each system’s participants relate to and within each virtual system” (1993: s).

Immersive First Person (IFP) Virtual Reality

Brill’s “Immersive First Person” (McLellan 1996: 464) or “Stage World” (Brill 1993; 1994a) virtual reality offers users cockpits or walk-in chambers and sometimes features associated head-mounted displays or treadmills to enhance the sensation of physical immersion in digital applications. Within the context of these technologies “participants find themselves totally surrounded by their virtual experience, not unlike being an actor in a play or film” (Brill 1994a: 31). They also feature a user manipulated first person perspective that is responsive to the actual positioning of the user’s head, torso or legs. The technology’s immersive features and the physical agility required to operate it have made IFP techniques popular for physical therapy in applied Canadian contexts (Sinitski et al. 2014). IFP techniques have also been utilized in Canada for exposure therapy and in the treatment of Post Traumatic Stress Disorder (PTSD) and phobias (Wiederhold and Bouchard 2014). While there are a variety of IFP products on the market such as Virtuix's Omni (2015) and virtual reality systems by Virtualis (Virtualis 2011), the Federal Government and Canadian health authorities have invested heavily in the CAREN system produced by Motek Medical, a company specializing in multi-

sensory digital interfaces based in Amsterdam (Motek Medical 2015). CAREN offers users modifiable components, but the basic product features a treadmill, screens, projectors, surround sound systems and body tracking devices to facilitate a responsive sense of immersion (Motek Medical 2015). Motek Medical provides associated software products depicting everything from anthropomorphic figures to natural scenery and city and ocean scapes (Motek Medical 2015). Canadian hospitals have also been engaged in software development for their own CAREN systems. For example, with the aid of city blueprints, the Ottawa Hospital has developed a walk through scenario for use with its CAREN system featuring the city of Ottawa (Ottawa Hospital 2014b). CAREN IFP systems, therefore, feature a first person perspective of diverse digital environments, including human forms, and facilitate movement of the body along a responsive lateral, vertical, and longitudinal treadmill axes. Advanced audio-visual techniques and infrared tracking functions further compliment these features.

Through the Window (TW) Virtual Reality

“Through the Window” technologies (McLellan 1996) or “Desktop Virtual Reality” (Brill 1993; 1994a), utilize standard computer components, “a virtual world is created and then experienced from a desktop monitor” (Brill 1994a: 32). TW technologies are by far the most cost effective and pervasive of Brill’s virtual reality systems. 3D graphics facilitate a sense of depth, rotation, and movement. More advanced features include the use of an associated “head-coupled display” or visor, providing the user with a more immersive digital experience (Brill 1994a: 32). A larger screen allows for multiple users.

In the early 1990s when Brill commented on these technologies they were still novel. Within the context of Canadian healthcare today interactive 3D modeling of human anatomy has been used extensively for the diagnosis of disease and in medical schools for education. Associated anatomical models rely on a series of other technologies, such as Magnetic Resonance Imaging (MRI) and Computerized Axial Tomography (CAT) to provide raw data that is then manipulated with various software programs to produce a final responsive TW application (Spitzer et al. 1996; Csordas 2002). 3D-visors and larger screens to augment TW experiences are also gaining popularity in Canadian medical schools. In the last 8 years there has been a proliferation of companies selling these technologies. For example, Cyber-Anatomy Med Virtual Reality (2009), zSpace (2015) and EchoPixel (2014) all offer TW visor technologies, allowing medical students and instructors the ability to peel back layers of tissue, bone and blood vessels in responsive applications. The scale of human anatomy is also negotiable. A kidney can appear to take up a 200-seat lecture hall or be dialled down in size to occupy more modest square footage. Digital experiences of birth or circulation can be approximated with live animations capable of an even higher level of manipulation beyond simple rotation or tissue stripping. Perspective is also negotiable, with the ability of users to manipulate various views of the body inside and out.

Mirror World (MW) Virtual Reality

Mirror World virtual reality technologies feature body-tracking systems and associated displays that provide digital environments that mimic or mirror participant's gestures (Brill 1993, 1994a; McLellan 1996). Brill emphasizes "users are able to see their image within the virtual world and to move accordingly to direct their image in

relationship to that world” (1994: 33). MW technologies were embraced by arts communities and developers throughout the 1970s and 1980s, particularly through the work of computer scientist and artist Myron Krueger (1991) and later Canadians Vincent John Vincent and Francis MacDougall who founded GestureTek in 1986, a company devoted to gesture tracking virtual reality systems (GestureTek 2014). In variations of MW technologies used today user’s body motions are tracked by an optical device that simultaneously projects a responsive virtual world onto floors or walls allowing the user to move through digital space in real time. Popular examples of MW virtual reality include participants seeing themselves as a goalie in a hockey game or, alternatively in the subsequent example, walking through images of colourful leafs that are disrupted as the user moves across the floor (GestureTek 2014).

MW virtual reality has been used extensively by companies to offer novel forms of interactive advertising (Samant 2013). Associated technologies have also been used for educational purposes in museums or in art gallery installations (Brill 1994b, 1994c, 1995). In applied contexts, MW virtual reality has been used in Canadian hospitals for physical rehabilitation. For example, Glenrose Rehabilitation Hospital has benefited from MW interfaces for physiotherapy and developed associated software in cooperation with the Department of Computing Science at the University of Alberta (Alberta Health Services 2010). MW technologies directly or indirectly insert the user into a digital world with unencumbered virtual reality interfaces, offering a first or second person perspective. With no associated cables, visors, or treadmills a greater range of physical movement through virtual worlds is provided.

While IFP, TW and MW techniques are popular in Canadian hospitals and medical schools, this study remains grounded in an analysis of the CAREN system as an IFP technology, recasting debates on sensation and digital experience. It does so through an emphasis on the movements, perspectives and representations the CAREN system fosters.

DISCUSSION

This study is attentive to how emerging immersive digital technologies flatten the body. My research also pushes anthropologists to consider associated exclusions as a multi-sensory experience. The movements, perspectives, and representations of the human form offered to users of IFP, TW and MR technologies are grounded in cultural assumptions, assumptions that shape users' experiences.

First, Brill's relational typology of virtual reality pushes researchers to consider how exactly human bodies fit into diverse immersive interfaces. Movement, perspective, and representation can shift with each interface. The specific ways hardware and software come together helps to shape experiences of our senses. Corporeal normativity can also be registered in different ways as different virtual reality technologies envelope and depict human bodies. Brill's efforts to broaden the discursive field of virtual reality also has salience for this study. Virtual reality is not one thing, yet conceptually studying immersive digital features in applied contexts has clear benefits both in and outside of anthropology, as the dissertation's literature review will demonstrate.

Second, intersectional approaches to the body draw attention to the need for accessibility(ies) in applied virtual reality interfaces. This approach is further substantiated in the literature review. Identity can be a plural experience. Intersectional

theorizing draws attention to the harm flattened corporeal planes do. Furthermore, intersectional approaches place an emphasis on resistance to norms and agency. Salient issues in the formulation of a theoretical framework that honours diverse embodied experiences of the CAREN system in the midst of the pull of corporeal normativity.

Finally, this study is situated more broadly within a discursive field that severely understates the exclusionary features of digital practices today. Focusing on exclusion is a political decision as much as a research decision. Persistent silences push some bodies to the margins.

STRUCTURE OF DISSERTATION

This dissertation is structured with an emphasis on movements, perspectives and representations – themes that inform my central question: in what ways is virtual reality based on assumptions about the normative body? These three themes echo the dissertation’s sub-questions addressing movement, perspective and representation. This approach facilitates an examination of the “body multiple” (Mol 2002), as a site of politics (Rose 2007), a symbol (Scheper-Hughes and Lock 1987: 19), experiential (Csordas 2002), and tied to complex material relations (Taussing, Rapp and Heath 2003). It also facilitates attunement to perception and power and the ways assumptions about the body aren’t just a question of representational practices in virtual reality, but are also rooted in expectations regarding how patients will receive and experience their multisensory treatments. This differs substantially from previous work in medical anthropology on diagnostic imagery (Rapp 2000; Mitchell 2001; Dumit 2004) or imagery used in the education of medical professionals (Csordas 2002: 260-284), here imagery is brought to life with clinical virtual reality’s technologies of sensation.

Introduction to the Research Problem: Chapter One has provided a basic overview, including: the rationale for the study, the value of multisensory ethnography, associated research questions and guiding concepts and theories.

Literature Review: Chapter Two documents the dearth of research by anthropologists examining experiential narratives of virtual reality. This includes discussion of anthropologist Thomas Csordas' (2002) call for more embodied accounts of virtual reality and one of the few ethnographic responses to-date by anthropologists Natasha Myers and Joseph Dumit (2011). Chapter Two also examines the value of multisensory research outside of anthropology in studies of virtual reality. For example, system designers have turned to cognitive psychology, biomechanical engineering, behavioural science, informatics, and neuroscience, among other fields, to develop applications that consider subtle user experiences from 'the ground up' (Durlach and Mavor 1995; Barfield and Furness 1995; Kim 2005).

Methodology: Chapter Three provides advanced discussion of the multisensory methods adopted in this project. Multiple methods are discussed, including my own use of the CAREN system, project filming and photography, clinical observations and in-depth qualitative interviews with CAREN practitioners and CAREN patients. Multiple approaches to data collection provide a robust methodological framework to examine body normativity and clinical virtual reality. Photos guide readers throughout the section, providing a breakdown of how, why and where the CAREN system works. Finally the study of a military technology used with both soldiers and civilians at a Canadian hospital requires advanced discussion of research ethics and the politics of ethnography. As an applied researcher and activist I also address research dissemination for the project,

including outreach to CAREN practitioners, the public and anthropologists and philosophers of science, technology and medicine.

Movement: Chapter Four examines how assumptions about human movement and the mechanical movements of the CAREN system come together in ideas about clinical care. How and why patients move in the CAREN system is an important question for practitioners. Patients also learn to move over time in clinical virtual reality as they undergo digital therapies. This coordinated dance between patients and the machine is likened to stagecraft by the primary CAREN technician who operates the system. Timing, the insertion of digital objects and treadmill exercises are carefully coordinated ‘in sync.’ Ultimately, Chapter Four provides an overview of how assumptions and expectations about movement guide clinical practices in the Virtual Reality Lab. It asks the question: During the use of the CAREN system, what assumptions are made about movement? Chapter Four reveals startling complexities tied to body normativity and movement in clinical virtual reality, including the impact of science fiction on clinical care.

Perspective: Chapter Five explores assumptions about sensations experienced in the machine. Perceptually, the CAREN system provides an immersive experience; however, how that experience is registered by patients can diverge substantially from the intentions of system designers. Rather than work against it, apt clinicians adapt their practices to make room for bodies that don’t fit perceptually without accommodations. Specifically, the chapter asks: what assumptions are made about perspective, or how the user can see, hear and feel? The resulting disconnect between user experiences and the intentions of designers disrupts the idea of the CAREN system as a ‘push button’

operation. Drawing from the anthropology of embodiment, space is also made for patient voices articulating their deeply personal experiences with the machine. Joy, fear, and even boredom, all shape perceptions of the machine and experiences of virtual reality.

Representation: Chapter Six deals explicitly with the images that appear in the CAREN system's digital worlds created for patients to occupy. Reproductions – of traumatic memories, of nature, Christian holidays, and advertisements – reveal the reach of culture and power in an area of medicine understood largely as value neutral. Race, class and gender also structure decisions about human representations and associated digital environments. Ultimately Chapter Six asks: What assumptions guide the creation of human representations and associated digital environments in the CAREN system? Chapter Six poses ethical challenges to practitioners accustomed to dealing with diagnostic imagery, who now face the prospect of therapeutic immersive digital worlds.

Significance of Research: Chapter Seven documents this study's contributions to research, including theory, method and practice. It highlights the stakes tied to virtual reality for anthropologists, practitioners and others invested in emerging technologies of “perceptualization” (Erickson 1993: 8).

LITERATURE REVIEW: CHAPTER TWO

In this study I draw on two complementary literature bases, including: 1) anthropological accounts of the body and virtual reality, and 2) multi-sensory research on virtual reality. *Anthropological Accounts of the Body and Virtual Reality* identifies a call from within anthropology to ground virtual reality in the body. Contemporary ethnographic debates regarding methodological approaches to virtual reality are then explored, in addition to the value of a multi-level analysis of virtual reality and the body. Finally, ethnographic studies that broach virtual reality and embodiment are examined.

Multi-Sensory Research documents the concept of presence in digital spaces, highlighting related research into multi-sensory interfaces in applied contexts. I also document the benefits of research attentive to multi-sensory interfaces. This section concludes with discussion of the importance of user identification with application content and corporeal normativity within virtual reality applications.

ANTHROPOLOGICAL ACCOUNTS OF THE BODY AND VIRTUAL REALITY

Scholars have characterized the immersive features of new digital technologies as encompassing “perceptualization” or the ability of these technologies to provide multi-sensory experiences (Erickson 1993: 8). Virtual reality technologies facilitate new forms of perceptualization, working against the idea of digital media as tools of visualization alone. Yet recent ethnographic work has focused almost exclusively on virtual reality and the body through the lens of technologies of visualization. Anthropologists Joseph Dumit and Natasha Myers (2011) have produced some promising research on the multi-sensory experiences of geological researchers working with Computerized Active Visualization

Environment Systems (CAVES), but grounded ethnographic accounts such as this are rare.

Here I provide an overview of virtual reality and ‘the body’ within anthropology. Specifically, this section features calls by anthropologists to re-insert the body into critical accounts of virtual reality through attention to embodiment and a corporeal politics grounded in material, social and economic inequalities. I also explore how anthropologists go about studying virtual reality and examine the value of nuanced ethnographic approaches to digital research attentive to hardware, software, sociality and the body.

Inserting ‘the Body’ into Accounts of Virtual Reality

Anthropologists emphasize that the post-human theorizing of the 1980s and 1990s neglected to account for the body in discussions of virtual reality (Gray and Driscoll 1992). Early scholarship on virtual reality also tended to adopt a technophobic or technophilic tone (Haraway 1997; Hayles 1999; Olivier 2012). Anthropologists responded with calls for nuanced studies of virtual reality and attention to structural inequalities and material and social factors. Over the years political, social and economic inequalities have been powerfully highlighted by anthropologists as central to experiences of techno-science (Ong and Collier 2005). Racialized bodies, poor bodies, persons with disabilities, gender and sexuality have also come to the forefront of ethnographic studies of virtual reality in attempts to offer more socially grounded accounts of techno-science.

How Anthropologists Study Virtual Reality

There has been considerable debate about whether or not virtual reality should be considered a topic of study (Hine 2000), an artifact (Gray and Driscoll 1992) or a field site (Nardi 2010), subject to discourse analysis like text (Hine 2000) or ethnographic methods (Boellstorff 2008). Increasingly digital ethnography has been accepted as a form of participant observation (Horst and Miller 2012). Recent anthropological ventures into virtuality have fostered extensive discussions regarding methodological approaches to virtual reality and associated research ethics. Anthropologist Simona Isabella (2007) recommends concurrent ethnographic projects in digital research, one mapping virtual community and digital scapes, the other related community as it extends outside of virtual contexts. Similarly, Nicola Green (1999) suggests virtual reality is best suited to multi-sited ethnography given the scope and scale of resources required for virtual reality to operate and the way virtual reality disrupts the “boundaries of research fields” (418). For example, anthropologist Bonnie Nardi (2010) has done research on the multi-player video game *The World of War Craft* by conducting participant observation in cyberspace and in person at Internet cafes in China and the United States. Contemporary ethnographers continue to experiment methodologically with digital anthropology reflecting expansive possibilities for research design (Boellstorff et al. 2012; Horst and Miller 2012).

Developing A Multi-Level Analysis of Virtual Reality and ‘the Body’

Coding structures provide graphic content, operating systems, present users with possibilities in digital applications, and are often co-designed for use with associated hardware. Anthropologists and other social theorists point out that coding structures are steeped in socio-cultural and historical context (Schaap 2002). For example, John

Unsworth (1996) provides a cultural history of the UNIX operating system, documenting how UNIX's structure is rooted historically in the unique institutional needs of Bell Labs, MIT, and General Electric dating back to the 1960s. While precision, creativity and technical prowess are commonly valued by coders, Paul Graham (2003) emphasizes that it is "empathy" and social sensitivity to user needs that makes a good programmer. In this sense, there is a dynamic cultural interplay between user choices, options coded into programs and associated application outcomes.

Coding parameters, user choices, and the relationship between virtual realms and communities reveal startling complexities in terms of conducting ethnographic research. Anthropologist Tom Boellstorff's (2008) research suggests a threefold approach to digital anthropology, including an emphasis on: 1) software coding limits; 2) attention to forms of sociality linked to specific technologies; and 3) points of user resistance. This makes it possible to explore salient issues like the body, for example, from multiple levels of engagement.

First, a software program's coders place fences around behaviour. The availability of user choices is guided, and limited, by application content and the options available. Physically, digital avatars are coded to act specific ways. For example, in *Second Life* male avatars sit with their legs wide apart in a confident posture, while female avatars sit with their legs together in a more reserved posture (Boellstorff 2008: 141). While Boellstorff's discussion is limited to application choices presented to users, hardware functionality, especially in multi-sensory virtual reality, is also strongly shaped by coding structures adopted by software designers who seek "system synthesis via hardware-software co-design" (Gupta and DeMicheli 1992: 1). Ranges of movement, for

example, may be off limits to users given hardware specifications. For example, the CAREN system's virtual reality applications offer users movement along longitudinal, lateral and vertical axes. Social conventions around coding structures, therefore, also strongly impact multi-sensory experiences of digital technologies.

Second, Boellstorff points out that users express various forms of sociality. This can be through expressive choices made in application content or in the specifics of relationships extending outside of related digital contexts. Users may also reinforce their day-to-day identities in digital applications or playfully subvert them (Boellstorff 2008; Nardi 2010; Schaap 2002). Other anthropologists have focused on the networks of people required to muster the resources, equipment, and staff necessary to operate high tech pursuits (Latour 1987; Ong and Collier 2005).

Third, while computer engineers set specific parameters around hardware and software, users also resist and reconfigure associated norms in a variety of creative ways (Boellstorff 2008: 143). For example, at the time of Boellstorff's research, and despite user requests to the contrary, avatars were available only in the binary options "male" or "female" (2008: 141). Users explicitly created androgynous looking avatars to subvert binary norms (Boellstorff 2008: 143). Computer monitors and keyboards can also be adapted. Keyboard sticks can be used to type on keyboards ergonomically designed for ten digits. While guided by codes, hardware and software can be incredibly dynamic in terms of actual human use.

The Anthropology of Embodiment and Virtual Reality

In 1997 anthropologist Thomas Csordas (1997) called for studies of virtual reality addressing the anthropology of embodiment. It was a reactionary call, situated in direct response to currents of post-human theorizing that overstated an emphasis on digital representation to the exclusion of phenomenological accounts of new technologies. Here Csordas was not calling for anthropologists to abandon representation altogether; rather, to draw more effectively links between digital representation and lived experience. Fundamentally Csordas remains focused on how virtual reality mediates embodiment and hence “our own culturally situated being in the world” (Csordas 2002: 274). Building on the work of anthropologists Nancy Scheper-Hughes and Margaret Lock (1987), Csordas’ accounts of virtual reality and embodiment remain attentive to the ways individual bodies, corporeal politics, and the social body are interwoven, specifically through the case study of the Visible Human Project.

The Visible Human Project aims to create the most comprehensive repository of interactive 3D anatomical data on the human body (Spitzer et al. 1996). Csordas points to ethical issues tied to the project. For example, 38 year-old “Texas death row inmate” Joseph Jernigan offered his body to the project in exchange for death by lethal injection versus electrocution (Csordas 2002: 261). Subsequently, his body was sawn into 1,800 1 mm wide slices (Spitzer et al. 1996). Each section of the body was then scanned into a computer database for virtual re-assembly. Explicit forms of sociality followed the project, in on-line community where the images are available, in popular media and in the ways physicians and medical students experienced the shift from “blood and guts” to “bits and bytes” in their studies of human anatomy (Csordas 2002: 276).

While Csordas predominately features scholarship on sensation and perception, both in and outside of anthropology (1994; 1997; 2002), and invokes Bourdieu's (1977) concept of habitus, a concept itself grounded in social conventions tied to multi-sensory experience, his discussions of virtual reality remain largely grounded in visualization, not multi-sensory ethnography. Although Csordas (2002) calls for an anthropology of embodiment attentive to diverse sensations, including taste, touch, smell, sound and movement, his accounts of virtual reality fall short in this regard. For example, in *Body/Healing/Meaning* (2002), Csordas extensively focuses on the "language of touch" and "bodily sensation" in *Part I* and *Part II* of his book addressing Christian charismatic healers and Navajo healing rituals (Csordas 2002: 128). *Part III* remains largely preoccupied with virtual reality, the eye and anatomical visualization despite his calls for more embodied accounts of virtual reality.

Natasha Myers and Joseph Dumit (2011) cite Csordas in their ethnographic account of CAVES, taking up his challenge to provide embodied accounts of virtual reality. They adopt an explicit multi-sensory focus, highlighting the playful forms of experimentation CAVES allow. For example, geologists twist and bend their bodies to move through data sets. CAVES are a unique technology that allows researchers "to get entangled kinesthetically and affectively with their data" (Myers and Dumit 2011: 240). 3D goggles and associated chambers with multi-dimensional digital screens allow researchers to walk through information, all the while manipulating data with responsive corporeal tracking systems (Myers and Dumit 2011). Like the scientists they study, Myers and Dumit situate themselves as explorers documenting a unique "place where our research problems and those of the scientists meet" (Myers and Dumit 2011: 258). This

particular kind of embodied research is new to geologists and is effective as a research tool.

MULTI-SENSORY RESEARCH ON VIRTUAL REALITY

There remains an ongoing disconnect between the social sciences and computer scientists working to develop virtual reality technologies. Chapter Three also provides discussion regarding engagement with healthcare practitioners working with virtual reality technologies in Canada. Outside of anthropology there is a considerable body of research that deals with multi-sensory experiences of virtual reality, including benefits in applied contexts, opportunities and barriers to use. Fundamentally, we are entering a unique period of development where haptic, kinesthetic, and other multi-sensory features have grown highly 'usable' compared to earlier periods in virtual reality's history. Historically, a general preoccupation with technological novelty resulted in applications that rated poorly in terms of actual usability (Sutcliffe 2003: 2). Declining costs and accelerated developments in computing (Gallace et al. 2012) have also influenced the current uptake of virtual reality in applied contexts.

The complexity of computer systems supporting multi-sensory functions in virtual reality has demanded unprecedented interdisciplinary collaboration (Sutcliffe 2003). For example, drawing from reverse electro-vibration, Disney's REVEL system provides users with physical sensations of changing textures – a technology that could allow people with vision impairments to experience a tactile art show (Bau et al. 2013). CAVES also benefits from complex systems, allowing users to 'walk through' data, incorporating both 3D technologies and body tracking devices (Penny et al. 2001). Designers have recently turned to cognitive psychology, biomechanical engineering, behavioural science,

informatics, and neuroscience, among other fields, to develop applications that consider subtle user experiences from ‘the ground up’ (Durlach and Mavor 1995; Barfield and Furness 1995; Kim 2005). Applied virtual reality techniques have also involved interdisciplinary collaboration as applications have moved more readily into professionalized contexts and experiences of day-to-day life (Fuchs et al. 2011). Finally, multi-sensory technologies have involved synchronization across several cross-currents of the computer sciences. The co-development of operating systems, software and hardware has strongly benefited audio-visual, kinetic and haptic techniques (Sutcliffe 2003). Here I provide an overview of the concept of presence in virtual reality and document research examining benefits associated with multi-sensory interfaces in applied contexts. I conclude with discussion of corporeal normativity in multi-sensory interfaces and the importance of user identification with application content.

Presence in Virtual Reality

Applied practitioner-directed research on virtual reality adopts an explicit emphasis on the concept of user “presence.” Brill emphasizes, “essentially a virtual presence is defined as having the effect, but not the actual form, of what it represents” (1993: q). Applied studies draw a strong connection between multi-sensory technologies and an enhanced sense of presence within digital applications (Gallace et al. 2012). Scholars in a variety of fields have attempted to measure presence within virtual reality for the benefit of developing more effective multi-sensory systems. Takatalo et al. (2008) put forward a “holistic” (1) framework for measuring presence, “integrating perceptual, attentional, cognitive-affective and motivational components” (10). Others remain focused on sensory modalities (Sutcliffe 2003), including: auditory; visual; haptic; and

even gustatory-olfactory modalities in applications such as Morton Heilig's *Sensorama* (1962). *Sensorama* was early attempt at virtual reality integrating the smells of Brooklyn's "city-funk" as users ride a motorcycle through the New York City borough (Turi 2014).

Engineers and developers commonly adopt perceptual 'tricks' to engender an enhanced sense of presence. For example, 3D sound systems utilized in CAVES provide more realistic sounds and can also facilitate a sense of movement (Lentz et al. 2007). A series of speakers strategically placed, and activated in orchestrated intervals, allows for a sense of sound in motion.

Users report a greater sense of presence when operating immersive virtual reality technologies that feature walking and whole body movement (Aymerich-Franch 2010), haptic techniques and stereoscopic images (Lee and Kim 2008), and a higher involvement of visual-spatial tasks and user-directed navigation (Rey et al. 2010). Applications that provoke strong emotional states (Robillard et al. 2003) and "increasing the number of senses stimulated" (Gallace et al. 2012: 1) have been further correlated with an enhanced sense of presence. There are also dangers associated with over-stimulating users. Simulator sickness has also been studied in attempts to offset associated symptoms. For example, Robillard et al. (2003) have included use of a "nausea scale" in their research (473). Apart from individual sensitivities, "bad virtual reality can literally make you sick," undermining experiences of presence and application objectives (Sutcliffe 2003:2).

Applied Virtual Reality and the Benefits of Multi-sensory Interfaces

Researchers have highlighted the benefit of multi-sensory virtual reality techniques in terms of applied uses for physical therapy, psychology, and training and education (Holden 2005; Klinger et al. 2005; Ghinea et al. 2012). For example, while exposure therapy remains controversial (Prochaska and Norcross 1999), psychologists have taken advantage of immersive virtual reality techniques to ‘walk patients through’ traumas and phobias in guided therapeutic processes. In a clinical study of virtual reality and social phobias, virtual exposure therapy resulted in “statistically and clinically significant improvement” after 12 weeks (Klinger et al. 2005: 76). Psychologists emphasize the ability to ‘dial up or dial down’ triggering multi-sensory stimuli, “one significant asset of virtual reality is the possibility of the therapist to control the intensity of the stimuli” (77). Researchers argue that when exposure therapy is situated outside of virtual reality contexts, less control is granted to professionals as they guide patients through triggering situations, making digital scenarios preferable (Klinger et al. 2005).

Studies have also shown that, for many learners, multi-sensory virtual reality improves both motivation and engagement (Fassbender and Richards 2008: 1). Education scholars invested in Neil Fleming’s (1995) four types of learning styles (visual, textual, auditory and experiential) point to the dynamic styles of learning virtual reality facilities (Farley and Steel 2012). In Canada, the resource and medical sectors remain actively engaged with virtual reality for the benefit of technical and skills training. Geologists can walk through virtual mines looking for safety concerns (MIRARCO 2002). Surgeons benefit from haptic feedback provided in simulators, while medical

students interactive with responsive 3D human anatomy (Conquer Mobile 2014; Centre of Excellence for Application Education and Innovation 2014).

Immersive virtual reality has been enrolled extensively in physical rehabilitation, particularly through the popular CAREN system. Amputees have reported that immersive virtual reality helps to counter a sense of corporeal disassociation following traumatic amputation. For example, one amputee describes a gradual process of re-building trust in his body and the ability to walk, “you really have the feeling like okay this was a good step and this was a less good step, you just feel it” (Rudolf qtd. in Moraal et al. 2013: 514). Multiple sensory modalities tease out dynamic possibilities for practice.

Corporeal Normativity in Multi-Sensory Interfaces and the Importance of User Identification

Strikingly absent from applied practitioner-directed studies of virtual reality is attention to diverse body types – a surprising feature given the established link between subjective identification with application content, personal relevance, and enhanced sense of presence (Takatalo et al. 2008). Applied virtual reality often skews visual representations of humans, weighting depictions of bodies towards the almost singular aesthetic of White, middle-aged, rake thin men. Disability advocacy groups have also called for multi-sensory studies of virtual reality that address diverse cognitive and physical abilities (Borgman et al. 2008). Literature on the therapeutic uses of virtual reality often conceives bodies through a homogenized lens, even as treatment options are put forward for a variety of health conditions and disabilities. For example, in clinically tested applications used to treat social phobias a surprisingly homogenous range of

human figures are presented to users undergoing treatment. The majority of figures presented in applications appear to be men dressed in professional attire, invoking a strong sense of both class and gender (Klinger et al. 2005: 80-82). Other applications feature body tracking techniques and motion capture gloves that allow users to adopt a first person perspective with responsive out stretched hands represented in digital space (Jamaluddin 2014). The skin colour of these hands is often fixed as white, erasing racialized bodies in cyberspace. Taking up recommendations put forward by disability advocacy groups there is also the possibility of modifying CAREN, for example, for deaf users with “acoustic vibrations” perceivable to deaf populations (Benari 1995).

In multi-sensory applications, bodies are conceived perceptually and representationally in a variety of ways. The body diversity of virtual reality users themselves remains an understudied area of inquiry within the context of applied techniques. Many of the pre-existing technologies are effective; however, they may be even more effective if corporeal diversity is taken into account. Bridging research agendas between the sciences and anthropology represents one such avenue to investigate more inclusionary practices.

DISCUSSION

Collectively this literature calls attention to several key points. First, there is value in documenting embodied multi-sensory accounts of virtual reality in applied contexts. Anthropologists have called for more research in this area, as have practitioner-directed studies of virtual reality. While the reasons may vary, both underscore the importance of studies of the body and virtual reality: in anthropology to address an analytic vacuum and in practitioner-directed studies to enhance the efficacy of applied

applications. Despite an established history of inter-disciplinary research into multi-sensory interfaces, there is poor linkage between the social sciences and practitioners actively working to develop virtual reality technologies. This has likely impacted the ways bodies are conceived perceptually and representationally in applications. The analytic vacuum that anthropologist Thomas Csordas' highlights (or missing bodies experientially tied to virtual reality) also carries weight here. For example, little attention has been paid to the homogenization of corporeal forms offered to users in virtual reality applications. Accessibility has been emphasized, but not as it pertains to messy intersectional bodies, the types of bodies that occupy the world outside of slick applications and tidy digital models. For many practitioners the technical objectives of applications eclipse subtle and overt assumptions made about the human form. For scholars of the body, however, this is a critical issue.

It is also noteworthy that even within practitioner-directed studies there is evidence to suggest that subjective identification with application content and personal relevance fosters an enhanced sense of presence. Presence itself has been strongly connected to the efficacy of virtual reality technologies. If users do not see themselves reflected in application content, perceptually or representationally, it may diminish user experiences and, therefore, the effectiveness of these technologies in applied uses for cognitive disabilities, physical therapy, psychology and training and education.

Anthropologists and critical theorists such as Kimberle Crenshaw also suggest that the persistence of corporeal homogenization can result in greater dangers outside of the immediate purveyance of digital applications. Assumptions about bodies do not just stay in digital worlds; rather, they travel, shaping broader values, relationships and

society itself (Leonard 2006). Kernels of social inequality also manifest in the cultural environments that foster coding choices made before the application is realized.

Enhanced dialogue between anthropologists and digital practitioners has the capacity to build more inclusive practices.

Finally, it is important to not only consider corporeal norms and assumptions tied to the perspectives, movements and representations virtual reality technologies allow, but also how users and practitioners make these technologies their own in innovative ways. Tom Boellstorff's analytic approach, emphasizing both coding limitations and resistance to coding assumptions, is useful in this regard, as is the intersectional emphasis on resistance. To disregard human creativity or the capacity to subvert corporeal assumptions in hardware and software design only serves to reproduce the status quo. Documenting these points of resistance in relationship to my central research questions can also aid developers and practitioners. It may even generate new, and very specific, design recommendations.

Exclusion can be a multi-sensory experience. In the midst of accessibility, inaccessibilities persist. Bodies don't fit neatly into flattened corporeal planes; rather, they reflect the dynamism of lived experience. How people experience virtual reality is not just a question for anthropologists, but also those invested in creating more accommodating and, therefore, effective virtual reality techniques. Ultimately this study fosters dialogue across several distinct yet inter-related bodies of literature and seeks to draw attention to persistent silences.

METHODOLOGY: CHAPTER THREE

The use of sensory ethnography in studies of digital technologies, although still rare, is a growing area of anthropological inquiry. Sensory ethnography “takes as its starting point the multisensoriality of experience, perception, knowing and practice” (Pink 2009: 1). As an orientating methodological framework it is attentive to both multisensory research methods and to research participants’ own sensory experiences (Pink 2009).

In Chapter Three I provide an overview of the research methods adopted in this study. Specifically, this sensory ethnography draws from semi-structured interviews, participant observation and photography and film to explore full body immersion virtual reality in a clinic. The following section discusses the history of the CAREN system, my study group, participant recruitment and eligibility, data collection, the field site and data analysis. I also provide a discussion of the ethical and political commitments guiding the project. Study limitations are also examined. A threefold approach to research dissemination includes outreach to practitioners, the public, and anthropologists and philosophers of science, technology and medicine. The section concludes with discussion of the value of sensory ethnography to accounts of full body immersion virtual reality.

INTRODUCING THE CAREN SYSTEM

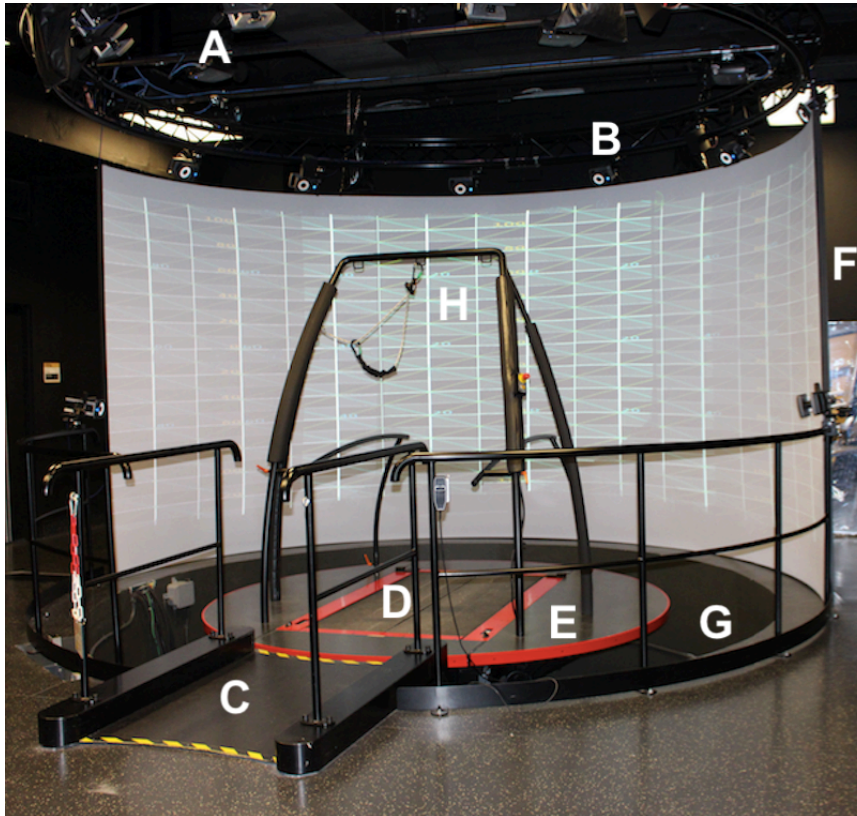
- Ethnographer: What other factors contributed to the development of the CAREN system?
- Respondent: Major milestone for us was the U.S. Department of Defense contacting us for the most advanced rehab system we could think of.

- Ethnographer: They said that to you? They said, “make us the most advanced system you can think of?”
- Respondent: The most advanced, the biggest, and it still needed to be cutting edge in ten years’ time. That was the challenge they gave us, and the reason they challenged us for that was the war going on, the second Gulf War [and] Afghanistan, and that they demanded the best clinical care from industry. So they bumped into us as being innovative rehab and they gave us that challenge, so we developed the CAREN High End for the San Antonio Center for the Intrepid in Texas.

In 1997, the Dutch animation studio Motek received a grant from the European Commission to develop the CAREN system, a full body immersion virtual reality system for therapeutic purposes (MotekForce Link 2017). In the years following the company’s successes with the system, it formally split into Motek Entertainment (centred on gaming, advertising, TV and film production) and Motek Medical (specializing in medical software and hardware). In the early 2000s, the US Department of National Defense approached Motek Medical to develop a more advanced version of the system for the American military. At this time, production of an extended CAREN system was developed, featuring more immersive components, including the popular treadmill interface mounted on pistons. Today the company has clients throughout Asia, Europe, North America and the Middle East. It has also partnered with the Dutch Military, Siemens, Philips and many large research-based universities around the globe. Recently, Motek Medical formally merged with Forcelink, the company responsible for producing the system’s treadmills. Further partnerships are currently underway with DIH International, “a corporate holding group from Hong Kong,” Switzerland’s Hocoma, a “world leader” in “robotic and sensor-based rehabilitation” (Business Wire 2016), and Monitored Rehab Systems, another Dutch-based company specializing in rehabilitation-based technologies (MotekForce Link 2017). Motek Medical, or MotekForce Link,

sources components for the CAREN system from over 40 companies. The system is advertised as a series of packages offered to institutions. Each is custom built. In Canada, the Ottawa Hospital and, in Edmonton, the Glenrose Rehabilitation Hospital share twin systems purchased by the Department of National Defense.

Figure 3: The Ottawa Hospital's CAREN System



- A) System Projectors
- B) Motion Capture Devices
- C) Retractable Bridge
- D) Dual Treadmills and System Force Plate for Pressure Sensitivity
- E) System Platform
- F) Curved Screen for a Sense of Immersion
- G) "The Pit" Where Six Hydraulic Pistons are Located for Tilt Effects
- H) System Harness Attachment

Unlike other system packages that are available to institutions, the Ottawa Hospital's version of the CAREN system does not include aroma features that waft smells into the room for added realism or an enclosed dome screen. It does, however, feature dual treadmills resting on six pistons – a configuration that allows patients to

climb hills or to be swept away in oscillating waves for therapeutic purposes. The dual treadmills also facilitate “trip and slip” applications that test a patient’s ability to recover from a bad fall. When the treadmills are run in opposite directions, or at different speeds, it effectively ‘trips up’ the patient, prompting a safe fall into the system’s harness. Force plates further add to the challenge of applications as the machine registers the force of the patient’s body weight. Effectively, this allows “leaning” applications, where patients can control the application with their weight distribution.

Figure 4: Ethnographer in "the Pit" Beneath the System



Figure 5: Close-Up of System Hydraulics



Figure 6: Close-Up of the Curved Screen from Below

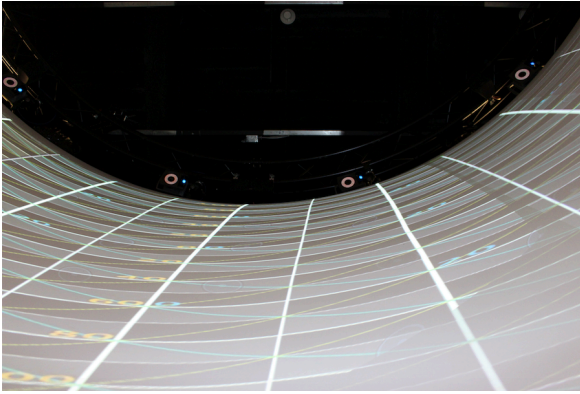


Figure 7: Motion Capture Devices (Foreground/Background)



Figure 8: Platform and Dual Treadmills Where the Force Plates are also Located

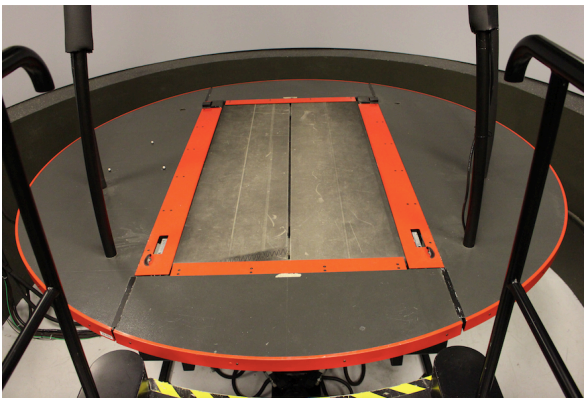
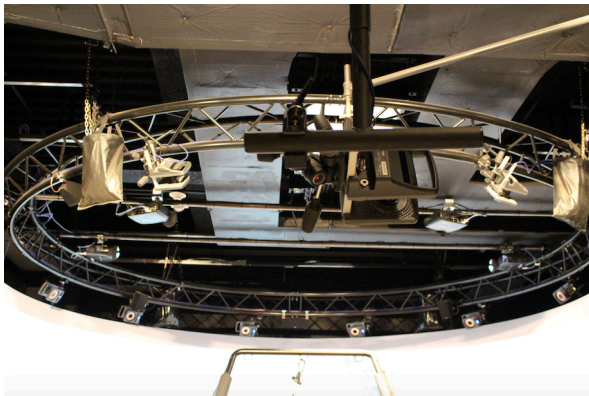


Figure 9: System Projectors and Motion Capture Devices Mounted Above the System



A number of programs are responsible for the operation of the system's components. The CAREN technician works primarily with D-Flow, a program run on a Windows Operating System designed to bring these elements together in a more user-friendly interface:

[A] key concept of the D-Flow software system is that the subject is regarded as an integral part of a *real-time feedback loop*, in which multi-sensory input devices measure the behavior of the subject, while output devices return motor-sensory, visual and auditory feedback to the subject. The D-Flow software system allows an operator to define feedback strategies through a flexible and extensible application development framework, based on visual programming (Geijtenbeek et al. 2011: 201).

Located just behind the system, the CAREN technician keeps a watchful eye on patients, manually modifying D-Flow as each session progresses. Four computer consoles are mounted on the technician's desk. These consoles allow the technician to simultaneously monitor the treadmill control, motion capture devices, patient body markers, and force plate pressure. The technician also uses them to insert digital objects into the screen, for application development using the open source software "OGRE" (OGRE 2016), and to control the system's audio features, among other uses.

Figure 10: CAREN Technician's Station Behind the Machine



STUDY GROUPS

Research participants in this study include two primary groups: 1) CAREN practitioners, including those involved in the operation, maintenance and oversight of the CAREN system, and 2) CAREN patients.

- **Psychologists:** Encourage CAREN patients and CAREN practitioners to explore the link between physical rehabilitation and psychology. They also specialize in promoting body awareness in patients and consider the psychological elements of associated applications. Finally, psychologists help guide clinical teams engaged in PTSD treatments in the CAREN system and provide debriefing for CAREN technicians present in the room during PTSD sessions.
- **Primary CAREN Technician:** Certified by Motek Medical, the primary CAREN technician is responsible for the operation and specialized maintenance of the CAREN system. In Canada, CAREN technicians also play a key role in software development, application operation and developing clinical treatments in the machine. The primary CAREN technician is at the centre of multidisciplinary teams that work with the system.
- **Back-up CAREN Technicians:** At the Ottawa Hospital back-up technicians are currently in the process of being trained and certified by Motek Medical. They fill in for the primary CAREN technician when the need arises due to illness or vacation time.
- **Physiotherapists:** Promote mobility, quality of life, and day-to-day functioning in patients accessing rehabilitation services at the Ottawa Hospital. Physiotherapists work very closely with CAREN technicians in the administration of applications. They continually monitor patients during clinical sessions and, in collaboration with the CAREN technicians, modify simulations according to the needs of the user and the clinical team's treatment objectives. Both civilian physiotherapists

and military physiotherapists work with the CAREN system at the hospital.

- **Researchers:** Engineers with the Ottawa Hospital's Rehab Engineering Department and the Canadian Forces conduct research utilizing the CAREN system. This includes, but is not limited to, prosthetics research, gait analysis studies, and clinical trials of treatments for PTSD.
- **Clinical Social Workers:** Social Workers work closely with physicians, physiotherapists, occupational therapists and psychologists to consider holistic approaches to rehabilitation. They play a fundamental role in helping families and patients address the impact of illness, disability and disease. In collaboration with CAREN technicians, social workers with the Department of National Defense also primarily direct clinical sessions, and clinical trials, focused on the treatment of PTSD.
- **Motek Medical Representatives:** Representatives from the Dutch company Motek Medical meet with the Ottawa Hospital and the Department of National Defense to discuss application development, new products and services, system trouble shooting and CAREN updates.
- **Managers:** Professionals who specialize in coordinating and directing virtual services and associated teams at the hospital.
- **CAREN Patients:** Patients accessing the CAREN system primary for physiotherapy treatments or the treatment of PTSD. Both inpatients and outpatients utilize the system at the hospital. 12% of clinical observations were of inpatient sessions, while 88% were for outpatient sessions.

Patients and clinicians consented to 210 clinical observations between April of 2016 and October of 2016:

- 39 patients were observed in total.
- 32 patients were followed over multiple sessions.
- 51% of patients who consented to clinical observations also participated in in-depth qualitative interviews.
- 67% of clinicians who consented to clinical observations also participated in in-depth qualitative interviews.

Interviews were conducted with those involved in the operation, maintenance and oversight of the CAREN system.

RECRUITMENT AND ELIGIBILITY

Patient and practitioner recruitment was negotiated through the Ottawa Hospital Research Ethics Board. Recruitment materials were made available to staff and patients in both English and French. Eight participants interviewed for the project self-identified as Francophone and/or Québécois. Recruitment emails for practitioner participation were sent to staff. Staff also assisted with distributing recruitment packages to patients, which included the researcher's contact information. Practitioners were selected to participate in the study based on their position at the Ottawa Hospital and their contributions to the administration, oversight and operation of the CAREN system. CAREN patient participants had to be: 1) 19 years of age or older, 2) accessing the CAREN system for therapy, and, 3) capable of giving full and informed consent.

DATA COLLECTION

This study's sensory ethnography draws from semi-structured interviews, participant observation and photography and film in order to better understand and situate the CAREN system. Sarah Pink (2009) suggests sensory ethnography is best suited to mixed qualitative methods, particularly in regard to the ways people make sense of embodied perceptions on multiple levels (131). A multi-sensory analysis engages critically with the perspectives, movements and representations the CAREN system fosters. An emphasis on mixed qualitative methods allows me to explore body normativity and the CAREN system, while remaining attentive to unique patient and practitioner experiences of virtual reality in applied contexts.

In-Depth Qualitative Interviews

Table 1: 40 Qualitative Interviews

20 Patients
9 Physiotherapists
1 Primary CAREN Technician
2 Back-Up CAREN Technicians
1 Clinical Social Worker
1 Psychologist
3 Managers
1 Motek Medical Representative
2 CAREN Researchers

A total of 40 in-depth qualitative interviews were conducted with research participants, including 20 CAREN patients and 20 CAREN practitioners. Interviews with patients emphasized: the patient's background, CAREN efficacy, clinical context and CAREN accessibility (Appendix A). Interviews with practitioners emphasized the practitioner's role and background, CAREN efficacy, clinical context, CAREN accessibility, and CAREN development, maintenance and partners (Appendix B).

Given the vulnerability of patients, especially inpatients, many of whom were quite ill, and workplace pressures for practitioners, including limited time, the average interview length was approximately one hour. I had, however, ongoing contact with most patients and practitioners over the course of the 210 observations. Interviews were complemented by the observation of clinical sessions and by my own use of the CAREN system. For example, if a patient complained about a feature of a CAREN application I

understood which application it was, how it worked and the context of its use during clinical sessions. Participant interviews were audio-recorded and transcribed by an offsite transcriptionist subject to a confidentiality agreement. Transcripts were uploaded into NVivo Research Analysis Software and a searchable database of project text was created. Patients and practitioners were assigned or selected pseudonyms. All interviews were conducted in person at the hospital in a confidential room set aside for the project. Patients were given the option of breaking up the interview into a series of shorter interviews. They were encouraged to stop the interview at any time if they felt too unwell to continue. If I was unsure about how the patient was feeling or sensed they were getting tired, I paused the interview to ask if they wished to continue. The fact inpatients were interviewed at the hospital not far from their beds made it easier to coordinate interviews with those patients staying at the Rehab Centre.

In order to better situate interviewee responses, self-identified demographic information was also requested.

Respondent: My name is Bhagya. I am 50 years old. I'm a female. And my background, I think is considered South Asian.

Ethnographer: What do you consider your background?

Respondent: Well I always just say Sri Lankan. I'm born in Canada, but my parents are from Sri Lanka. So I think that falls under the South Asian category.

Anthropologists not only document categorical imperatives, they produce them. I tried to listen carefully to how research participants understood their identities. I tried to avoid simple “go to” categories that often appear in ethnographies. Transgender research participants, for example, might not fit into the boxes of “he” or “she.” These binaries on a demographic information sheet following an interview are inappropriate for researchers

seeking anti-oppressive approaches to fieldwork. Likewise, someone who is Indigenous and identifies as “Two-Spirited” might not necessarily identify as transgender, he or she. This resulted in some awkward moments for participants who viewed their identities as self-evident, but also more revealing data. For example, some of the highly masculinized soldiers balked when I asked them their self-identified gender.

Initially it was hard to break away from the formality of interviews conducted in a small hospital office, but over time patients opened up to me as an interviewer. The more clinical observations I conducted of patient sessions the more likely it was patients responded favourably to requests to participate in interviews. Without conducting clinical observations, and familiarity with me as an ethnographer, it is unlikely patients or clinicians would have participated in the study. Fieldwork, in this sense, was essential to the interview recruitment process. Given time, most practitioners and patients I observed during clinical sessions consented to interviews. As a rule of thumb, I often observed three sessions before requesting an interview.

Clinical Observations

Participant observation within institutional contexts has proven a particularly effective method for studying the day-to-day experiences of service providers (Good 1994), patients (Fadiman 1997) and medical students (Atkinson and Pugsley 2005), including the relational features of new technologies used in associated settings (Mitchell 2001). In order to elucidate day-to-day experiences of virtual reality systems in applied healthcare settings, seven months of participant observation was conducted at the Ottawa Hospital. Similar ethnographies of medical schools (Flick 2009: 228) and hospitals

(Janssens, Have and Zylicz 1999) have adopted fieldwork within a focused time frame in order to minimize disruption to healthcare practitioners and patients.

210 clinical observations were conducted. Observations primarily centred on the work of the CAREN technician, including:

- The roles, responsibilities and duties of the technician;
- Representations of the human form;
- Digital geographies;
- The specific applications utilized, including application content, and auditory, visual, kinetic, and other sensory features;
- The outcome and objectives of the specific applications utilized in the system.

The average clinical session was between 45 and 60 minutes. Members of the Canadian Forces accounted for 49 of the 210 clinical observations. Their sessions tended to run slightly longer than civilian sessions. Two practitioners with the Canadian Forces were also interviewed about their work, including one military physiotherapist and one military social worker. Six soldiers, who were patients, also participated in interviews. Members of the Canadian Forces were much more likely to report Multiple Traumatic Brain Injuries (TBIs) compared to civilian patient populations.

The majority of the 210 sessions were for patients with TBIs, followed up by Complex Regional Pain Syndrome (CRPS). Patients with Acquired Brain Injuries (ABIs), TBIs, CRPS, and Guillain-Barré Syndrome (GBS) were likely to report multiple disabilities or health conditions, including those related to mental health, movement, balance, partial deafness, partial blindness, and other visual or auditory conditions.

Table 2: Primary Reason for CAREN Clinical Use

TBI 28%
Multiple TBIs 15%
CRPS 23%
ABI 10%
Spinal Cord Injuries 8%
GBS 8%
PTSD 5%
Lower Limb Amputation 3%

A project information sheet was distributed to patients and practitioners prior to the beginning of clinical sessions. Verbal consent was also sought. Many clinical social workers and physiotherapists working with the system use a clipboard and pen to take notes during sessions. My role as an ethnographer taking notes was, therefore, not out of place. Patients were used to being observed. This makes clinical ethnography different from other forms of observation. The role of the observer was also reversed as I monitored clinicians accustomed to conducting observations. “What are you writing?” they would ask and I would share my observations.

A reflexive, multi-column approach to field notes was adopted (James, Milenkiewicz and Bucknam 2008: 81). All 210 observations were hand written during clinical sessions and later retyped and entered into NVivo. This included information such as: the duration of the session, the purpose of the treatment, the patient’s condition, the specific CAREN applications used, coded references to who was in the room, what

happened during the treatment, what people in the room paid attention to, a general description of activities, emerging questions and analyses, and reflective thoughts on my own biases and responses. Project interviews and my own use of the CAREN system also gave me the opportunity to clarify questions, thoughts and concerns emerging from the observations. It was not uncommon to be addressed by patients, practitioners and CAREN technicians with information they felt was important for me to document. For example, the state of the patient's recovery, updates to the CAREN system's software or what were understood as particularly effective elements of CAREN applications.

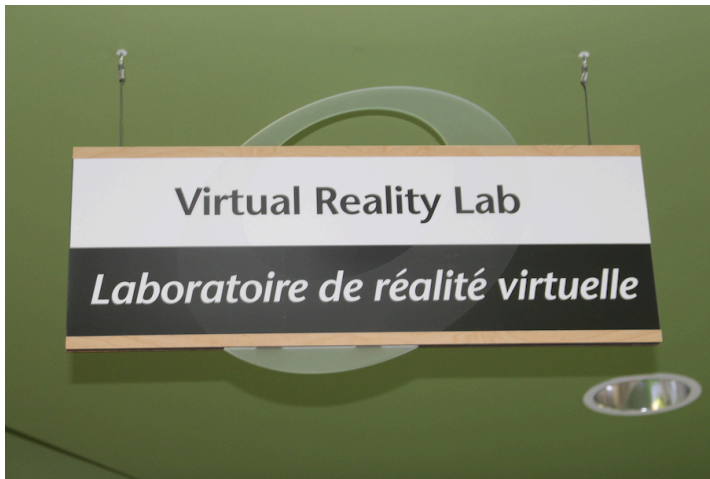
Film and Photography

“Video ethnography” is considered supplementary to other research methods (Pink 2007: 21). Unlike ethnographic film, it is not a standalone method. Within the context of this study, video footage and project photography focus on the perspectives, representations and movements the CAREN system fosters. Furthermore, they serve as reflexive visual tools. For the benefit of maintaining clinician and patient confidentiality, only the researcher is identifiable in the project's associated footage and photos. For example, with the permission of the hospital, footage of the ethnographer using various CAREN applications is provided and photos have been taken of CAREN system hardware and software with no identifiable practitioners or patients in sight. The use of cameras to capture multiple perspectives and vertical, lateral and longitudinal axes brings heightened attention to sensation, kinetics and movement. A short video ethnography with various cuts of the footage, approximately 15 minutes, accompanies the final written dissertation for the benefit of communicating research results. A longer film will also be

created for public engagement about the project. Project photos will be submitted to art galleries to further public outreach.

FIELDSITE

Figure 11: The Ottawa Hospital's Virtual Reality Lab



With the establishment of the Virtual Reality Lab in 2011, the Ottawa Hospital became home to the first CAREN system in Canada and one of the few institutions globally providing full body immersion virtual reality treatments in a clinic. The Ottawa Hospital is engaged in application development for the system and is strongly invested in research that crosses disciplinary boundaries – these factors made the hospital an ideal choice for my research. This section provides an overview of my clinical fieldwork and the City of Ottawa, which is located in the Canadian province of Ontario. It also provides essential context to understanding research conducted at the Ottawa Hospital throughout 2016.

Clinical Fieldwork

Figure 12: Hospital ID



As an ethnographer at the hospital I received an ID badge, emergency training, a workstation, a hospital email address, a dedicated phone line for the project, access to patient scheduling and other privileges granted healthcare practitioners at the hospital. I also participated in, and assisted with, training sessions for CAREN operators and clinicians. Throughout the study, I participated at the hospital in other ways. For example, when there were no patient bookings I took the time to help make patient body markers for the CAREN system's motion capture device by adding fixative to the back of the markers.

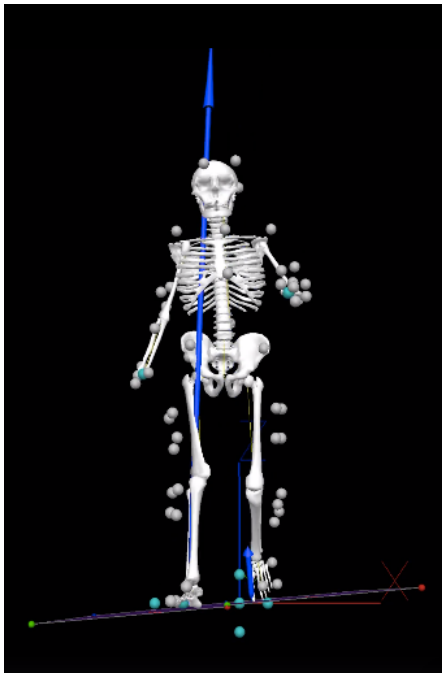
Figure 13: CAREN System Body Markers for Tracking Patient Movements



For example, body markers are commonly used for upper body exercises conducted in the machine. For the benefit of reciprocal research practices, my role as an ethnographer was also reversed as I became a research participant in a hospital study on the biometrics

of slow walking. Approximately 50 body markers were taped to my body as I wandered through CAREN environments and this data was recorded by engineers and specialists in human kinetics.

Figure 14: Screen Capture of Reproduction of the Ethnographer's Skeleton



At the time of my ethnography there was a shortage of properly trained back-up CAREN technicians. Back-up technicians often struggled to control the CAREN system and were in the midst of being trained by the primary CAREN technician at the hospital. One day after hundreds of observations, there was a moment when a back-up technician turned to me for advice: “do you know where the application is?” Together we found the correct application. As a participant-observer, by the end of the study I had a base-line understanding of how to operate the system. My initiation as an anthropologist was complete.

Ottawa

Ottawa, from the Algonquin “Adawe” or “Atawa” meaning “to trade” (Rayburn 2001: 231), is located on the unsurrendered and unceded territories of the Algonquin peoples (Yundt 2010). As the nation’s capital, it rests on the banks of the Ottawa River boarding Gatineau, Quebec. The location was originally selected by British colonialists for its strategic military advantage, including its centrality, riverways and a lack of proximity to the American border (Knight 1991). The Rideau Canal, built in 1832, stretches across the city, linking Lake Ontario to the St. Lawrence (Schliesmann 2013).

Ottawa, ON is home to Canada’s federal government, the city’s largest employer (Butler 2017). It also features some of Canada’s larger cultural institutions, such as the National Art Gallery. With a population of 934,243, it is the country’s fourth largest city (Statistics Canada 2017). Much of the population is bilingual, fluent in both English and French, with other languages spoken such as Arabic, Cantonese, Spanish and Italian (Statistics Canada 2017). Algonquin language, cultural revival and arts-based mentorship programs are also strong (Algonquin Treaty Negotiation Funding Trust 2013). Algonquin peoples are artificially divided between the political borders of Quebec and Ontario, historically communities “lived on both sides of the river” (ATNFT 2013). Large numbers of workers from the Gatineau region of western Quebec work in the city, commuting daily. Most government jobs require both English and French.

Today the city is home to large numbers of immigrants and refugees from Europe, Asia, Africa and the Middle East (Statistics Canada 2017). It is also home to a

LGBTQ2+³ village near the Glebe area of the city, stretching from “a six by two block area of Bank Street—from Nepean to James Streets (north to south)” and “Kent and O’Connor Streets (west to east)” (Ottawa Tourism 2017). During my fieldwork, I commuted daily from this area of the city to the Ottawa Hospital across the Rideau River to the East.

The Ottawa Hospital

In 1998, Riverside Hospital, The Ottawa General Hospital and Ottawa’s Civic Hospital merged to become the Ottawa Hospital (TOH 2017). The Rehabilitation Centre joined the Ottawa Hospital in 2005, providing services for residents of Ontario, Nunavut and Western Quebec (TOH 2017). The hospital’s proximity to Gatineau, QC means that many patients and clinicians commute every day across the Macdonald-Cartier Bridge from Quebec. The hospital is officially bilingual, with services in both English and French. Many immigrants and refugees from African and Middle Eastern countries also access services at the hospital, including CAREN system treatments. Translators are provided and the hospital has physicians and researchers specializing in immigrant and refugee health (TOH 2017). Military physiotherapists working in the Virtual Reality Lab reported not wearing their uniforms in order to avoid frightening immigrants and refugees from war torn countries. “Civies” are commonly worn.

The Ottawa Hospital is a publically funded teaching hospital affiliated with the University of Ottawa and the University of Ottawa Heart Institute, the largest cardiovascular health centre in Canada (TOH 2017). The hospital provides services for

³ Lesbian, Gay, Bisexual, Transgender, Queer, Two-Spirited and others who identify outside of dominant understandings of gender and sexuality. Two-Spirited identities are diverse and specific to unique Indigenous cultures.

over 1,150,000 outpatients and 50,800 inpatients annually (TOH 2011), with 1,117-bed beds between the General, Civic and Riverside campuses (TOH 2017). It is one of Canada's largest acute care hospitals (TOH 2017).

In the "history" section of the hospital website, the work of early Catholic nuns is credited as an influence, including the work of Elisabeth Bruyère, a nun with the Sister's of Charity (TOH 2017). Bruyere was responsible for establishing "one of the first bilingual schools" in Ottawa, "as well as the first hospital consisting of seven small beds" prior to 1847 (TOH 2017).

The Civic Hospital famously harboured Queen Juliana of the Netherlands during the birth of Princess Margriet in January of 1943 during the Nazi occupation of Holland (TOH 2017). The Canadian Government "temporarily ceded a room at the Ottawa Civic Hospital to the Netherlands" so that the princess could be born a Dutch citizen on Dutch soil (Waterloo Region Record 2012). To this day, Holland gifts over 10,000 tulips to Canada annually (Waterloo Region Record 2012), a tradition culminating in the city's Tulip Festival. The hospital website also emphasizes that the Civic Hospital is the birthplace of Prime Minister Justin Trudeau (TOH 2017), whose father was Prime Minister at the time.

Cuts to the Rehabilitation Centre

In 2015, the Ottawa Hospital announced that it would "cut 32 jobs in physiotherapy, clinical nutrition and social work" (Hurley 2015). In the months leading up to my arrival at the hospital the Centre for Rehabilitation had been hit hard by the cuts. Some physiotherapists participating in my study reported that their workload had doubled. Early on in my research it was difficult to get physiotherapists to participate,

some feared that my research was part of a staff appraisal process tied to more cost cutting measures at the hospital. I was eventually able to get clinicians to participate; however, building trust took time. \$100 million had been taken out of the hospital's budget (Hurley 2015). Linda O'Regan, Chief Steward of Ontario Public Service Employees Union Local 464, argued with hospital administrators, emphasizing that not enough services existed in the community to compensate for the cuts (Hurley 2015).

At the Rehabilitation Centre, there was also a tension between the million-dollar CAREN system and the recent cuts to basic physiotherapy services. Although it was hard to get set figures from the Ottawa Hospital or the Canadian Forces regarding the true cost of the machine, including the annual contract fee with Motek Medical, participants commonly reported that the CAREN system cost approximately one million euros or \$1,650,000.00 CAD on top of a service contract with Motek Medical for approximately \$1,000,000.00 CAD annually. The cost of the hospital's entire 2015-2016 budget is \$1.082 billion CAD (TOH 2015).

The Canadian Forces' Physical Rehabilitation Centres of Excellence

The cost of the CAREN system would likely be prohibitive without a shared agreement with the Canadian Department of National Defense. The CAREN system, like other virtual reality technologies (Durlach and Mavor 1995), is strongly influenced by relationships with the military. Canada's military systems are also based in urban centres far from rural communities. Renovations, staffing, upkeep and supplies represent further expenses associated with running a full body immersion virtual reality system in a hospital. Many of Motek Medical's future schemes for marketing virtual reality in healthcare centre on smaller systems more easily accessible to hospitals and patients at

home. For example, the Glenrose Rehabilitation Hospital has a second simpler CAREN system on site. It features motion capture devices and a force plate, but lacks a large curved screen and complex hydraulics, treadmills and audio-visual systems. Multiple sites in Canada feature smaller versions of the machine, for example, in Montreal, QC, London, ON and Calgary, AB (MotekForcelink 2017).

At the time of my research the Canadian Armed Forces had an approximately 40/60 CAREN time-sharing agreement with the Ottawa Hospital. The majority of CAREN Lab time was taken up by civilian patient sessions. A representative of the Canadian Forces is located on site to better coordinate CAREN military research and CAREN health services for soldiers.

Tuesdays at the lab are set aside for research. This includes civilian researchers from the hospital or affiliate universities, military researchers and companies renting the system for exorbitant fees. Tuesdays were also the day I conducted associated filming and photography for the project under the watchful guidance of the primary CAREN technician, who took the time and effort to operate the system for the project.

The Ottawa Hospital Rehabilitation Centre is one of seven Canadian Forces' Physical Rehabilitation Centres of Excellence (Government of Canada 2011). The Centre plays a key role in providing rehabilitation services for veterans returning from the war in Afghanistan. Early on, the CAREN system was used extensively with military amputees for prosthetic training. While fewer and fewer amputees use the system today, this history is evident in the hallways of the Rehabilitation Centre, where framed news articles about the rehabilitation of soldiers hit by improvised explosive devices (a leading cause of injuries in Afghanistan) cover the walls (Fisher 2011). Veterans experiencing

TBIs, Multiple TBIs, PTSD and CRPS from Canadian peacekeeping and combat missions are also common at the hospital today. Joint Task Force 2's counter terrorism unit, engaged in covert high-risk deployments overseas (Government of Canada 2014), also continue to use the machine extensively. These soldiers pose unique challenges for physiotherapists and occupational therapists, who are unable to complete workplace assessments given restricted access to JTF2's headquarters at Dwyer Hill near Ottawa. At the time of my research, the use of the CAREN system *primary for PTSD* was transitioning from clinical trials to clinical treatments at the hospital. Clinical treatments focusing solely on PTSD generally involved members of the Canadian Forces who had previously participated in the trials.

Interdisciplinary teams work with each patient at the Centre, for example: physicians, clinical nutritionists, pharmacists, nurses, occupational therapists, speech pathologists and physiotherapists. Links to community-based services and events are also provided and the Centre is well networked with non-profit organizations and Government services for persons with disabilities. Rehab Engineering at the Centre deals extensively with CAREN system upkeep and repair, research, prosthetics, and modifications and repairs to wheelchairs and other assistive devices. Nationally, the Centre is known for its holistic approach to patient care.

DATA ANALYSIS

Following completion of my work, the Ottawa Hospital mailed my field notes, files and consent forms to the University of Victoria. Electronic information was wiped from my hospital computer and downloaded onto an encrypted USB stick that was also protected by a locked device. Project photos and film footage were transferred to an

external hard drive. Duplicates of audio-visual files were mailed by the hospital. The USB stick and external hard drive accompanied me on my flight home. Once the project was completed, the transcriptionist deleted personal project files. A research assistant later labeled video footage for the purposes of video editing and data analysis.

Approximately 830 photos and 200 film clips were taken with a Canon EOS Rebel T5i – a camera popular with solo documentary filmmakers. A Rode directional microphone was used with the camera and ambient audio was captured with an H4N stereo recorder. Interviews were recorded using a Sony ICD-UX533.

Interview transcripts, clinical observations, and demographic information were imported into NVivo Qualitative Research Software. NVivo facilitates text searches and coding. Multiple data sources can also be reviewed at the same time while working with the program. For example, if a patient notes a particular illness or CAREN application in an interview, a window can be opened simultaneously featuring an associated observation. Likewise, text searches and unique data modeling options allow the ethnographer to consider the data from multiple perspectives.

Transcripts were ‘cleaned’ prior to import and participant names were removed and replaced with pseudonyms. The entire NVivo file is locked and password protected. Only I have access to the file. I also thematically coded all transcripts. As a qualitative research process “thematic coding” involves the systematic identification of common themes across the data (Gibbs 2007). Initial transcript coding themes followed the pre-determined topics of semi-structured interviews; however, “inductive” codes also emerged over time, allowing for participant understandings of the CAREN system (Brinkmann and Kvale 2015). For example, the “aftereffects” of the system emerged as a

common theme throughout observations and interviews. Over the course of the project audio-visual data was also reviewed with an emphasis on the perspectives, movements and representations the CAREN system fosters. Here, visual anthropology is used for research presentation and as “part of the research process” (Murdock and Pink’s 2005:149).

Field note analysis first centred on the pre-determined focus of observations (i.e. interactions between practitioners and patients, roles, representations of the body in the CAREN system during clinical sessions and digital geographies, etc.). The reflexive, multi-column approach to field notes assisted the ethnographer in critically reviewing related observations. Participant observations were also considered in relationship to interviewee narratives and the associated videos and photos of the system. Points of agreement and disagreement between observations, narrative accounts of the CAREN system and videos and photography were also noted. A case-by-case analysis was conducted documenting central themes. The ethnographer’s own use of the system benefited data analysis. The relationship between power and sensation was also documented, a critical area lacking in sensory ethnography today.

ETHNOGRAPHIC ETHICS AND PRACTITIONER ENGAGEMENT

Site selection in Canadian anthropology is marked by its own kind of politics. There are also obvious ethical issues that arise from conducting research on a military technology at a Canadian hospital. This section explores the politics of fieldwork location in Canada, provides advanced discussion of the ethics of fieldwork, and energizes debates in applied anthropology with a discussion of anti-oppressive practices in medicine and my own commitment to action as a clinical ethnographer.

The Politics of Domestic Fieldwork

My decision to conduct research on science, technology and medicine at a Canadian hospital is rooted in a critique of anthropological practice in Canada that lays claims to ‘the study of human diversity’ while maintaining exclusionary practices. My decision to conduct research ‘close to home’ doesn’t mean that I ignore human diversity in my research; rather, it represents resistance to the fetishization of human difference through a rejection of dominant understandings of fieldwork, including the prioritization of overseas studies. It also comes at the risk of professional marginalization.

White, straight, cis-gender, middle-class anthropologists devote themselves largely to the study of racialized people, Indigenous communities, LGBTQ2+ people and poverty class contexts where people struggle to meet their basic needs. This would be less problematic if anthropology itself was more inclusive. In *Culture and Truth the Remaking of Social Analysis*, Renato Rosaldo (1993) indicates similar issues in American Anthropology. It has also resulted in “lost credibility” amongst academics external to our field and in community-based contexts outside of university settings (AAA 2007). As an instructor I invest a lot of energy in supporting minority students in a discipline that often marginalizes their experiences in the classroom while fetishizing their experiences through selective understandings of fieldwork.

For a paper presented at the 2016 Ethnography in Canada Conference, I conducted a review of every anthropology website in Canada (Perry 2016) – I could find none featuring a tenure track position for an anthropologist specializing in research conducted *only* in Canada that was not fixated on Indigenous communities. While it is common today for anthropologists to trouble the distinction between the local and the

global in their fieldwork, it is still the global, not the local, that carries ethnographers' careers. There is also a persistent fetishization of the Indigenous. Canadian anthropologists write about all kinds of things - from experiences of genetic testing for Huntington's disease in Vancouver, to Haitian performance art in Toronto. In practice, however, the exoticization of the 'Other' is still rewarded. This, I think, has gone unchallenged.

There are also dualities carried along with the idea that domestic research contexts are less valuable than studies conducted out of the country. When overseas ethnographies are valued more than domestic ethnography it's easy to engage in a series of dualities that anthropologists like to think of themselves as working against. Feminist ethnographers may be familiar with the idea that what's 'close to home' is undervalued. When overseas ethnographies are valued more that tells us something about how we understand culture and relies on much older narratives of expansionism, the colonial gaze, international relations and power. This also hints at a tacit understanding that local contexts are acultural. They are natural, not worthy of ethnographic inquiry in the same way. Or if the argument is a matter of distance, that local ethnographers can't gain enough distance from their topics of study, you begin to make assumptions about self and other that Indigenous anthropologists, ethnographers from mixed cultural backgrounds, and feminists may disrupt (Abu-Lughod 1991). As a reminder we are always situated in relation to our research participants, there is no "gaze from nowhere" to quote Donna Haraway (1988: 581). Finally, privileging overseas ethnographies over local ethnographies carries along ideas about objectivity and subjectivity, about researchers

and research participants. These are a series of inferences that follow the politics of fieldwork location in Canada.

Anthropological theorizing tells us that culture is everywhere. It is not a box, nor is it static. Today anthropologists commonly describe networks, global flows and assemblages of people, things and ideas. Aihwa Ong and Stephen Collier (2005), for example, have worked hard to reconceptualize ethnography and the concept of culture, documenting global assemblages and the increasingly complex global flows of social practices, values and knowledge. Likewise, drawing from feminist and post-colonial scholarship, Michael Fischer (2003) encourages ethnographers to break away from 19th and 20th century dualisms such as North/South, East/West, Primitive/Civilized, and Us and Them, adopting ethnography as a form of cultural critique in a variety of contexts. My question is if anthropological inquiry is valid both here and there, and here and there can be intermingled, why do we continue to practice anthropology in Canada as though culture is out there?

Lost in Translation

Although it was clear in the project consent forms at the hospital that I was a researcher, I also had to reinforce understandings with my research participants that I was not a healthcare practitioner. Many patients initially viewed me as part of the clinical team. This is common in my experience working in science, technology and medicine, where the role of the ethnographer is not well understood. It also represents a failure in Canadian anthropology to engage in adequate public outreach regarding ethnography. A common reference point for anthropology at the hospital was “Indiana Jones” (Spielberg 1981), a highly colonial and problematic representation (Shohat 1991) of our field in

overseas archaeology. Challenges aside, I was welcomed at the hospital as a multidisciplinary researcher working in a clinical setting. The daughter of the director and founder of the Institute for Rehabilitation Research and Development at the Ottawa Hospital is a cultural anthropologist. This was a key asset in getting the ethnography off of the ground given how poorly understood medical anthropology is in Canadian healthcare settings.

In Canada today, nursing and sociology departments lead the way in clinical ethnography; however, substantial barriers still exist for ethnographers seeking to conduct research in hospitals. Ethics processes are largely centred on clinical trials, representing a ‘culture clash’ commonly played out in bureaucratic processes associated with fieldwork. For example, at the time of my study there had been no precedent for a clinical ethnography at the Ottawa Hospital’s general campus. Eight months of full time ethics paperwork was required. Attending to the need for change will take time and a concerted effort on the part of anthropologists to engage in public outreach. Information falls through the cracks when health research is entirely predicated on statistical appraisals – qualitative research has much to contribute. These are discussions that should be pursued nationally with hospital ethics boards across the country.

Confronting the ‘Culture of No Culture’ and the ‘Difference of no Differences’

The majority of clinicians, engineers, and researchers at the hospital had been trained to view science and biomedicine as value neutral, outside the purveyance of culture. Allowances were made for the idea of bioethical assessment after the fact, but the very idea that drugs, machines, labs, clinical trials, and assistive devices *shaped culture* and *were shaped by culture* from the very beginning was a harder idea to sell.

These understandings were so strong that not even Christmas themed CAREN applications used with practicing Muslims and Jews could disrupt the idea of value neutral medical practice. “What’s Christian about Christmas?” practitioners asked, who were deeply steeped in traditions they could not see.

In her ethnography of high energy physicists, Sharon Traweek describes a culture of no culture “which longs passionately for a world without loose ends, without temperament, gender, nationalism, or other sources of disorder—for a world outside human space and time” (1988: 162). Medicine, science and technology strongly inhabit cultures of no culture (Haraway 1997). However, theorizing is one thing, “confronting culture in medicine's culture of no culture” in an attempt to make healthcare safer for human difference is another (Taylor 2003: 555).

The “colour blind ideology” (Frankenberg 1993) liberal White supremacy advocates, ‘we are all the same,’ also wipes out human differences and structural factors shaping experiences of social inequality. Medicine’s “culture of no culture” and liberal White supremacy’s “difference of no differences” work in concert in selective practices with the CAREN system. These values underscore the importance of mainstreaming anti-oppressive education for medical professionals in Canada and the need for more culturally robust approaches to medical ethics and new technologies.

Anti-Oppressive Practice in the Clinic

Medical practice is strongly mediated by institutional norms and agendas (Good 1994). Shifting understandings of clinical care as value neutral is a difficult task. Anthropologists have also critiqued biomedicine’s focus on ‘crisis based interventions’ to the detriment of day-to-day factors influencing patients’ experiences of health, wellness

and healing (Lock and Gordon 1988). This works against situating inequalities as a critical feature of health outcomes. One friend described the disorientating state of her transition from medical anthropology to medical school as an education in tensions. How to proceed when working with clinicians?

Anti-oppressive practice in clinical care seeks to move beyond inclusion – to empower patients historically marginalized by biomedicine (Rai 2017). It also centres on the idea that clinicians themselves are embedded in broader systems of power, but that they can partially subvert rules, procedures and practices that are oppressive through strategic counter practices (Rai 2017). For example, identifying bureaucratic loopholes, patient advocacy, civil disobedience, lobbying government, and educating other clinicians and healthcare practitioners about stopping discriminatory practices. In Ontario, physicians involved with migrant workers’ rights movements and immigrant and refugee health have led the way (Beder 2017; Rai 2017). Processes of colonization (Kelm 1999), racialization (Bashford and Levine 2010), homophobia and transphobia (Bayer and Spitzer 1982) are also intimately tied to the history of medicine itself. Educating physicians about this history is also centred as an important component of providing clinical care that is responsive to the diverse needs of patients from a variety of backgrounds (Rai 2017). These activities help to disrupt claims of neutrality in the clinic and the persistent marginalization of certain populations in healthcare.

In Canada, the work of ethnographers in the clinic often overlaps with “social determinants of health” research conducted through medical schools and affiliate research institutes (Mikkonen and Raphael 2010). Here, social inequalities are identified as an important feature of health outcomes (Mikkonen and Raphael 2010). What, however, is

determined? Why not shift the cultural milieu? Why document without action? For example, is it ethical to conduct a clinical trial housing “homeless HIV positive patients” (Buchanan et al. 2009) when we can clearly anticipate the outcome? Anthropologists too negotiate a thin line between offering up cultural critique and a voyeurism of pain. Working towards principled approaches to reducing human misery is an ongoing project in both healthcare and anthropology.

The Ethics of Engagement

Recently, the American Anthropological Association issued a statement denouncing the US Military’s Human Terrain System Project, featuring teams of social scientists, including anthropologists, embedded in Iraq and Afghanistan (AAA 2007). These projects violate the Association’s mandate that anthropologists “do no harm” (AAA 2007). Critiques of the militarization of anthropology (González 2007) are nothing new and played a critical role in shaping the politics of anthropology during the Vietnam War (Price 2004). The ethical conduct of ethnographers engaged in military projects continues to be debated in anthropology today – the Canadian Anthropology Society, however, has remained disappointingly silent. The society is currently debating “whether or not CASCA should adopt a code of ethics” (CASCA 2017).

My own role as an anti-war activist and my personal discomfort with the links between “The War on Terror” and racial profiling and the erosion of civil liberties in Canada (Perry and Kang 2012) complicate my relationship to war. I also feel an uncomfortable politics associated with some of the poverty class communities in which I grew up. With limited resources and support available to pursue post-secondary education, predominantly young men bore the personal cost of war in order to have

access to education and training. My own social location as a minority, subject to multiple violent hate crimes, also makes it difficult to adopt a strictly pacifist stance. Self-defense and community organizing can be a matter of survival.

An ethics of practitioner engagement poses unique ethical challenges associated with the military. For example, how can I honour the time, emotions and effort soldiers put into the project while remaining attentive to the tensions militarized healthcare poses? Soldiers were essential to understanding the CAREN system's history and how the wounds of war impact people's personal lives and experiences of virtual reality treatments.

I predicated the study on four ground rules. First, I would engage in outreach regarding the findings of my study with the military. This included participation at the Canadian Institute for Military and Veteran Health Research's Annual Forum in Toronto. Second, I had to acknowledge that understandings of military service varied greatly between service members and often differed substantially from my own. Third, I would not back down from related critiques of the system. Fourth, I would engage in outreach to the military but I would not accept money or co-publication opportunities with the Canadian Armed Forces. The prospect of co-publication of the project under the umbrella of military research was a possibility posed during my data analysis phase.

Ethnographers Document, Practitioners Take Risks

By participating in a new form of medicine, practitioners took risks. They figured out what worked and what didn't. They revised clinical techniques every day, inductively working with the system because the minutia of clinical practice with the machine had never been fully developed. Most of the clinical techniques I document in this

ethnography have never been documented before. My role as an ethnographer is to critique, but also to honour ‘the work,’ ingenuity and uncertainty that goes into exploration. At times the risks were rewarding. For example, when patients with debilitating TBIs unexpectedly improved after treatments with the machine. At times practitioners failed. For example, when patients navigate virtual worlds populated with racist Edmonton “Eskimos” sports team logos. As an ethnographer I document the stakes involved in new territories in medicine, but also the vulnerability inherent in working with new forms of medicine for the first time. It is easy to critique, but less so to attempt the work of care using new medical tools. Patients also live with the consequences of practitioners’ representational choices in the CAREN system.

Ethnography and Contextual Limits

Throughout my ethnographic research I was invited to social events by both military and civilian physiotherapists. As a researcher far from home these moments were welcomed. While the social events were revealing in terms of the personal lives of practitioners, this material was not included as a source of ethnographic data. Dinners, parties and other social events were ‘off limits.’ I tried to get to know practitioners, but explicitly kept these social events out of the data out of respect for participant’s privacy and the bounds of the field site dictated by the hospital.

RESEARCH DISSEMINATION

Figure 15: Research Dissemination Process



Research dissemination for the project is staggered between practitioners, the public, and anthropologists and philosophers of science, technology and medicine. This study addresses a poor linkage between the social sciences and practitioner-directed studies of immersive virtual reality. Critically, the voices of anthropologists have remained largely absent from literature on applied virtual reality. To foster better community linkage (Schultz et al. 2001: 548) and reciprocal research practices (Maiter et al. 2008), a technical report will be ‘gifted’ to the Ottawa Hospital. The report will address central themes in this study and, if applicable, will provide specific design recommendations based on the study’s research findings. Additional outreach may be undertaken at practitioner-directed meetings and conferences, including hospital rounds.

Several art shows, featuring project photography, and film screenings will be undertaken with project data. The use of full body immersion virtual reality for clinical treatments is poorly understood in Canada. The social issues linked to these new forms of medical technology are even more poorly understood. As part of research dissemination I will also create a press release about the project and contact major Canadian media outlets to further public dialogue. The Ottawa Hospital will be contacted and given the study’s report prior to public outreach.

Finally, I will craft the dissertation into a book for publication. Implications for anthropological method, theory and practice are far reaching and embodied accounts of virtual reality are rare in the literature. Studies of sensation in anthropology also sidestep questions of power. Through this three phase approach to research dissemination I hope to make my research accessible to different audiences. As an activist researcher, impact matters. Ultimately this project opens up areas for anti-oppressive practice in the clinic by exploring virtual reality and assumptions about the body.

STUDY LIMITATIONS

There are several limitations to this study, including a regional bias and limited engagement with French speakers. First, this study neglects primary research on the use of the CAREN system at Glenrose Rehabilitation Hospital in Alberta. Alberta, for example, is a key leader in the development of CAREN software in Canada. Furthermore, given that the Ottawa Hospital and Glenrose Rehabilitation Hospital share twin CAREN systems, they are engaged in ongoing knowledge exchange.

French speaking contexts remain outside the purveyance of this study, demonstrating an explicit bias for English. As someone who grew up transnationally between the Southwestern United States and Canada, I received education in Spanish as a second language, not French. Québécois participants in the study all spoke fluent English, however, French was their first language and it is likely my ability to speak French would have deepened my relationships and the content of interviews. Many initially assumed I spoke French as a first language. At the hospital, and in the Glebe where I stayed throughout the duration of my fieldwork, it was not uncommon for me to be greeted or

asked a question in French rather than English. A registered French translator was hired to translate project consent forms and recruitment packages for Québécois participants.

CONCLUSION

Sensory ethnography enhances this study in several critical ways. First, sensory ethnography draws attention to how sensory modalities are not discreet; rather, they are dynamically intermingled (Ingold 2000; Pink 2009). For example, the use of film to examine kinetics and perspective in the CAREN system is supported by the idea that vision is not exclusively concerned with sight, but dynamically linked to other sensations.

Second, the research questions posited in this study are structured with an explicit emphasis on the perspectives, movements and representations immersive virtual reality technologies foster. A multi-sensory approach to data collection is well suited to a study preoccupied with diverse sensory experiences. Furthermore, participant observation featuring filming of the researcher's own use of the CAREN system allows for relational and reflexive interviews centered on participants' and the researcher's experiential use of the machine. The CAREN system, in this way, is grounded very much in unique embodied experiences of new technologies in addition to the normative body.

Third, developers, practitioners and researchers in a variety of disciplines have already documented benefits associated with multi-sensory research methods in studies of immersive virtual reality. This study's emphasis on intersectional bodies, sensory ethnography and power brings a social science lens to an area of research that has historically drawn from multi-disciplinary research methods in fields such as cognitive psychology, biomechanical engineering, behavioural science, informatics, and neuroscience (Durlach and Mavor 1994; Barfield and Furness 1995; Kim 2005).

Fourth, sensory ethnography fits comfortably with research approaches emphasizing the anthropology of embodiment. For example, Thomas Csordas' (1990) calls for a research emphasis on perception, corporeal experience, sensation and embodiment first shaped the development of sensory ethnography as a methodological focus in anthropology (Pink 2009: 24). Furthermore, Csordas' (1997) challenge to anthropologists to engage more deeply with questions of embodiment and virtual reality as a specific topic of study is complimented by a methodological focus on multi-sensory experiences.

Finally, by building new partnerships and challenging disciplinary boundaries this ethnography is a call to action in an area of medicine that remains understudied and unexplored by social scientists. From a practitioner's perspective these practices are largely value neutral – but here the virtual clinic, like all clinics, tends to reproduce inequalities. I invite clinicians, activists and other practitioners to be a part of a process of appraisal. If digital worlds are here to stay in medicine, what should they look like and how should they feel? Should we create them at all when basic services in healthcare are cut? How can anthropologists meaningfully engage with clinicians, practitioners and the public? For patients, it matters.

MOVEMENT: CHAPTER FOUR

Human movement and the movement of the CAREN system are coordinated in clinical approaches to virtual reality treatments. They are also informed by “body work” in physiotherapy, as clinicians attempt to translate therapeutic practice into digital worlds (Van Dongen and Elema 2001). Here “movement” does not just represent the therapeutic range of CAREN treatments, but how assumptions about the body inform clinical practice. Algorithms, hardware, and clinical techniques coalesce in assumptions about the body in hospital-based virtual reality. More specifically, Chapter Four addresses the question of how dominant values about the body leak into multisensory practice at the Virtual Reality Lab. During the use of the CAREN system, what assumptions are made about movement? How do they manifest in practice?

Chapter Four provides an orienting framework for the study, examining some of the basic assumptions about body work, preparation and aftercare that guide CAREN clinical practices. Little of this work has been documented before. Some clinical techniques are surprising. For example, in the CAREN system science fiction aesthetics are literally brought to life as therapeutic robots push patients to engage in new physiotherapy challenges. The CAREN system’s multisensory features are also carefully choreographed to work in unison with the system’s movements for the benefit of physiotherapy. Here the CAREN technician’s metaphor of “stage craft” references the importance of timing, follow through, and calculated clinical plans. Clinical strategies with the system also vary by patient condition, prompting a range of approaches to CAREN treatments – each dependent on clinician expectations for patients. How and

why patients move are important questions for clinicians working with the CAREN system.

PREPARING TO MOVE

A representative from Motek Medical's head office in Holland has arrived at the hospital. He pitches a presentation on the future of healthcare and brings stroopwafel – a sweet Dutch treat. The presentation begins with an argument between a physiotherapist at the hospital and the representative. Motek Medical is selling its new line of human biometrics software. The physiotherapist says that a well-trained clinician doesn't need biometrics software, and argues instead that a good pair of eyes can quickly assess a patient's body movements. With over 20 years of experience, many physiotherapists at the hospital were involved in the Department's early Gait Lab in the 1980s. Human Body Modeling software is also sometimes limited in its ability to identify the ideal biomechanics of bodies with disabilities, bodies that don't conform to norms dictated by algorithms. Later in an interview, the representative from Motek Medical describes his mystification with Canadian culture. The presentation concludes with the company's business plan for the future – a robotic, virtual reality driven revolution in physiotherapy, involving fewer and fewer clinicians. Motek Medical is in fact a conglomeration of over 40 suppliers, with additional links to the American, Canadian and Dutch militaries. Chances are, automated futures in healthcare are on their way.

While Motek Medical advocates staff reduction at the hospital to minimize expenses associated with the CAREN system, body work prior to, and in the machine, is strongly shaped by the skilful guidance of the hospital's physiotherapists in consultation with the CAREN technician. Clinicians describe a gradual process of getting patients

ready for CAREN system use through a variety of home and gym exercises. Patients are also carefully tested and screened before undergoing virtual reality therapies. Building a strong base from which to work with the CAREN system is a key feature of CAREN therapeutic approaches.

Readying the Patient

Patients and physiotherapists viewed the CAREN system as a complementary device for other therapies. Physiotherapy services at the Ottawa Hospital include use of a therapeutic pool, peer support groups, an exercise gym, stationary bikes, stairs for practicing climbing, resistance bands, weights, other machines and standard exercise devices. Practitioners at the hospital emphasize that the CAREN system is not to be used as a singular therapy. A physiotherapist elaborates:

Especially early on in rehab... I mean, the traditional strengthening exercises, flexibility, all the stuff, super important. And there's stuff that you have to do in the clinic that you can't do on the CAREN...So it really is a supplement, it is a tool in the clinician's toolbox to use.

Outpatients commented on the importance of activities such yoga, home weight training, and bike riding. The CAREN system was understood as an opportunity to test and bring together multiple areas of patients' body work. A patient accessing the CAREN system for a spinal cord injury explains:

I do a lot of rehab for my legs, my balance, and all of those usually are separate. You do the legs a bit and then the week after you work a bit on your balance and your legs and so on. I find the CAREN system brings all of that back together and puts you there and in the movements. It's one thing to walk in the gym and then look left and right and try to keep your balance, but doing that while you're walking on the treadmill and looking at a screen with moving objects it's the plus that you kind of need and that's how it helps me a lot.

Here CAREN therapies work in concert with traditional techniques in physiotherapy to help the patient build confidence in walking. This particular in-patient progressed from

an electric wheelchair to walking unassisted over a three-month period. Physiotherapists also use supplementary devices creatively inside the machine. Yoga mats, resistance bands, weights, and mirrors are all used in conjunction with the machine. One physiotherapist, in consultation with the CAREN technician, developed a paddleboard application. The mock-up benefits from resistance bands tied to the base of the system's sidebars and a kayak paddle:

I had a client who that was her goal. She wanted to be able to paddle board on Mooney's Bay. So the technician basically made that one up and we, together, found what we needed to have on that particular app, and so that I use a fair bit as well for balance. So we had her sitting on the treadmill and then kneeling and then getting up, just like you would on a real paddleboard and then you can increase the waves too, so it had all the components that we needed.

Figure 16: Paddleboard Application with Kayak Paddle and Resistance Bands



Most patients accessed the system only once per week, but it allowed them to bring together elements of their regular physiotherapy sessions in a safe and challenging environment.

The Test

A screening test I use is using the Wii system that we have... just to make sure they can tolerate a screen and the effects of a screen because a lot of the clients don't like it very much. And then if I think they're appropriate, then we go ahead and set up a trial down in the CAREN lab. – Physiotherapist

Clinicians have to decide which patients are appropriate for CAREN system treatments. Space is limited and the machine is not considered appropriate for all patient populations at the hospital. In the physiotherapy department's gym, physiotherapists can also treat two patients in the same amount of time it takes to treat one in the CAREN system. Given the effort required, clinicians have to have a good justification for virtual reality therapies. The system's timesharing with the Canadian Forces also places civilian patient time at a premium.

Prior to beginning CAREN sessions, patients were commonly asked two questions. Do you get sick when you watch IMAX films? How are you with Nintendo's Wii? IMAX screens encapsulate viewers in a domed screen environment, providing a sense of visual immersion (IMAX 2017). Nintendo's Wii system allows users to play games with their bodies (Nintendo 2017). The CAREN system was often compared to both. Wii has proven a popular choice for physiotherapy and recreation at long-term care facilities and in rehabilitation hospitals (Pompeu et al. 2012). Prior to admission, a more formal assessment is also conducted:

- "Patients must be able to consistently follow verbal commands and observe safety precautions."
- "Patients must be able to tolerate wearing a full body safety harness."
- "Patients with amputations should be able to tolerate socket wear for 30 minutes in a weight bearing position."
- "Ambulatory patients may use gait aids and they should be able to stand for 30 minutes."
- "Patients with Antibiotic-Resistant Organisms will not be accepted" (Information Sheet for Practitioners).

Patients prone to motion sickness and severe light and sound sensitivities often did not do well in the system. Antibiotic-resistant organisms also posed a challenge to clinical treatments given patient contact with the full body harness and handrails. The harness has to be wiped down in between sessions when it becomes damp with patient perspiration. In many ways the patient's very first session was used as a test of their ability to withstand the sensory overload the CAREN system sometimes caused. For these reasons, clinicians and the CAREN technician were very careful to screen patients.

The Tour

Welcome to the Rehabilitation Virtual Reality Lab. To make your session successful, please see the following instructions:

1. Wear snug fitting, non-reflective clothing and no loose hair or jewelry.
2. Wear gym shoes that are non-reflective.
3. Secure long hair close to your head.
4. When you arrive at the Rehabilitation Virtual Reality Lab, please wait in the reception area for your therapist.
5. Be aware of and follow the safety rules of the Rehabilitation Virtual Reality Lab at all times.
6. Be on time for your appointment.
7. Please notify your therapist in a timely manner if you are unable to attend the treatment session.

– Information Sheet for Patients

The CAREN technician prepares for the patient orientation with a cup of Earl Grey tea. It takes a lot of energy to provide a tour of the CAREN system and to carefully monitor the patient for side effects during their first session. “This is the harness, I’ll clip you in.” A tether to the harness is adjusted to match the patient’s height. The screen, treadmills, pistons, force plates, body markers and safety controls are all explained. There are two bright red emergency stop buttons, one on the CAREN technician’s console and one on the platform. The patient is advised not to “over do it” during their

first CAREN experience. Patients often underestimate the impact of the machine. One patient, with CRPS, repeatedly ends up on the floor. A bed is eventually brought into the Virtual Reality Lab. Another patient loses all sense of time and place after returning home – a “delayed reactor” is a common refrain.

The system is mostly used for therapies; however, there are times when it informally serves as a diagnostic aid. A patient’s foot suddenly jerks out to the left after walking for 15 minutes, something the physiotherapist has not seen before. The CAREN technician stops the system. The application is repeated as the technician and physiotherapist try to make sense of what they are seeing, “you don’t want to go left!” In this session a problem with sensory input is identified in the left foot of a patient with GBS, a surprise to everyone because the left foot is technically stronger than the right foot. First sessions help patients make sense of the CAREN system and help practitioners make sense of patients’ body movements.

Practitioners also orient patients with a list of safety precautions:

- “No one will be allowed to use the CAREN system without a certified operator present and a second person (either the attending clinician or researcher) present.”
- “No one will be allowed onto the platform unless initially accompanied by the operator or attending clinician/researcher.”
- “No one (patients, research participants, staff, visitors, researchers) is allowed on the CAREN platform without a safety harness while the system is in use.”
- “The attending clinician/researcher and operator are responsible for ensuring that the harness is properly secured.”
- “The attending clinician/researcher and operator are responsible for ensuring that the tether rope is the correct length.”
- “All persons on the platform should be facing the screen.”

- “No one will get on and off the platform without using the bridge.”
- “Authorized spectators will be allowed to attend clinical/research sessions at the discretion of the attending clinician/researcher and will be asked to stay in a specified area” (Information Sheet for Practitioners).

If used incorrectly the system can be dangerous. Padding has been added to the harness support bars to prevent patients from hitting their heads on the system, something that, unfortunately, has happened in the past. The machine itself requires a key to operate – only certified technicians trained by Motek Medical have access to the key. A bridge is carefully extended to the platform as patients mount the system to prevent falls into “the pit,” a dark area beneath the system that houses the hydraulic pistons that the dual treadmills rest on. There is also a drain at the bottom, in case patients vomit. Wheelchair users are brought onto the system with a low-tech wooden board that fits into a small gap, only a few inches in diameter, between the extended bridge and the platform.

Wheelchairs are not used in the system and are removed from the platform prior to beginning sessions. Walkers and canes are not uncommon, particularly with patients who have experienced strokes, GBS or spinal cord injuries.

The patient, clinician and technician work carefully in consultation to develop therapeutic routines. A patient emphasizes:

I really believe it's a three-way dialogue between the physiotherapist, the system operator, and the patient to talk about what kind of activities they should work on as well as what particular settings and speeds. So it's a case where I feel very empowered.

Typically this involves activities to improve gait, balance, physical conditioning, functional training, and “neural desensitization” for the complex symptoms experienced by patients with TBIs that require gradual exposure to sound, light, and movement. Once therapeutic objectives have been achieved CAREN patients are discharged. Some use the

system for months, others for weeks or days. Most patients who participated in my study viewed it as a distinctively unique experience, unlike anything else they had done before.

Body Sensitivity and the Therapeutic Process

The CAREN system requires patients to develop a particular “body sensitivity,” characterized by anthropologist Loïc Wacquant (1995) as a physiological re-socialization. The CAREN system is not a “post-bodied” digital experience – it is predicated on body technique (Featherstone 1995: 243). For the CAREN system to work at its best in physiotherapy correct body technique and corporal knowledge of multisensory games must be embodied unconsciously through repetition, physical corrections on the part of the physiotherapist, and the strengthening and expanding of body skills after illness, injury or disease. Wacquant emphasizes, “it cannot be effected by an act of will or a conscious transfer of information. It necessitates, rather, an imperceptible embodiment of the mental and corporeal schemata” (1995: 72). In this way virtual reality sometimes works best in physiotherapy when it is so thoroughly embodied that it eclipses patient awareness. It is at that point play can be realized in physical therapy because the rigour of clinical body directives and working with the machine have become second nature. There are no longer interruptions of CAREN play by the physiotherapist with constant reminders of correct body technique. The peculiarities of the machine have been worked through by the patient, it’s sudden stops and starts, time lags and quirky ways of registering body movements – the patient has it nailed and can give into the joy of play. Pain can intercede, but at times the machine’s capacity for play is so fierce patients gleefully push through for the thrill of the game.

Thinking About Movement in Clinical Virtual Reality

A new buzzword in anthropology, “movement” may point away from the power structures that regulate life and toward the mobilities, strategic and otherwise, that exceed those systems. But for me, this shift is important not only for what it signifies about liberatory turns in ways we think about power, but for what attention to tensile, cultivated and restless ways of being in the world bring to light about living with suffering – Sarah Pinto (2011)

In medicine movement is understood as both a cure and pathology (Pinto 2011).

In the physiotherapy department’s gym, patients’ bodies burn with pain as they strive to rehabilitate from illness, injury and disease. For some patients this means learning to move with new limitations, for others it means regaining movement where it has been lost. The difference between the gym, with bars, stairs, treadmills, and weights, and the CAREN system, is a question of sensation and generally play. Power is also implicated in clinical practices with the CAREN system as assumptions about the body inform and direct activities with patients in the machine.

The primary CAREN technician likens her work to stagecraft, much like the dance studio where she assists with teaching, rehearsals and shows. Over a 1000 pounds of metal make the CAREN system a cumbersome dance partner. Patients, however, over time learn to move with the machine. Physiotherapists at the hospital describe a process of learning to “read” patients’ bodies during CAREN therapies, negotiating a delicate balance between issuing directives and taking in patients’ bodies “where they are at.” This “reading” of the body described by physiotherapists is dependent on subtle cues. It is described as a skill acquired over time by working with particular patients. A nervous laugh, a leg twitch, grumpiness – all can signify that the CAREN patient has had enough, that the session is moving away from the therapeutic threshold towards a place of harm, over exertion or too much pain. Anthropologist Cheryle Mattingly (1991) describes this

as a “habituated expertise that allows the therapist to pay attention to relevant cues” and to respond by shifting therapeutic practice (983). Physiotherapists at the hospital describe cultivating this sensibility and approach to care after decades of work.

Anthropologist Sarah Pinto (2011) cautions ethnographers to remain attentive to the aspects of movement in medicine that are indicative of power, while remaining aware of the more enlivened aspects of movement that resist interpretation. Intersectional approaches to embodiment also address resistance in enlivened bodies (Taylor, Hines and Casey 2010). Skilful clinicians don’t overdo it with patients in the machine. Skilful patients can sometimes relax and enjoy the playfulness of their experiences in the machine. As Chapter Five will demonstrate, the CAREN system is sometimes most useful for clinical care when it is used in ways it is not designed for. This is because the relationship between technologies and bodies can be messy (Star 1990) and resistant to assumptions, even in hospital settings that prioritize routine, control and predictability (Fadiman 1997). Bodies cannot be squeezed into the machine and its’ associated sensory features as is, clinical ‘riffing’ and improvisation is generally required.

As patients are taught to use the system they learn to self-regulate their desire for play and physical compensation for changes in the body following illness, injury or disease when it pulls them away from the therapeutic objectives of physiotherapists. Overtime many physiotherapy patients also embody clinicians’ therapeutic techniques for movements in the machine – at that point they can sometimes relax and just have fun. Once you’ve learned to play therapeutic virtual reality Pong the right way, and you don’t have to think about it, you CAN just have fun. Fun, joy and play can be an important feature of therapy (Zahr 1998).

Play has been characterized as “pleasurable, distinct temporally from other behaviour, and distinct in having a make-believe or transcendental quality” (Norbeck 1974: 1). The make-believe and transcendental quality of clinical virtual reality is what makes it such a powerful tool in physiotherapy. However, as clinical observations demonstrate, it is also important not to overstate patient experiences of the machine. Impatient patients can grow weary when they are expected to move in ways that do not come naturally – here boredom can fill sessions where time is “endured” (O'Neill 2014: 9). They want to play games quickly and impulsively because it is fun, but the physiotherapist won't let them, at least not just yet, not until they get it right (or as close to right as possible). In this sense, in CAREN treatments physiotherapists learn their patients' movements and patients learn how to move – it is a feedback loop with some degree of freedom and some degree of control. Here bodies are both enlivened with play and schooled in therapeutic techniques.

FUTURE MEDICINE NOW

So the CAREN system, what it does is it just offers a whole new environment of potential things that one can do, which just is the icing on the cake for rehabilitation in my mind. Yes, as I said, I really see it as a really futuristic system. – Patient

Patients and clinicians encountering the machine for the first time marvelled at the CAREN system's impressive technology. Visually, the machine is imposing. Lights blink, pistons hiss, the treadmill spins and roars. Infrared motion capture cameras glow red and blue. The curved screen provides a sense of immersion, even if you are not physically on the system's platform. For this reason, viewers outside of the machine sometimes experience motion sickness and nausea. The walls, ceiling and floors are all

painted black in order to add to the experience of immersion. The CAREN system takes centre stage in the Rehabilitation Virtual Reality Lab. There is no professional association for virtual reality technicians in Canadian hospitals. Patients have a difficult time describing to outsiders exactly what kind of healthcare services they are accessing. Nearly everyone characterizes a sense of stepping into the future; that they are participating in future medicine now. When I look at the system I think to myself, “only the military would have funding for such a machine!”

Figure 17: The CAREN System as Futuristic Healthcare



Setting the Stage

The primary CAREN technician has a background in aerospace engineering and human kinetics. She also teaches ballet and was, for many years, an elite diver who trained with members of Canada’s current Olympic team. I identify with her inability to fit into tidy career trajectories. At 4 foot 11” she commands Black Ops military personnel five times her size with a calm authority. When they access physiotherapy or treatment for PTSD in the machine they listen to the technician. The primary CAREN technician is well liked by both patients and staff; a less personable operator would struggle with such diverse patient populations. The primary CAREN technician makes

operating the system look easy. When she is away some of the physiotherapists cancel their sessions – the backup operators just don't have the same knack for the system.

The primary CAREN technician's unique background in engineering, human kinetics and dance shapes how she understands her work with patients and the system. "Setting the stage" for clinical treatments is an important feature of each session. It also blurs the line between entertainment and medicine – the very feature of the system physiotherapy patients enjoy.

Technician: I do kind of treat running the CAREN almost like running a dance show...But what does help is that it allows me to kind of think about different perspectives of when you produce a dance, you want to think about how different people see it from different places [and] what it will look like from multiple angles. And the same in the CAREN, you have a camera perspective and that's what people see on the scene. But you also want to layer it so that you know what they're seeing at what time and that it makes sense...Having been a stage manager for my dance studio, [it's] knowing how to set things up so that when you look at it from a very specific perspective, it looks like it should. But if you look at it from behind, it's pieces of wood. But it looks really convincing from the front, but if you look at it from the side or the back, you're like oh god, just don't fall over.

Ethnographer: And so that's a little bit like the CAREN system graphics in some ways.

Technician: Absolutely, where you're making sure everything is designed specifically for that perspective, and you want to keep in mind that perspective and what you're trying to achieve with it. But everything else outside of that perspective, it could be nothing but like a rickety... well, it won't be rickety in the computer, but it can be a plane, it doesn't have to have anything underneath, it doesn't have to be real like you would in the real world, it just has to look right on the screen. So I think that's what helps me the most from there. And also the idea of making sure everything arrives at the proper time, so the stage managing, like okay, I have to be ready to turn this on exactly when this happens, and how to program events so that things happen as we want them to at very particular times, much like a stage show.

Here the work of the CAREN technician turns to stagecraft. Timing, scene changes and movement must all be carefully coordinated. It is not only for the benefit of therapeutic approaches, but also for patient safety. Activity on the screen, pistons and the treadmill must work in concert. Setting the stage for clinical treatments has to be done right.

Science Fiction Comparisons

“You're running what looks like a Star Trek console.” – Hospital Manager

“Have you seen the movie Star Trek? [to patient]” - Social Worker

“I feel like I'm on a Star Trek holodeck!!!” – Patient

Prior to my fieldwork, I toured Canadian CAREN sites looking for the right location to conduct my research. The first time I saw the machine I could not believe how much it looked like it came from a 1950s science fiction movie. Blinking green lights, large red buttons, the harness, the platform, and the sounds of the system as the bridge extended all had the aesthetics and ambiance of “Invaders from Mars” (Menzies 1953) or “Forbidden Planet” (Wilcox 1956). I also considered the Rehabilitation Virtual Reality Lab's aesthetic parallelism to Dr. Frankenstein's lab in “The Bride of Frankenstein” (Whale 1935). Like many patients, I couldn't resist taking photos of myself in the system and posting them to social media – it was the ultimate photo op.

Figure 18: Ethnographer Photo



Scholars have commented on science fiction’s reach into contemporary design and science. For example, “Microsoft, Google, Apple and other firms have sponsored lecture series in which science fiction writers give talks to employees and then meet privately with developers and research departments” (Gunn 2014).

Figure 19: Science Fiction Aesthetics and Clinical Virtual Reality



It was difficult for patients and clinicians to describe the system to their friends, family and co-workers. Comparisons to Star Trek’s holodeck, an environment of immersive and interactive holograms, were common in an effort to communicate just exactly what clinical virtual reality at a hospital looks like. The aesthetics of the system clearly contributed to patient’s experiences of participating in a world of futuristic

healthcare. Clinicians also strategically inserted “therapeutic” robots and UFOs into applications during treatments.

UFOs whiz loudly across the screen and robots stomp, shaking the platform up and down. A session for CRPS proceeds as follows:

Patient: Where’s those robots at, I’m going to beat up some robots!

Platform jerks as robots stomp.

Patient (making muscle man posture): Come on robots! Take that robots!

Technician: He’s doing well.

Figure 20: Therapeutic Robots



Military personnel accessing treatment for PTSD responded less favourably to robots and UFOs, which tended to frighten them. Other patients enjoyed the challenges the goofy cartoon-like imagery posed.

The CAREN System as an Event

Patients and clinicians felt they were participating in something special. More than a treatment, a CAREN system session was a unique event. The idea of a fully immersive virtual reality system in a hospital was both puzzling and exciting. During my

observations it was not uncommon for patients to bring friends and relatives into the room in order to show them the machine. Photos and video footage of the system were captured on patient cell phones and cameras. Hailed as “a game changer” in medicine, the CAREN system was also a media event, drawing attention from the CBC and other national news networks (Parry 2015). One reporter notes, “the virtual reality lab at the Ottawa Hospital looks like the bridge of a spaceship or the world's biggest video game” (Parry 2015). Here the primary CAREN technician plays a dual role as both a system operator and a public relations manager. With classic arcade games like Pong reimaged as physiotherapy, immigrants and refugees, poverty class patients, and elderly patients, who did not grow up with video games, also have a steep learning curve in terms of the system.

The game like quality of the machine was appealing to patients, who described it as a distraction from the pain and “work” of physiotherapy. One patient with a spinal cord injury emphasizes, “it takes away from the grind of being in a gym and having to work out and hurting. Your mind is quite occupied in having fun. And then you realize afterwards, whoa what an exercise I’ve just had!” Practitioners, however, were very careful not to refer to the CAREN system as a “game” – “application” was the preferred choice of language. In a climate of funding cuts, scarce resources and staff reductions, any hint of the system being used for entertainment was quickly dispelled. In my report for the hospital I was asked to minimize patient experiences of “fun” for fear hospital administrators would think the system was being misused. However, it was precisely the game-like quality of the system that appealed to patients, especially in-patients who had to live with gruelling physiotherapy routines and the boredom of day-to-day life at the

hospital. Many patients also liked the opportunity to socialize with the physiotherapists and CAREN technician. The joy during physiotherapy sessions was sometimes palpable. Laughter, clapping and cheering filled the room as patients attempted to navigate digital worlds and mark new achievements. Patients who had experienced significant physical and often socio-economic and lifestyle changes could sometimes take a brief respite from their worries and immerse themselves in a therapeutic game. The result was powerful and far more emotional than I anticipated.

CLINICAL STRATEGIES

Figure 21: Figures from Clinical Observations

A patient's "double hand slap" approach to hitting birds and butterflies in "Forest Road."



Careful weight distribution guides falling boxes in "Physics Box Drop," controlled with the system's force plates.

Clinical approaches in the CAREN system vary by patient condition.

Physiotherapists have to pay special attention to the patient's posture, ability to engage in controlled movements, balance, weight distribution, spatial awareness, and sensitivities to movement, light and sound. For patients accessing the system for PTSD, a physiotherapist or social worker maintains verbal contact with the patient, constantly checking in about their levels of arousal and hyper-vigilance. It is a lot to keep track of. In choreographing therapeutic routines the art of inserting objects, such as balls, robots

and photos into the screen at just the right moment is also important. The following section provides an overview of common tactics for working with the machine in different patient populations. It is important to emphasize that many tactics used by clinicians are used across patient populations. For example, CAREN treatments addressing a disruption of spatial sense are used for patients with both TBIs and CRPS. During observations both populations demonstrated a midline shift, or a shift in the patient's understanding of their body's centre.

Traumatic Brain Injury (TBI) / Multiple TBIs

Patients experiencing Traumatic Brain Injury (TBI) or Multiple TBIs accounted for 43% of the patients observed during clinical sessions. This study population represents the majority of CAREN users documented. TBIs ranged from mild concussions to patients who had experienced coma due to their injuries. Vehicle and bike accidents, combat and military training injuries, violent attacks, and falls were all reported. In terms of therapeutic treatment and symptom management, patients with TBI and Multiple TBIs represent some of the most complex cases associated with CAREN system therapies. Balance and movement disturbances, difficulties concentrating, light and sound sensitivity, nausea, dizziness, and headache were commonly reported. One physiotherapist viewed the CAREN system as a last resort for patients with TBIs who had tried every other therapy with no success; “the physiatrists are saying let's try the CAREN because you haven't had that and you've had everything else.” For patients with TBI/Multiple TBIs the CAREN system was commonly used to:

- Help identify triggers that contribute to difficulties concentrating, light and sound sensitivity, nausea, dizziness, and headache;
- Better identify specific areas of sensory difficulties;
- Recover sensory function or better compensate for sensory problems;

- Build tolerance to light and sound;
- Develop symptom management techniques;
- Practice cognitive dual tasks;
- Practice visual exercises.

Complex Regional Pain Syndrome (CRPS)

Complex Regional Pain Syndrome (CRPS) is a persistent pain condition believed to be caused by “damage to, or malfunction of, the peripheral and central nervous systems” (NINDS 2013). It most commonly impacts limbs, and generally manifests after trauma or injury to the limb (NINDS 2013). Many patients with CRPS will never live pain free, however symptom management techniques and body awareness can help reduce pain over the duration of the patient’s life and can sometimes help restore some functionality where it has been lost. One long-time CAREN user with CRPS emphasizes:

I didn’t think I would ever see pain levels this low, in all honesty. So I’m extremely happy and grateful for that. And just general stuff, walking around the house to do like small light chores or cooking, being on my feet for a longer period of time before that onset of pain. And then also the... I guess the education behind it, knowing, learning as I feel the onset of those symptoms, okay sit down, change what I’m doing, and then that’s going to help me throughout the rest of the day.

In this study the second highest user group of the CAREN system was patients with CRPS at 23%. For CRPS PTs endorse the use of the CAREN system to:

- Help identify pain triggers;
- Better identify specific areas of pseudo-neglect;
- Better identify specific areas of sensory difficulty;
- Recover sensory function or better compensate for sensory problems;
- Promote body awareness;
- Develop symptom management techniques;
- Regain limb functionality where possible.

Acquired Brain Injury (ABI)

10% of CAREN clinical observations were for patients with an ABI (Acquired Brain Injury). Patients with ABIs ranged from those experiencing autoimmune diseases to strokes. For these patients, the CAREN system harness can play a critical role in providing a sense of security and safety that allows both the physiotherapist and patient to push the boundaries of therapeutic sessions, particularly for those with significant mobility issues. One patient who had experienced a stroke emphasizes, “The CAREN specifically, it’s a really safe environment. I can push myself as hard as I want.”

Physiotherapists developed a variety of clinical tactics for dealing with stroke patients in the machine, including: mock-ups of horseback riding sessions to enhance core stability, placing tape on the patient’s shoes to prevent gripping to the CAREN treadmill surface during foot drag, and manually manipulating the patients’ limbs in order to assist with therapeutic body movements.

ABI conditions can be highly variable, however, throughout the course of observations physiotherapists used the CAREN system to:

- Enhance core strength;
- Develop balance, flexibility and upper and lower limb movements;
- Help identify pain triggers;
- Better identify specific areas of pseudo-neglect;
- Better identify sensory difficulties;
- Recover sensory function or better compensate for problems with sensory function;
- Promote body awareness;
- Develop symptom management techniques;
- Regain limb functionality where possible.
- Recover sensory function or better compensate for difficulties with sensory function;
- Promote patient awareness of weight distribution;
- Develop symptom management techniques;
- Practice cognitive dual tasks.

Spinal Cord Injury

Patients with spinal cord injuries accounted for 8% of clinical observations and represented some of the most dramatic recovery stories documented. One patient, who was initially reliant on a neck collar and electric wheelchair following trauma to his spinal cord, emphasizes:

So for me, the walking path (Forest Road) is something that actually has helped me tremendously. You yourself, you've been in pretty much all my sessions I think, and there's been tremendous improvement week after week, literally week after week I've been walking better and better and have more stamina and I can walk faster.

The patient also emphasized the important role of other therapies at the hospital used in conjunction with the CAREN system. Collectively, these treatments allowed the patient to take new risks, build confidence in walking and work on balance, flexibility and stability. Physiotherapists working with patients experiencing spinal cord injuries generally use the CAREN system to:

- Help fight the boredom of long inpatient hospitalizations and rehabilitation;
- Enhance core strength;
- Develop balance and flexibility;
- Promote patient awareness of weight distribution;
- Develop symptom management techniques;
- Practice cognitive dual tasks;
- Promote body awareness;
- Develop limb functionality where possible;
- Better identify specific areas of sensory difficulty;
- Recover sensory function or better compensate for problems with sensory function.

Guillain-Barré Syndrome

8% of clinical observations focused on patients with Guillain-Barré Syndrome (GBS), a condition where the “body’s immune system attacks part of the peripheral nervous system,” which can result in weakness, paralysis, compromised heart and lung function, and sometimes death (NINDS 2011). Patients experiencing even extreme forms

of GBS can go on to recover over time (NINDS 2011). Like patients with ABI and Spinal Cord Injuries, patients with GBS reported that the system's harness provided them with a safe opportunity to push the limits of rehabilitation with a particular focus on walking over variable terrain. The system also represented a good opportunity to work on core strength, flexibility, and balance. Patients with GBS reported heightened confidence in walking similar to that reported by patients with ABIs and Spinal Cord Injuries. The CAREN system's visual components were also useful when patients with GBS experienced compromised vision, giving practitioners and patients a better sense of where visual disturbances lie. The CAREN system's capacity to promote body awareness was also a central theme. One patient with GBS notes:

So the CAREN lab has been helping me ... with my awareness of where issues are in my legs where sort of there's deficits in the connections and giving me confidence... helping improve my confidence in terms of managing unfamiliar terrain, and teaching me basically how to walk normally again. I live in the country, I'm comfortable now walking a little bit more on fields or up a hill, whereas before I came here, I was really kind of scared of doing stuff like that because I wasn't sure how my balance was. So the insight and the confidence and the competence is really helpful.

Physiotherapists working with patients experiencing GBS generally use the CAREN system to:

- Enhance core strength;
- Develop balance, flexibility and upper and lower limb movements;
- Practice visual exercises;
- Promote patient awareness of weight distribution;
- Develop symptom management techniques;
- Practice cognitive dual tasks;
- Promote body awareness;
- Better identify sensory problems;
- Recover sensory function or better compensate for problems in sensory function.

Post-Traumatic Stress Disorder (PTSD)

During observations, 5% of patients accessing the system sought treatments primarily for PTSD. Over the course of the study CAREN treatments for PTSD transitioned from clinical trials to clinical sessions at the hospital. However, a large percentage of physiotherapy patients experiencing traumatic injuries, including combat related injuries or injuries as a result of military training exercises, vehicle accidents, and assaults, had a secondary diagnosis of PTSD. Therefore many patients with CRPS or TBIs also had a diagnosis of PTSD, although they were not accessing the CAREN primarily for that reason. In patients with PTSD the CAREN system was used by social workers and physiotherapists to:

- Pursue Exposure Therapy
- Pursue Eye Movement Desensitization and Reprocessing (EMDR) Therapy;
- Help identify triggers;
- Promote body awareness;
- Develop PTSD management techniques;
- Work on breathing, relaxation techniques, and self-regulation for hyper-vigilance;
- Identify and de-escalate Subjective Units of Discomfort (SUDs).

It is important to note that only military social workers directed Exposure Therapy treatments for PTSD fixated on reproducing targeted memories through the incorporation of patient's personal photos in the CAREN's 3MDR application. Physiotherapists did, on occasion, treat patients for "hyper-vigilance" associated with PTSD. These sessions tended to draw from elements of existing physiotherapy applications. For example, Tricky Road's robots and UFOs, which make loud noises and sudden movements.

Lower Limb Amputations

Patients with lower limb amputations represent the smallest user group in this study at just 3% of clinical observations. Practitioners reported that soldiers returning

from Afghanistan historically represented the largest user group at the hospital. One manager emphasizes:

I mean, you really saw the patient population morph over time where at the beginning, it was during the time when we were in the conflict in Afghanistan and you had a high percentage, almost 95 percent of the patients that were going on the system were lower extremity amputees and that was the population.

Isaacson, Swanson, and Pasquina (2013) point out “musculoskeletal extremity trauma has been estimated to occur in 50% of all injuries in theatre – with 2% of war fighters incurring limb loss” (296). Many CAREN systems in North America are owned by the military, and as a consequence much research has focused on the use of the system by patients with lower limb amputations. Physiotherapists work with patients with lower limb amputations in the CAREN system to:

- Assess gait;
- Allow patients to test new prosthetics over variable terrain;
- Practice running on prosthetic blades;
- Develop balance, strength and stability;
- Promote body awareness.

WHEN VIDEO GAMES BECOME MEDICINE

Physiotherapist: Your walking is quite fast.

Technician: Well done. This is a busy environment compared to the Park.

[“Train” application rocks back and forth.]

Technician: Why do I always get the competitive ones in here? I can make it winter. I can also put clutter in.

Patient: Clutter is fun.

Technician: There now you have lots to look at [inserting an umbrella, a magazine, a bag of Doritos and a Butterfinger chocolate bar into the passenger train car].

Patient: Are there any banana peels to slip on? I'm laughing too hard, give me a second.

There is an interesting tension between practitioners' resistance to understanding the CAREN system as a "game" and patients' love of the system because of its game-like qualities. Understanding CAREN system use as play has benefits in terms of thinking about the clinical impact of competition, speed, childhood nostalgia and getting lost in the experience. Play, as it turns out, can be therapeutic. A fact documented by researchers studying healthcare and child psychology (Zahr 1998). While the Children's Hospital of Eastern Ontario is directly adjacent to the Ottawa Hospital, children did not use the system. The average age of a patient using the system was 46. In the CAREN system, how does play impact clinical outcomes? What lessons does it teach us about therapeutic approaches to pain and physiotherapy? If we embrace the idea of games as medicine where does it lead us?

Figure 22: The Train Application



Competition

Physiotherapist: I know he's competitive, so I'm going to have to talk him down from that.

Technician: A lot of people who come here get competitive."

Patients can become fixated on high scores or completing applications in record times. The speed and height of waves in applications featuring water can be adjusted by the technician – daring patients request larger and larger waves as they progress through sessions. MM Boat, the Rope Bridge and Paddle Board all involve water and invite patients to navigate increasingly difficult wave patterns. Larger waves and blowing winds open up new challenges in physiotherapy. Other patients become fixated on increasing inclines in the Park or the addition of lightning and thunderstorms to add to the mix. During my observations former elite athletes used the system, including dragon boaters, marathon runners and bike racers. Many of the military patients engaged in highly demanding physical training prior to illness or injury. The challenge of new game settings was often irresistible and added to a sense of play. Results from previous sessions are also logged by physiotherapists for comparison. At times it is difficult for physiotherapists to stop patients from playing an application once they have started:

Patient: I'm going to finish it!

Physiotherapist: An hour from now I don't want you to be sick.

Technician: I'm just going to finish. It never ends well.

Patient: [sticks tongue out, disappointed].

During my observations, two competitive Canadian Forces soccer players stationed at the Garrison Petawawa base in Ontario kept in touch about their progress in the machine, eager to outdo their previous scores and levels of endurance. Most patients do not have the ability to compare their outcomes with others; however, occasionally stories of the system were circulated between patients on the inpatient unit. Access to the system was coveted.

Speed

Patients who had experienced illness, injury or disease resulting in a loss of mobility reported that the CAREN system allowed them to virtually participate in activities they had enjoyed prior to their health difficulties. For example, a former boater with GBS could once again go boating in the CAREN system's MM Boat. In MM Christmas 2014, a former snowboarder could return to snowboarding after suffering brain damage. Some patients with TBIs had lost their drivers' licenses, and MM City Ride allowed them to drive again in an artificial environment. For that reason, MM City Ride was popular choice. Apart from the obvious therapeutic benefits of working on agility, balance and timing, the sensation of "speed" itself was welcomed by patients who now had to adjust to going "slow" due to their health conditions. Speed was compelling and added "fun" to therapies, providing an emotional boost.

Nostalgia

Both digital geographies and the game-like quality of the system prompted feelings of childhood nostalgia and added to experiences of playfulness. Breakout, a paddle ball game, prompted memories of Atari's Pong (1972).

Patient: "I remember this from a previous life."

Physiotherapist: "It's like a game that came out when video games first came out. Before you even start, can you turn your right foot out a bit so your toes are pointing out?"

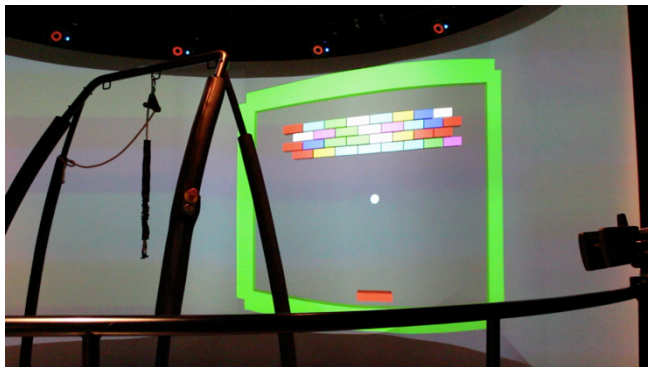
Breakout is a clinical version of Atari's 1972 arcade game Pong. A ball flies across the screen as patients desperately try to control a paddle with force plates or markers.

Here the CAREN system reveals its roots in arcades and home entertainment systems.

Despite erratic ball movements and a difficult to control paddle, many patients enjoyed

the game because it reminded them of their childhoods.

Figure 23: Breakout Application Modeled After Pong (Atari 1972)



With representations of forests, mountains, beaches and parks, digital geographies also draw physiotherapy patients into childhood experiences of play in other ways. The Rope Bridge application features a rope bridge over a body of water that swings back and forth as it blows in the wind. Incremental climbs also add to the challenge of maintaining balance and stability on the bridge. Several patients compared the application to the Capilano Suspension Bridge in North Vancouver, BC. One physiotherapy patient, who grew up in Manitoba, particularly enjoyed the Rope Bridge. She emphasizes, “it reminded me of [the] bridge back home. We jumped on it when we were kids.” As one of her favourite applications, the Rope Bridge drew the patient back into experiences of childhood play despite a rigorous and painful rehabilitation process. In clinical virtual reality reproductions have surprising clinical consequences.

Lost in the Game

While not every patient was entirely fixated on the experience of CAREN system applications during clinical sessions, multisensory immersion did pull many patients into “the zone.” Researchers describe this as heightened “presence” in virtual reality as users

become fixated on tasks and immersive environments in digital worlds (Schuemie et al. 2001). For patients with mobility issues the harness provided an additional sense of safety that allowed them to relax and further engage with digital worlds. With less to worry about in terms of falling, patients could easily slip into a therapeutic walk in the park enjoying the sights and sounds of a reproduced nature. Practitioners had to work hard to ensure patients, many of whom described being distracted from their pain, did not overdo it. An intensive workout is sometimes easier when physiotherapy feels like play. The distraction from pain the system offers represents both its clinical utility and one of the more dangerous aspects of the CAREN system. Patients could easily overdo it and sometimes did; skilled clinicians and the CAREN technician constantly had to check in regarding the patient's progress.

LEARNING TO MOVE IN MULTISENSORY VIRTUAL REALITY

For many patients the game like quality of the system eclipsed the fact that time spent in the CAREN system was a physiotherapy session. Game scores became much more important. In these cases clinicians had to work hard to maintain clinical applicability. Correct body movements are everything in physiotherapy practice. Distracted by car racing, obstacle courses, soccer, skiing, and snowball fights with elves, patients sometimes disappeared into the games to the point of ignoring the physiotherapist's and CAREN technician's instructions. Novice users had to learn to move correctly in the system, achieving a balance between gaming performance and body performance.

Maintaining Clinical Applicability

Clinical virtual reality calls for forms of play that meet therapeutic objectives. In the CAREN system it is possible for patients to perform well in terms of game scores, but to perform poorly in terms of their actual physiotherapy. Leaning forward in a perpetual fall might make for record times in MM City Ride's car racing, but unless movements are controlled and precise it might not have much to do with prescribed techniques in physiotherapy. Patients also become anxious and sometimes agitated if their scores in the system are low, even if they have successfully followed the instructions of their physiotherapists and have shown gradual improvement over time. For these reasons, physiotherapists sometimes requested that the technician remove scores from the screen. For many clinicians, the central question is one of how to maintain the clinical applicability of the system. While competition, speed, nostalgia, and getting in "the zone" are part of what make clinical virtual reality so powerful, clinicians also have to carefully guide patients, keeping CAREN sessions therapeutically relevant.

Patient "Cheating"

- Motek Representative: What we try to do when we are developing application [sic] is to make them so rigid that it's really hard to cheat. But nothing is more creative than the human brain, so patients always find ways where we did not think of to cheat programs, to make a high score with doing something wrong. But for us, it's always the focus – to focus on quality of movement versus the quantity of the movement.
- Ethnographer: Absolutely.
- Motek Representative: But that indeed is challenging. And they'll always find a workaround. It's very, very good to see that they're so

creative in finding compensation strategies or methods of cheating the games.

Ethnographer: And that's certainly not unique to the CAREN system. I know they do it in regular physiotherapy sessions too.

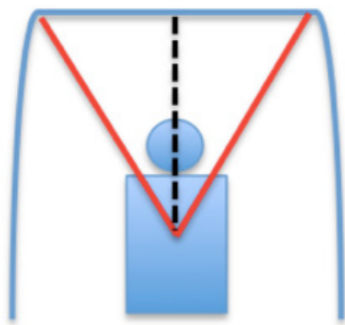
Motek Representative: Yeah. But it's part of the human body. Like, if you hit your toe, you immediately start walking differently because it's just by nature that we compensate for anything that's being thrown at us. So we are always exploring for alternatives.

With variable applications, a harness, screen, treadmill, and dynamic audio-visual features, patients demonstrated a variety of ingenious tactics for compensating for their conditions in the CAREN system. Following illness or injury, compensation can be a healthy and necessary response to changes in the body. Practitioners reported that much of the 'prepackaged' Human Body Modeling Software available for the CAREN system fails to account for compensation, providing unrealistic models indicative of bodies without disabilities, disease or injury. The ideal biomechanics of a human body can vary by condition, and the unique compensatory tactics patients have developed over time. Movement, like human bodies themselves, can be incredibly diverse. Within the context of CAREN system use and physiotherapy practice, however, there are times when recovery involves addressing compensatory techniques and relearning biomechanics that produce less pain, increase the patient's range of movement or represent a return to previous levels of functioning. In this sense, unlearning compensatory tactics can be also therapeutically beneficial.

Patients and clinicians commonly describe the concept of "cheating" in the CAREN system. "Cheating" can be understood as adopting incorrect body posture or using audio-visual or physical cues in the CAREN system to "win" or "complete" specific applications without adopting the technique prescribed by the attending

physiotherapist. While cheating happened in regular physiotherapy sessions, and was not exclusive to CAREN system use, the CAREN system did provide unique opportunities for cheating due to its features. For example, one patient with CRPS tasked with working on his spatial sense in the machine confessed to using the feeling of the harness rope on the back of his neck to identify where he was in space. The harness was adjusted so that the safety rope was removed from the centre of the harness and replaced with two ropes on each side in a V formation. The patient could no longer feel the rope on the back of his neck and was forced to use his vestibular sense and eyesight to make his way through various applications.

Figure 24: Alternative V Shaped Harness Configuration to Avoid Sensory "Cheating"



Similarly, patients might “cheat” in the CAREN system by looking at their feet while they walk, using the handle bars as a visual cue for balance (the handle bars can be removed), taking a step instead of leaning to activate an object on the screen, or by moving fast through an application in a perpetual fall instead of adopting slow controlled movements.

Patients also describe using elements of the CAREN system’s software to “cheat.” For example, scene transitions in the Park sometimes briefly flash brightly with a wall of light. Patients use this visual glitch to physically anticipate when the next hill is coming,

reporting that it can make the application easier to complete.

The intersection of specific patient conditions and software can have a bearing on “cheating.” One patient, who experienced a severe TBI, reported that his partial loss of eyesight made it easy to complete the CAREN system Stroop Test. Stroop testing in the CAREN environment requires that the patient say the colour of a word, not what the word says. For example, the word “BLUE” might be spelled out on the screen in black text. The patient, while walking through a CAREN digital application, would be required to say the colour of the text, not the word “BLUE.” The patient emphasizes, “I could not be tricked by reading the word.” With the word partially obscured due to the patient’s vision loss, the patient reported that it was much easier to just focus on the colour of the text of a single letter.

Physiotherapist Tactics for Addressing Patient Cheating

Physiotherapists created a variety of tactics for dealing with patient “cheating” in the CAREN system, including:

- Changing the position of the harness;
- Switching applications;
- Moving the position of infrared “tags” used to control various applications, for example, from the shoulders to the pelvis to encourage proper body movement;
- Clipping into the harness and joining the patient on the platform in order to physically direct the patient’s movements;
- Providing explicit instructions for body movements;
- Removing the sidebars;
- Providing positive reinforcement;
- Slowing down, or speeding up, the patient’s body movements depending on the

- health condition and objective;
- Switching to force plate activities;
 - Using a mirror at the side of the platform or on the platform to encourage body awareness;
 - Prompting the patient not to look at their feet.

AFTER EFFECTS

Bodies in movement sometimes become squeamish. Nausea, headaches and dizziness were commonly reported after CAREN system use. Practitioners also spend a considerable amount of time trying to establish if patients experience immediate aftereffects from the machine or if they are “delayed reactors.” A host of bizarre aftereffects were reported by patients in the minutes, hours and days following system use, including: amnesia, hunger, sleepiness, increased pain, heightened emotionality, irritability, unsteadiness, an inability to stand, chills up the back of the neck and at the base of the skull, “fullness” in the head, loss of a sense of space and time, the feeling of being drunk, and a general sense of disorientation. During observations I was initially sceptical of the extent of CAREN system aftereffects. However, patient conditions and disruptions in body sensations due to illness, disease or injury coalesced with the machine’s unique multisensory features, prompting a range of responses. As a participant researcher I eventually also experienced my own aftereffects from the machine.

The Check-in and Questionnaire

Military physiotherapists are careful to administer a “Simulation Sickness Survey” following each session for members of the Canadian Armed Forces. One military physiotherapist copied the survey onto a plastic laminated sheet, recorded patient scores, erasing the sheet after for the next patient. As an aerospace engineer, the CAREN technician was sensitive about the system being referred to as a “simulator;” however, simulator sickness scores are useful for tracking patient responses to the machine. The Canadian military’s survey is based on the work of Kennedy et al. (1993), specifically their method for quantifying simulator sickness. This includes attention to:

- General discomfort,
- Fatigue,
- Headache,
- Eyestrain,
- Difficulty focusing,
- Increased salivation,
- Sweating,
- Nausea,
- Difficulty concentrating,
- Fullness of the head,
- Blurred vision,
- Dizziness (eyes open),
- Dizziness (eyes closed),
- Vertigo,

- Stomach awareness,
- and Burping.

Throughout the course of my observations all of these symptoms (and more) were recorded.

Civilian physiotherapists at the hospital had less paperwork to negotiate in terms of tracking patients' responses to the machine. In these cases an informal check-in was generally conducted after each session in order to help guide future sessions. The technician also encouraged patients to document their responses, "write down how long you had a nap." A typical session with a patient experiencing aftereffects proceeds as follows:

Patient: If those lights [overhead lights] were on right now it would kill me.

Physiotherapist: Oh, that machine!

Patient: You're telling me. I talk to Peter [another patient] about it. Is it me, am I going crazy? Does it take long to process stuff when you're on the machine? He's like, "yes!" My eyes are open now, but they hurt. When I leave here I'm dead.

Technician: The best formula seems to be tons of food, nap, more food.

Patient: It might be because it's two o'clock, later than usual.

Technician: And you will probably be emotional for the next few days.

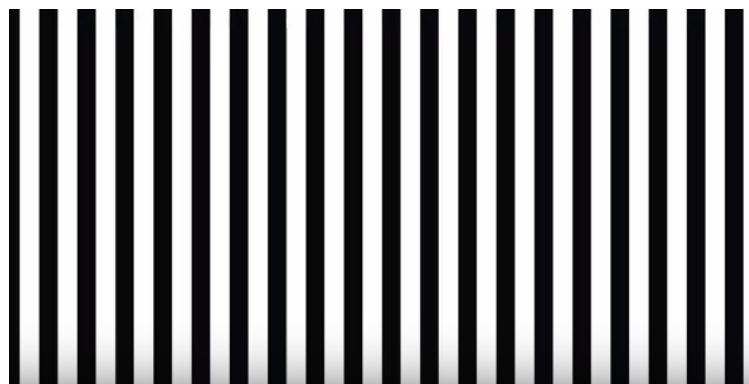
A common metaphor for CAREN system aftereffects was a sense of being drunk or hung-over. One patient explains, "the only way to really explain it would be like a terrible drunk night." The technician sometimes directly used the metaphor of drunkenness to gauge patients' reactions to the system, "still feel five beers in?"

“Sticky Foot”

Ultimately the system prompted unusual responses in patients. Some responded more strongly than others. Making calculated judgments about which patients the machine would impact the most was a fundamental feature of CAREN clinical tactics. One approach to limiting potential aftereffects was to look for “sticky foot.” Sticky foot is described by practitioners as walking like “a cat with tape on its feet.” When sticky foot hits, patients begin to wobble and exaggerate their leg movements. It generally took some time for patients to build up to sticky foot in the machine, but when it was observed by the attending physiotherapist or technician the plug was pulled and the session ended. Just exactly what sticky foot is mechanically is a puzzle for practitioners, but it is likely a combination of fatigue and some sort of physical or neurological response to multisensory virtual reality, the pistons and the treadmill system.

Researcher Experiences

Figure 25: Optokinetic Stimulation



We talk about my poor response to the OKS ALL application when it runs to the right. The patient laughs and says, “Welcome to my world!” I describe instant sweat at the back of my neck, tingling at the base of my skull, dizziness and the feeling that will I immediately vomit and fall over. Later when I review video footage of the incident it

makes me ill again; however, not quite as ill as when I am in the CAREN system staring at an enormous screen:

Individuals with vestibular dysfunction may experience visual vertigo (VV), in which symptoms are provoked or exacerbated by excessive or disorienting visual stimuli (e.g. supermarkets). Individuals with VV are believed to be overly reliant on visual input for balance (i.e. visually dependent). VV can significantly improve when customized vestibular rehabilitation exercises are combined with exposure to optokinetic stimuli (Pavlou 2010: 105).

OKS ALL is a large-scale reproduction of more traditional optokinetic exercises used by physiotherapists. Generally videos of repeating horizontal or vertical lines are shown to patients in an effort to desensitize them to visual stimulus over time. In the CAREN system, depending on the CAREN technician's settings, the lines run up and down, from left to right, or from right to left. As a newer application it is still being tested on patients, and while much research has focused on small video-based optokinetic exercises in physiotherapy, no formal clinical trials have been conducted on the impact of the exercises in the CAREN system. After sceptically observing after affects during clinical sessions, I was completely overwhelmed by the intensity of my response to OKS ALL, particularly the tingling at the base of my skull – it was, I felt, overwhelmingly bizarre. Of the forty or so applications used at the hospital, I only experienced aftereffects with two other applications: MM Boat and the Park.

Researchers have described “visual flashbacks” as a side effect of simulator use (Kennedy et al. 1987). After a gruelling day of back-to-back clinical observations, largely involving the Park, on my walk home from the hospital I passed a park – for just a moment leafs on the trees appeared to shimmer and transform into triangles mimicking the CAREN system's basic shapes and visual representations of leafs. While I've entered sailing races, ridden roller coasters, repelled down climbing walls, and played hockey and

roller derby without any ill effects, MM Boat also had the capacity to make me nauseous during longer ocean voyages between digital islands. In time I came to appreciate the aftereffects patients and practitioners associated with the CAREN system, but only after experiencing them for myself. Multisensory ethnography pulls the anthropologist's body back into accounts of medicine and digital technologies. As a researcher it was a strange and humbling experience to confront the effects of the machine in such a visceral way.

CONCLUSION

In the CAREN system bodies move, but how they move is strongly guided by the clinical objectives of practitioners. For structural reasons (suspicious administrators, limited funding, and tightly packed scheduling) practitioners are reluctant to refer to the system as a "game," practically speaking, however, patients enjoy the game-like quality of their physiotherapy the most. Clinical techniques vary by condition (with occasional overlap). Patients must be taught how to move correctly in clinical virtual reality. Coordinated sights, sounds and movements ground these experiences in carefully choreographed treatments. Unruly bodies, however, can resist tight control. Fun can pull patients into the game and away from therapy – fun can also fuel persistence in physiotherapy despite pain and fatigue. The multisensory features of the machine also prompt aftereffects felt throughout the body in strange and unsettling ways. Patient conditions mix with the machine's unique sensations to muddle the predictability of aftereffects. As patients and practitioners turn to "medicine of the future," science fiction makes an appearance in the aesthetics of clinical virtual reality, further blurring the divide between medicine and entertainment.

PERSPECTIVE: CHAPTER FIVE

The CAREN system hugs the patient's body. The harness fits snugly. The curved screen puts the patient at the centre of a bright blue world. The audio system kicks in and pistons surge to life as seagulls cry and ocean waves crash. Each component of the application - from the treadmill to the speakers - works in unison to cultivate sensations that are understood as therapeutic. Assumptions about the body are built into hardware and software choices created to cultivate sensory immersion, revealing what patients are supposed to see, what patients are supposed to hear, and what patients are supposed to feel.

The CAREN system is a unique form of experiential medicine designed to create a range of human experiences in diverse digital environments. Anthropologists have documented the interplay between sensation and culture and the cultivation of bodily experiences rich in social meanings (Lock 1993; Scheper-Hughes and Lock 1987). Like other forms of medicine the CAREN system does not operate outside of culture. Values shape medical practices, including values about the body. All of that sensation in imagined digital scapes also fosters "bodily dissent" in personal embodied responses to the technology (Lock 1993: 114). Memory, joy, fear and boredom intercede. Here the anthropology of emotion (Csordes 1994) helps to situate the complexity of virtual reality in the clinic and how thinking, feeling and doing are bound together (Csordes 1994). Life, in all its complexity, disrupts the plans of CAREN developers and the rigidity of "mythical norms" (Lorde 1984: 116).

Chapter Five asks the question: what assumptions are made about perspective, or how the CAREN user can see, hear and feel? From this line of inquiry flow questions

about attempts to engineer human affect in medicine; emotion and clinical experience; and “bodily resistance” to hardware and software (Weiss and Haber 1999).

Chapter Five’s central question opens up gaps between the intentions of CAREN system designers and how clinical virtual reality is experienced by clinicians and patients. Chapter Five also explores the creativity, clinical expertise, memories, feelings and emotions that fill these gaps. Here particular bodies, with particular pains, disabilities, and stories inhabit virtual reality on their own terms.

SENSATION, MEDICINE AND VIRTUAL REALITY

Bodily sensation is informed by the way medicines are understood to act on the body (Nichter 2008: 163). For example, this can be through shamanistic techniques that cultivate trance like states (Csordas 2002), analgesics that numb bodies to pain (Sinatra, Jahr and Watkins-Pitchford 2011), or therapeutic massage (Goats 1994) and herbal remedies (Craig 1999) that increase blood flow. Sensation is mediated by culture, including medical culture, and “emotions inevitably involve both meaning and feeling” (Lock 1993: 139). Clinicians working with the CAREN system have a difficult time policing the distinction between ‘the hard facts of bodies’ and patient emotions; both, of course, turn out to be intermingled in experience. The assumption of a division between minds and bodies is a deeply held value in biomedical practice (Haraway 1997) and manifests in approaches to medical technologies (Dumit 2004) and areas of professional specialization (Fadiman 1997).

In the CAREN system, sight, sound and feeling are designed to cultivate multisensory clinical experiences. However, there are also times when patients’ “bodily being-in-the-world” foils expectations (Csordas 1999: 143). Engineering particular

sensations in clinical virtual reality can be troublesome. Patient conditions disrupt assumptions about the normative body. Clinicians improvise. Patients feel the “wrong” things while they wander through the “right” digital planes. All of this feeling, meaning and doing comes together in clinical experiences of interactive digital realms.

BODYSCAPES AND ESSENTIALIZED BODIES IN MEDICINE

Anthropologists have documented biomedicine’s role in establishing ideas about ‘normal’ and ‘abnormal’ bodies (Lock and Nguyen 2010). Psychiatry has also played a fundamental role in defining ideas about normal and abnormal experiences of human perception (Foucault 1988). Historically African American resistance to slavery, for example, was cited as a form of madness (Reed 2014). Homosexuality too has been classified as a form of madness outside of heteronormative desire (Bayer and Spitzer 1982). Bowker and Star (2000) point out that classification schemata in science and medicine are laden with power. In the CAREN system the clinical directive to judge human perception as normal or abnormal also shifts in attempts to produce experiences of human perception through multisensory clinical tools. But values about abnormality and normality are still apparent – in human representations in virtual worlds and in the ways sensory experiences are crafted to be perceived.

Nicholas Mirzoeff (1995) uses the concept of a “bodyscape” to draw attention to body normativity in Western artistic traditions. Here idealized likenesses of the human form reflect social values – predominantly straight, white, able-bodied male bodies dominate artistic convention. He also documents queer and anti-racist politics that bring ruptures to body normativity. Anthropologist Pamela Geller (2009) develops this concept further, documenting the ways bodyscapes are interwoven into day-to-day experience:

Through idealized depiction, fragmentation, and reductive meanings, a bodyscape produces and sustains cultural norms and exclusionary beliefs (i.e., sexism, racism, heterosexism, and homophobia). The bodyscape therefore is not just an abstraction but also something that has an impact on the physical body (504).

Biomedicine too values particular bodyscapes (Geller 2009: 505). For example, in clinical trials largely centred on men as the biological norm (Holdcroft 2007), in assumptions that the ideal female body is rooted in reproductive capacity (Martin 2001), and in heteronormative assumptions about patients and the pathologization of homosexuality (Bayer and Spitzer 1982).

Bodyscapes in the Virtual Reality Lab are not without impact – they are felt by patients at the visceral level. Calls for diversifying spaces are often met with trivialization by those in power (Rosaldo 1993), but digital representations matter and multisensory technologies reveal their own kinds of bodyscapes - ones built on assumptions about human sensation.

LIVING WITH PAINS AND DISABILITIES

A patient equals a disease – a “diabetes patient,” a “cancer patient,” an “HIV patient” – and each disease is in turn articulated to a set of care components that are ranked by the level of specialization required to provide the care and by the time to be expended on it (Patton 2010: 124).

Medical anthropologists have critiqued practices in biomedicine that reduce patients to a disease, a disability or “disorder” (Lock and Nguyen 2010). An organ, a case, a symptom, a cure – all can feature isolated understandings of patients’ experiences. These understandings also atomize multiple health conditions with clusters of specialists fixated on individual pathologies. “Complex patients,” patients with “dual diagnosis,” and multiple disabilities or health conditions disrupt specialization as experiences of illnesses intersect in nuanced ways. For patients to access services at the Virtual Reality

Lab multiple illnesses must be ranked on a hierarchy of prioritization. This is viewed as a bureaucratic necessity for some practitioners and a clinical necessity for others.

CAREN clinicians are also divided by specialty. 3MDR's reproduction of trauma using patient photos for Exposure Therapy is the explicit domain of military social workers specializing in PTSD. At the hospital, CAREN practitioners and patients are divided according to unit, for example: Chronic Pain, ABI, TBI, and Orthopaedic or Neuromuscular Units. In practice, however, many patients crisscrossed across units in terms of their actual healthcare needs and sometimes ended up being treated for multiple illnesses in the CAREN system. In highlighting patient conditions it is important to emphasize that these conditions are not always discrete. The reality of patients' and clinicians' experiences is much more complex – treatments in the CAREN system reflect this.

Biomechanical Normativity

I, along with many of us, am alive because of medical technology and the ideology of cure that drives the discovery and development of those drugs, machines, protocols. Yet, cure also responds to the 'trouble' of being fat with gastric bypass surgery, dieting, and shaming. I have found body-mind comfort and connection through the medical-industrial complex. Yet, cure also responds to the 'trouble' of significant facial birthmarks with laser surgery and the 'trouble' of walking in ways deemed broken (Clare 2017: 183).

I reciprocated interest in my ethnography at the hospital by participating in a hospital study. The research project – Extreme Slow Walking Biomechanics as a Control Mechanism for a Lower Limb Exoskeleton – was designed to help test and verify a robotic exoskeleton, or ARKE, worn by patients usually unable to walk. ARKE is produced by Bionik Laboratories and is currently nearing clinical trials (Bionik 2017).

The Rehabilitation Engineering Department is located adjacent to the Virtual Reality Lab. Engineers often wander up and down the hallway testing devices for patient use. Prosthetic legs, wheelchairs, motion capture systems and tripods litter Rehab Engineering's workshop. Devices are also tested in the Rehabilitation Virtual Reality Lab. During my research, prototypes of the exoskeleton were used by researchers with walkers, crutches and canes. The suit is heavy, difficult to control and requires extensive physical training to use properly. It also moves at a glacial pace, thus requiring the related study on the biomechanics of slow walking. In theory the exoskeleton allows certain populations, such patients who have experienced strokes, to walk up stairs and over variable terrain unassisted. The exoskeleton also highlights cultural assumptions about idealized notions of human mobility. If the suit is so slow that it is impractical to use on a day-to-day basis, is it better just to use a wheelchair or elevator and get to where you are going faster? Is the exoskeleton for the comfort of people with disabilities or is it really for people without disabilities, more comfortable with the idea of upright locomotion? The answers to these questions are complex, but it shows how assumptions about human movement speak to social norms.

Resisting Biomechanical Normativity

Several patients in my study described the intense experience of transitioning from being perceived as able bodied to being perceived as disabled. The transformations patients experienced weren't just physical – they were social. Barbara was struggling with losing friends after painful experiences with CRPS. We sometimes ended up riding the bus together to the hospital in the mornings. Me for clinical observations and her for appointments, many of which I would end up observing. Like me, her daughter was

queer, and as a former librarian she loved science fiction literature – this fuelled her desire to use the CAREN system, which she perceived as a futuristic form of healthcare. I decided to ask Barbara about what so many of the other patients had expressed during interviews, notably that disabilities acquired later in life can come with new forms of discrimination:

Ethnographer: Some of the folks I speak with, they talk a lot about how there is a lot they took for granted before they ended up using walkers or wheelchairs in terms of how stores are structured, in terms of how differently they're treated, in terms of what they missed before when they were more able bodied in that regard. Did you experience that?

Respondent: I had a group of friends, I used to go every couple of months, we'd go out to dinner together, friends from the school network. And now they don't invite me. I mean obviously I'm out of the school at this time, but I would say, "let me know when you're going. I'd be happy to go." But it turned out there's a couple of them just didn't want to be in a restaurant with me with my walker trying to navigate, you know. And I just thought 'aw gee.'

Respondent: But that's reality. Some people, they reject it. I think it makes them uncomfortable or it makes them feel vulnerable that things can happen and they don't want to address it. So I had a lot of people fall away that way. I made some great new friends and found out who my supportive friends are, but yeah, people start looking at you, even people I know on the street would talk to me as if I was nine years old. Just like I was a little pet dog, "Oh look at you. You're walking down the street."

Ethnographer: And the irony of that too is that those folks at the dinner table will likely at some point in their lives end up in a walker themselves.

Respondent: Exactly...you know, it just made people uncomfortable...I just stopped going to those dinners, that was like maybe two years ago...But I think now that I've lived with it... I think I would have just muscled my way in and just tried to be as normal as possible and just try to ease that discomfort. You have to be more conciliatory towards other people, even though they think they should be towards you. You have to like do double duty.

As an ethnographer, and minority several times over, I am familiar with doing “double duty” – the work that goes into making other people feel comfortable with your difference. Double duty is labour. For this patient, who also faced substantial economic difficulties, a lot of double duty was required to navigate life.

Other patients expressed “ah ha” moments when they encountered store aisles with no room to accommodate wheelchairs, or parking lots with no accessible parking. Some patients described feeling “invisible.” Many were shocked into an awareness of a culture that privileges some bodies at the expense of others.

Patients utilized adaptive devices in and outside of the CAREN system. During my research this included: wheelchairs; hearing aids; canes; leg, arm and neck braces; and walkers. Wheelchair users are transferred to a chair prior to CAREN system use. For these patients activities often centre on upper body movements or brief bursts of leg strengthening exercises with the sidebars in place. Mechanically, patients moved in the ways that worked best for them; sometimes these movements were consistent with the objectives of physiotherapy in the system and sometimes they were not. Overall, physiotherapists at the hospital did their best to recognize diversity in patients’ body movements and prioritized “quality of life” over normative biomechanics. One physiotherapist explains:

Yeah, if it’s not broke, don’t fix it. The human body is pretty good at finding a new homeostasis after trauma, after illness, which is not necessarily pathological but rather just a new way to move and manage your biological system and still have good quality of life.

Many practitioners struggled to understand how CAREN treatments were tied to cultural norms in digital reproductions of the world, but when it came to the clinical aspects of working with patients with disabilities biomechanical norms were more easily identified

and rejected.

Biomechanical normativity and assumptions about movement also come together in the CAREN system's hardware design. "Fat activists" have fought for broader recognition of body diversity in engineering and design (Lupton 2013: 29). For example, blogger and fat activist "ArteToLife" has described humiliating experiences associated with flying on planes, squeezed into seating with little room for large bodies (2014). Architecture, doorways, and seating all reflect cultural assumptions about idealized body types. Taller, larger patients reported that they hit their hands on the CAREN system's sidebars, requesting taller, wider railings. Shorter, smaller patients requested shorter railings closer together. While many patients experiencing strokes, GBS, and spinal cord injuries who fell into the harness reported that it felt comfortable and safe to fall into, there were also requests for larger harness sizes. One physiotherapist explains, "one challenge would be with big people, the largest harness is only large. We would need an extra large one." The European company Motek Medical sources the harness from does not produce an X-large size. Clinical hardware too reveals cultural norms about bodies.

Accommodating Multiple Health Conditions and Disabilities in Clinical Virtual Reality

"Because it's a complex care facility, most of our clients would have multiple disabilities." - Physiotherapist

Individual accommodations were common at the Virtual Reality Lab. One patient explains: "between knee pain, back pain, shoulder, arms, neck, hearing, yeah, and mental, yeah I've got a lot of conditions going on." This sometimes required a rethinking of approaches to CAREN system sessions. Historically "complex patients" and patients with "dual diagnoses" have faced stigmatization (Evans-Lacko and Thornicroft 2010) and

poorly coordinated care (Schoen et al. 2011). Because the CAREN system is housed in a complex care, facility physiotherapists and social workers are accustomed to working with patients with multiple healthcare needs. This translated into unique clinical approaches to working with the system.

Table 3: Examples of Patient Accommodations

Double vision or visual field loss*	Prism glasses worn in system. Prism glasses are special glasses worn with prism lenses. They can reduce visual symptoms associated with TBIs*
Deaf patient	Sign language interpreter placed in harness on the platform
Partial blindness	Location of digital objects modified
Peripheral vision difficulties	Location of digital objects modified
Colour blindness	Application colours manually adjusted
Light sensitivity (TBI common)	Dark applications used, facility lights dimmed, sunglasses worn in the system
Sound sensitivity (TBI common)	System audio reduced or eliminated, communication between CAREN Technician and PT via hand gestures, notes or whispering
Upper body mobility only	The patient is placed in the system in a chair, platform movement eliminated, hand tags used for exercises
Motion sickness (TBI common)	Platform movement eliminated, highly challenging movement orientated applications eliminated, wave size reduced in water applications, eyes directed to be closed for “zooming in” or “bridge up” effect at the end of applications
“Secondary” diagnosis of PTSD	Fireworks removed from applications, early warnings regarding fire alarm tests, flying objects removed from applications, lightning removed from applications, avoidance of trauma specific imagery (i.e. Bus 325 was not used with the survivor of a bus crash seeking physiotherapy services), removal of harness ropes from view of patients with suicidal ideation fixated on hanging
Locked in Syndrome	Body movements manually made by PT for the benefit of

	“morale boosting”
Patients with “foot drag” as a result of stroke	Tape placed on shoes to prevent gripping to the CAREN treadmill, quad cane used in the system
Difficulties walking	Sidebars remain on

A number of soldiers in my study reported multiple TBIs, with concurrent CRPS, PTSD and partial deafness or tinnitus as a result of improvised explosive devices in Afghanistan.

Ethnographer: You mentioned the ringing in the ears. Some of the folks I've spoken with who have been deployed, it was the result of blast injuries.

Respondent: Mine was a range practice in '95 and then constantly combat arms. You're exposed to a lot of noise and I started getting the blast(s)...you know, for about five years.

Ethnographer: So it's part of the work.

Respondent: It is. It was part of my job.

Patients with tinnitus and partial deafness had a difficult time with the sounds of the system, including the hissing hydraulic system and the roaring of the projectors. For these patients, application sound effects such as music, bells, and penalty noises were turned down or shut off altogether. During observations it was often difficult for me to hear conversations between patients and clinicians over the noise of the machine.

Patients with ABIs, TBIs, CRPS, and GBS were likely to self-identify as having multiple disabilities and health conditions, including those related to: mental health, movement, balance, partial deafness, partial blindness, and other visual or auditory conditions. Severe head, neck and back injuries often resulted in extensive, and complex, damage to patients' bodies. The survivor of a bike accident explains:

I was taken to Intensive Care...the accident caused a loss of two teeth, front teeth, and big scrapes and [a] bang on my face, even though I had a bike helmet on, there's blood on my bike helmet now. And it caused damage to this arm, a sort of bruising burn but also impact in the finger, the lower finger, the pinkie and the wrist a bit, so they're still recovering, they were in a half cast but now they're bandaged after five weeks. And it caused a head injury that has affected my vision. And so if I look at your face, your left eye is nice and strong but your right eye is dimmer. And to the right lower, is all faded. And so I'm waiting for that to recover. And that's affected my reading ability quite strongly because all the second syllables in words as I look at a word are all hard to catch...And that's affected my balance a little bit and sort of my kind of comfort level with movements, it's a little bit cautious and reduced at the moment. And another impact from this was also a slight memory impact in that I'll sort of come across in talking, a word that I should know and I can't catch it, and things like that. And I found that that has been improving. It was considerably worse weeks ago than it is now. That's my situation.

Clinicians reported that most CAREN patients' situations were unequivocally complex.

Not surprisingly, those accessing the system as inpatients generally also required higher levels of care at the hospital.

CAREN Patients with a Concurrent or Primary Diagnosis of PTSD

Of my clinical observations, 15 of the 210 were focused on patients accessing the CAREN system primarily for PTSD. At times it was also difficult to separate out experiences of PTSD from the physiotherapy process. For example, survivors of severe traumatic accidents accessing physiotherapy in the CAREN system were likely to have a concurrent diagnosis of PTSD.

Figure 26: Rope Bridge with Fire and Lava Additions for a Firefighter's PTSD



Here the CAREN technician discusses a firefighter pursuing physiotherapy and related treatments for PTSD:

We had a firefighter who had a bad accident at work and what we did is use the Rope Bridge...we put it on difficult settings for balance retraining. We put in a dark and smoky scenario with lava underneath to try and at least simulate some of the stuff that they would see at work and we loaded them up with a pack, not as heavy as they normally would, but they were getting lower back pain because they were losing truck control when they would trigger their PTSD. So we were trying to work on maintaining trunk control while still having to work on the PTSD symptoms at the same time.

Understandings of PTSD and its impact on patient physiology strongly shaped clinical virtual reality sessions. Fear, pain and emotional stress can tighten back, neck and limb muscles, or cause muscle weakness. A sense of panic can wreak havoc on patient experiences of sensation and movement. As they grappled with patient fear, physiotherapists often found themselves doing work conventionally delegated to psychologists or registered clinical counsellors at the hospital. CAREN treatments obfuscate professional boundaries in new ways. It wasn't that PTSD had never been understood to impact physiotherapy sessions before, it's that the CAREN system allowed physiotherapists to visually and kinetically summon human fear through exposure to digital reproductions of the world.

The disruption of professional boundaries in the CAREN system also worked in reverse as clinical social workers confronted bodies wrought with emotional trauma from war. In an associated interview one clinical social worker speaks to the idea of trauma held in the body and the use of the CAREN system to physically “work out” trauma:

It was the motion part that sort of piqued my interest here...the way that we work, and from what we see, a lot of trauma is held in the body. So to be able to have some motion that can help work that out, it's very different than sitting in a chair in an office.

In their practice at the hospital, clinical social workers dealt with the porosity of the body-emotion divide. Patients whose bodies are ravaged by war have physical wounds tied to feelings. Patient feelings, in and outside of the machine, disrupt the divide between body and emotion and the disciplinary boundaries this divide is predicated on. Physiotherapy, clinical counselling and psychology are not that far apart in CAREN system treatments. This raises ethical issues for professionals of course, but it also points to the fallacy of dualisms that don't quite fit treatments in the machine.

On Recovering and Not Recovering

It was not uncommon for me to be greeted by patients eager to share their stories of recovery by the picnic tables outside of the hospital during my lunch hour. Securing a hospital discharge date, the removal of an uncomfortable neck brace, or no longer requiring a wheelchair were often cause for celebration – patients wanted to share their joy with me. Although I made it clear I was not part of the clinical team, I was sometimes thanked.

My physiotherapist, you, and the technician, yeah. You always encourage me and give me very nice words. Yes. I like your words, I like your... how you act with me, yes. This is a very good point to me and really it helps me.

Most of the physiotherapy patients I followed over multiple sessions showed marked improvement over time. Recovery, however, represented the outcome of a complex series of factors that included access to patient supports both in and outside of the machine.

The system harness and the ability to set the machine to variable terrain had pronounced benefits for patients working towards regaining limb and trunk control. Many patients placed a considerable amount of hope in their CAREN system treatments. A patient with

Multiple TBIs explains:

I like the fact that I'm challenging both my mobility or balance, my balance with some the cognitive and visual processing tasks. So I really like it in that respect. And my hope is that we will also be able to do potentially some visual desensitization with it, I think that's the hope with my case in particular is that that system will allow for that in a controlled environment. And so I think it's a unique opportunity. I don't know how else I would get this kind of therapy, so I think it's a potentially exciting avenue for me personally because it could contribute to significant healing or progress that we haven't in three years been able to achieve.

While some patients' high hopes were met with a full recovery, others had to adjust to the idea that they might not, or would not, recover. When patients in the CAREN system are faced the prospect of an impossible recovery, clinicians shift focus to cultivating "mindfulness." Attention is placed on learning limitations, "listening" to pain as it increases, and backing off of specific activities before symptoms get worse. Over time patients learn to "read" their bodies and respond accordingly.

The development of subtle body awareness, meditation techniques and breathing exercises were the last thing I expected to encounter in clinical virtual reality sessions. Techno-science is often presented as an antithesis to the body and day-to-day life (Hayles 1999; Haraway 1997). Virtual reality, especially, is presented in the literature as existing beyond the body, time, and place. Yet rooting particular bodies in the moment along with all the pains, physical limitations and aches this encompassed was an explicit

therapeutic tactic used by clinicians working with virtual reality time and time again.

While virtual reality offers technologically mediated views of the world, yoga mats were used in the system, patients slowly counted down from ten attempting to control their breathing, and soothing visualization exercises were conducted on the CAREN system platform.

EMOTION AND THE MACHINE

The most striking aspect of the CAREN system is its ability to transform therapy into play. The machine also elicits strong emotions. Sights, sounds and movements coach patients to feel. Sometimes these emotions are positive, sometimes they are negative, but they are always felt through the intersection of biography and personal experience. In many ways the CAREN system is crafted to engineer human affect – it is an experience-making machine. Setting the stage, correct object insertion times and clinical choreographies are carefully selected. Emotions, however, can be unruly. As a clinical ethnographer I knew how the CAREN system was *supposed* to make patients feel, but I wanted to know: how *did* the CAREN system make patients feel?

Joy

“Find a place inside where there's joy, and the joy will burn out the pain.”
– Joseph Campbell

Patients who use the CAREN system for physiotherapy have a lot to say about the joy of play and its impact on experiences of pain. In virtual reality difficult feats became fun. Gruelling physiotherapy routines in the gym can't compete with the CAREN system. There was also something else that marked CAREN sessions as different; a devoted

audience of cheerleaders who coached patients through skills based games. It was a definitively social experience. The power of joy, the moral boosting the system provided, and a “drug like” high all shaped patient experiences of the machine.

Audience Driven Performance

The large curved screen and central placement of the machine means that family and friends can easily observe loved ones in the system. Visor virtual reality technologies offer no such view from the sidelines. In this sense, the CAREN system is a more social form of digital medicine than other forms of virtual reality in the clinic. Once the clapping, cheering and laughing start I often find myself joining in. The technician, physiotherapist and I are all rooting for the patient. Unlike other forms of medicine, the CAREN system invites spectators in the room to actively participate in sessions as engaged cheerleaders. Entertainment and medicine once again collide.

Technician: You hit a shark! I told you there was going to be sharks!

Patient's Daughter: Hit the boat, hit the boat!

Patient's Son: Only 5 penalty shots!

[Patient laughing]

Clapping and cheering from spectators appeared to have a positive impact on clinical outcomes in the machine. Of course there was also the danger of patients overdoing it for an audience. One patient, a former physician at the hospital, pushed too hard when his children attended sessions. The Technician emphasizes, “he seems to be showing off for [his] kids, I’m worried he’ll pay for it later.”

The Power of Emotion

The power of the machine was the joy it prompted. One back-up CAREN Technician explains, “playing a game is so fun that you enter into the game and you don’t think about how much effort you are doing. And the time goes so fast, and you try to do better every time, and it’s very challenging and very fun. It’s a fun therapy.” Expressions of joy were a key feature in interviews and observations. A patient emphasizes, “it kind of gives me that opportunity to just kind of have some fun.” During project filming there were also moments as an ethnographer where I found myself in the machine, losing track of time, completely fixated on game play. My favourite applications featured dual platform and treadmill movements, including hilly versions of the Park and sweeping waves in MM Boat and Paddleboard. If I said I didn’t enjoy testing the applications I’d be lying. I also found using the system on higher settings to be a good workout after long days of sitting at a computer writing.

Moral Boosting and Inpatients

Many long-term inpatients with spinal cord injuries looked forward to their CAREN treatments every week. In juxtaposition to other therapies at the hospital, the pleasure the system gave these patients was critical:

It’s something that’s different, you know, it’s an hour during the week that I do, and that hour is just different than everything else I do during the week. It kind of, let’s say, it brings me out of my shell that I’m kind of stuck in here. Day in, day out, you do a little bit of lifting of this, you do a bike, you do some stretching and you do some movement and try to pick up things with your fingers. But the CAREN system is completely different. It’s something that brings maybe some fun that is not there for [the] other things you do during the week.

Rehabilitation can be painful, difficult and boring. For in-patients these feelings can be amplified by the loneliness of hospitalization and the tedium of routine. The CAREN

system injected fun into the stew of new experiences associated with ending up in the hospital. It was a welcome respite from some of the more emotionally taxing elements of healing.

Getting High on Virtual Reality

My first observation of the CAREN system during site visits across Canada featured a young construction worker who was high on medical marijuana for a work related injury. The marijuana helped treat his pain while he used the system. As his giggling filled the clinic, it was clear to me he was enjoying himself in the machine like so many other patients. Patients throughout my study took drugs prior to CAREN treatments for pain and to relax muscles tight with tension. This ranged from oxycodone to herbal medications. Drugs also appeared to add to the pleasure of the system – a topic too taboo to discuss with clinicians.

One mental health worker participating in an interview located the “joy” the system prompted in the opioid receptors of patient’s brains:

Ethnographer: I mean, the 3MDR [PTSD] sessions are very serious, very dire, people get very upset, so there's a very different sense of them from the physiotherapy sessions which, I mean there's clapping, there's cheering, there's often a room full of laughter...This idea of a video game becoming medicine, it's really powerful.

Respondent: It is a cheer squad, right? And you release different neurochemicals with a video game in your brain, right. I mean, video games release opiates, there's a reason why we use them for pain treatment. And so I think you're galvanizing on multiple different things when you use it.

Here, the mental health worker refers to literature in psychology that draws comparisons between virtual reality and opioids (Gold, Belmont and Thomas 2007). These frameworks are currently popular in psychology as parents struggle to control their

children's use of video games (Gentile 2009) and clinicians work to document, and treat, an "epidemic" of digital compulsions (Christakis 2010) from Tamagotchi pets (O'Rourke 1998), to cellphone use (Jones 2014) and Facebook "addiction" (Andreassen et al. 2012: 501). Virtual reality visors are also being used for burn treatments. Distracted by games filled with snow and ice, patients' brains are understood to produce analgesics that help offset the pain of bandage changes (Hoffman et. al 2011). The CAREN system's use for physiotherapy fits into these understandings of patients' brains, video games and pain. Many clinicians at the hospital also felt that patients became "addicted" to the CAREN system, requiring that they be slowly "weaned" off. Whether rooted in the sociality of game play or the biology of brains, the addictive qualities of the machine are open to interpretation. If one thing is clear, it is that many patients, despite painful injuries, illness, and disease, enjoy clinical virtual reality immensely.

Fear

Joyful play drove the majority of physiotherapy sessions and fuelled patient desire for CAREN system therapies, but not every patient experienced this. Phobias, suicidal ideation and pain also shaped negative experiences of the machine. Fear was viewed as a necessary and central feature of treatments for PTSD. However, patients also sometimes expressed fear during CAREN sessions fixated primarily on bodywork in physiotherapy. Hardware, software, and the physiotherapy process itself all had the capacity to foster feelings of dread in patients at different times for different reasons.

Drop Zone

The wind currents are volatile. A young paratrooper jumps from a plane during a military training exercise. His dream is to be in "Black Ops," the most secretive and elite

branch of the Canadian military at Joint Task Force 2's command near Ottawa.

Colloquially referred to as "secret squirrels," when Black Ops soldiers are deployed they are not allowed to tell their families where they are going or when they will come home.

Adopting the language of author and former Lieutenant Colonel Dave Grossman (Grossman and Christensen 2004), the paratrooper describes himself as a "sheepdog" driven by a strong protective instinct. Upon landing he is knocked unconscious and comes to being dragged across the drop zone on his face. Like many young soldiers he had considered the possibility of injury or death as a consequence of combat, not a military training exercise.

Military training exercises account for a high percentage of soldiers' injuries (Kaufman, Brodine and Shaffer 2000). In my own study participants with the Canadian Forces had fallen off armoured vehicles at the Petawawa Base in Ontario, got caught in poorly controlled explosions during grenade drills, and had experienced bad parachute jumps. Service members in the field, particularly Black Ops in high-risk zones, reported catastrophic injuries. Many had severe TBIs as a result of getting caught in multiple explosions during combat. One former soldier had a re-bar pierce his knee, head and face "like a shish kabob." The price of war is high for civilians and soldiers. Few seem to consider the aftermath of training exercises crafted to turn young men into instruments of war, including the soldiers themselves.

Paul is the paratrooper. His arms are wrapped in elaborate Catholic tattoos. Every morning he body builds, even when his legs wobble from CRPS. His physiotherapist encourages him to do fewer "muscle man" exercises and more lower bodywork and stretching. When he confronts a new challenge in the CAREN system and

succeeds he pauses to curl his biceps in a show of strength and virility. His performance of aggressive masculinity is tempered by his ability to clearly communicate his emotions to both the physiotherapist, the CAREN technician and me, the ethnographer. Paul is afraid of the CAREN system:

Respondent: There's a lot of mental challenges with it. Whether you realize it right away or not. It pushes your mind and a part that I don't think I was actively using that often. It pushes me and forces me into a very scary place, a place that's very uncomfortable. And basically you're working within that space of discomfort or fear. And then I've also increased significantly the stuff that I can do on a day-to-day basis without pain, and I think that's the key.

Ethnographer: I just want to be clear, when you talked about the challenge of the machine pushing you to fear, what's the fear of?

Respondent: For me, my rear spatial understanding [is] pretty much nonexistent. So through the sort of initial testing of finding that out, I was forcing my body [to] lean backwards and that in itself is frightening. It's pushing my mind into a place that it doesn't know, that it doesn't want to be. So slowly each time, each week, I show up. The people I've been working with have figured out how to slowly push me there, a little bit more, a little bit more. And I think some of the fear comes from if you have a bad week or a bad session, the next session you're coming in a little bit hesitant, there's a little... something deep inside, because you know that maybe by my own doing, I pushed myself a little bit harder and then I have a bad two days of extra pain because of that. So there's a little bit of that, I don't know, subconscious fear I guess.

Ethnographer: I think I've observed you now over maybe four or five sessions, and I know the last session ended with your leg shaking quite a bit.

Respondent: Yes.

Ethnographer: But over time, even in that very limited timeframe, I've been able to see you progress a little with each session.

Respondent: Yeah. Generally I progress for maybe even four or five sessions and then there seems to be a setback, or it could be more progression.

At the beginning of CAREN treatments Paul was in so much pain that he couldn't sleep most nights. At one point he asked doctors to amputate his leg. Physiotherapists at the

hospital who have lost chronic pain patients to suicide are cautious, especially when dealing with CRPS. Clinicians report high levels of suicidal ideation in patients diagnosed with CRPS (Lee et al. 2014). Given the devastating impact chronic pain can have, this is not surprising. In the machine Paul took great pleasure in improvements in his physical conditioning. He also had to confront his fear of falling backwards due to his loss of spatial sense and his fear of the physical pain.

Physiotherapists and the CAREN technician describe a process of working against military training that teaches soldiers to numb their emotions and bodies. Pushing through pain is seen as “part of the job” for soldiers. Clinicians describe this as “down training” and emphasize that it often takes time for soldiers to recognize and work with their limitations during recovery.

In the CAREN system Paul learned to “read” the pain in his body. Eventually he took breaks or changed activities when his pain increased, common pain management techniques taught to patients at the hospital. Pulling back allowed Paul to do more in his day-to-day life. Eventually he regained some strength in his legs and no longer wanted an amputation. He also began to sleep more soundly. This he attributed to the skilled clinicians at hospital and the opportunities for “retraining” the CAREN system provided.

CAREN System Hardware and Suicide

As a former applied anthropologist working in Disaster Emergency Management I had confronted the topic of suicidality in First Responders on a day-to-day basis. I was not surprised that the CAREN system frightened some patients who had experienced traumatic accidents or violent attacks. From my perspective, it was obvious that administering Bus 325 to a survivor of Ottawa’s 2013 Barrhaven bus-train crash might

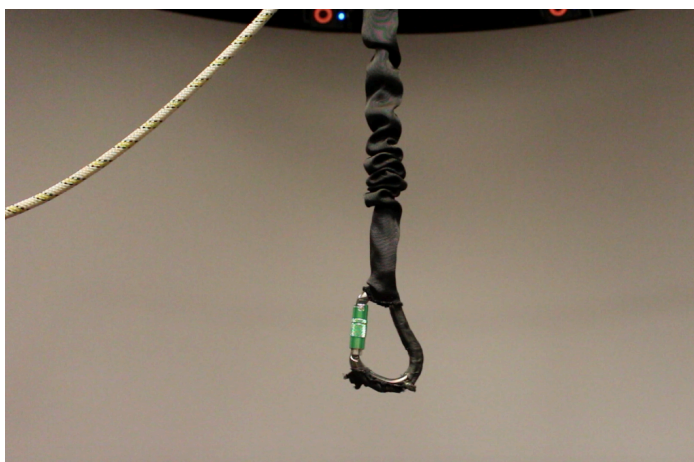
not a good idea during physiotherapy sessions. However, I had largely considered the impact of representations in CAREN system software, not the impact of the system's hardware. When I began looking into accommodations clinicians made for individual patients one patient's story stood out:

Respondent: If they are hyper-vigilant, some applications they really don't tolerate well because they feel like people are hiding behind the bushes or will come out of the buildings and hit them or something like that. So [that] heightens their symptoms a lot...It prevents them from using some applications, or we really need to warn them properly and make that little speech about how they use it...[The Technician] she had a person, he was in a wheelchair, and the way they were using the harness and the hook at the bottom, he was thinking about suicide and the way the rope to the harness hangs reminded him... like fostered his suicidal ideation. So that was a really bad...but they knew about this and so the family flagged it and then they realized it was then kind of triggering that every time he's come here. So then they had to change, every time he'd come they'd change it and they'd attach him from the bottom so that he wouldn't feel like this.

Ethnographer: So they accommodated his needs to make it more comfortable and less triggering.

Respondent: They did. They completely changed the way he was attached to the machine and the harness so that he wouldn't be triggered by this.

Figure 27: CAREN'S Nooselike Harness Ropes



Here the patient's fear of suicide, and compulsion to commit suicide, clearly eclipsed the clinical utility of physiotherapy sessions. Complex digital interfaces for clinical

treatments require a rethinking of computer system design and their impact on patients. This means clinicians need to consider not just software content, but also the impact of hardware that inserts patients' bodies into therapeutic digital scapes.

The Birds: Patient Phobias

The system's sights, sounds and movements can transport patients to a sense of other times and other places. Palm trees in groups of twos and threes rest on islands dotted with sand. The bow of the ship rocks up and down, it moves in a fluid motion with the waves. A boat motor seems to propel the motion as it loudly rumbles. There are other sights and sounds, the sights and sounds of birds – in this case seagulls.

Figure 28: A Trio of Seagulls Appears in the MM Boat Application



Ethnographer: You smiled when you said you had a bit of a bird phobia and those birds in the simulation... how's that?

Respondent: Well in the beginning, it kind of really freaked me out. I felt like 'ah, they're coming from behind' and yeah, it kind of freaked me out. I'm even getting a little warm now thinking about it. But mind over matter, it wasn't real. But yeah, when they're screeching in my ear... I had an incident in Hana Beach where they pretty much attacked me for my French fries, yeah I was very scared and very tormented. And it sounded exactly the same with them coming down in my ear and

coming from behind me. But I over-rid that...it's a very sensitive issue.

The assumption in most physiotherapy sessions is that birds are benign, just part of the backdrop in MM Boat that provides a sense of immersion. But patient biographies intersect with the CAREN system's application content in uniquely personal ways. Birds are never just benign; they can also be harbingers of fear. As quirky as this patient's narrative might seem "they pretty much attacked me for my French fries" experiences of the CAREN system were commonly shaped by the idiosyncrasies of life and personal experience. What one patient found relaxing in the CAREN system, another found terrifying. Joy and play were important to clinical outcomes in the system, but so were biography and personal experience. This, of course, is not unique to digital therapies. Patient biographies and personal experience always shape health, wellness and healing. Biomedicine's cultural practices might sometimes strip patients of their individuality, but ethnographers and attentive clinicians have the opportunity to listen to patients and what they have to say about their treatments. This should include conversations about fear.

Boredom

The ability to change CAREN system settings and to switch between applications kept things fresh for most patients. However, over time some did become bored. The CAREN system as an "event" had the capacity to fade. Patients took fewer photos of the system. Family and friends came with less frequency. Competition, speed, childhood nostalgia and getting lost in the experience of play made the time fly by in the Virtual Reality Lab. When these elements wore thin, patients were left with physiotherapy, physiotherapy they might not want to do because it was difficult or painful or tedious. Patients were also sometimes prevented from going fast in the CAREN system. Speed

was perceived as exhilarating and fun. This created a distance between what patients wanted to do in the machine and what they could do, or should do, according to their physiotherapist.

Patient: I'm bored. Ok move the platform. It's slow I want to go faster.

Physiotherapist: I want you to know where you are in space. Slow can be therapeutic.

Scholars have highlighted a lack of attention to boredom in research (Gardiner and Haladyn 2017). Theorists emphasize that a sense of boredom can loom when a lack of agency is experienced (Dumm 1999). Time endured can also be power endured as CAREN patients confront limitations placed on their experiences of game play in the system. While documenting the novel ways virtual reality therapies keep therapy interesting for patients is important, it is equally important to point out how boredom too can leak into even the most novel forms of medicine. Physiotherapy is after all based on routine, even when conducted in full body immersion virtual reality.

HUMAN CREATIVITY, CONFRONTING THE INTERFACE

Physiotherapist: The speedboat might be in your way, steer around it.

Technician: Or sink it! Sarah always gets everyone to sink it. She's quite a pirate.

According to software developers, hitting sharks and boats in MM Boat represents a penalty. Patients are supposed to dodge and weave through objects avoiding contact. Physiotherapists know this, but they sometimes direct patients to aim for boats and sharks in order to work on speed, agility and balance. Of course this also keeps things interesting for patients. As Tom Boellstorff (2008) documents in his ethnography of Second Life, software users don't always observe design conventions in computing. In the clinic

CAREN system use can be creative. Hardware and software are engineered for specific tasks, an order of clinical events and carefully orchestrated activities. However, improvisation and modification in clinical virtual reality also lead patients down new therapeutic pathways. It is important to document not only how technologies *are supposed to be used*, but also how technologies *are actually used*. When clinicians use the CAREN system in ways it was not originally designed for it can broaden the therapeutic range of digital treatments. By turning the lights off to accommodate patients with light sensitivities, attaching a kayak paddle with resistance bands to the system's base or directing patients to sink ships when they are supposed to dodge them it demonstrates a rejection of design principles in order to meet clinical objectives. This was not uncommon. Throughout my research the CAREN system was treated as a dynamic clinical tool, not static product or machine with fixed capabilities. The real innovation might not lie with developers and software engineers, but with the clinicians who reject principles of design in the system's hardware and software.

CONCLUSION

The corporeal realities of living and working with pains and disabilities in the CAREN system highlight how virtual reality treatments are far from a 'push button' operation. Biomechanical normativity is resisted and emotions cannot be engineered as expected. Furthermore, how the CAREN system is designed to be used and how the CAREN system is actually used by clinicians can be two different things.

Embodied accounts of the emotional and therapeutic aspects of the CAREN system reveal the complexities of clinical virtual reality. The CAREN system is not a blunt tool – it is reworked and reimagined by practitioners in order to meet diverse

clinical objectives. CAREN system treatments also challenge conventional disciplinary boundaries. Furthermore, patients and clinicians resist the body/emotion divide these boundaries are predicated on. Patients with multiple health conditions and disabilities who use the system also reveal how multiple diagnoses may intersect in complex ways, impacting experiences of health, wellness and healing.

In juxtaposition to the theorization of the post-humanity of the virtual reality, the CAREN system is, in part, an effective therapeutic tool precisely because of its emotional impact. But there are also dangers. The machine's capacity to evoke joy and playfulness in patients can easily shift focus to a debilitating fear. The politics of fear are also important. Chapter Six, Representation, addresses this and takes readers on a journey through representational practices in the CAREN system's virtual worlds.

REPRESENTATION: CHAPTER SIX

Multisensory experiences come together with representational practices in clinical virtual reality. Processes of colonization, the racialization of patients, class, gender, and religion strongly mediate images in clinical virtual reality. Patients also live with the consequences of CAREN system image choices. Understood as benign by most practitioners, these images in fact shape experiences of marginalization and can perpetuate broader inequalities that leak into, and direct, activity in the clinic. Unlike other representational practices in medicine, images in the CAREN system are also crafted to elicit targeted traumatic horror in treatments for PTSD. Here, images help to root fear in the body in highly masculinized and militarized understandings of trauma and recovery. Capitalism, dependent on ever expanding markets, also makes an appearance; not only in the web of material relations surrounding the system, but also in advertising directly appearing in clinical applications. Advertisements become medicine as social workers and physiotherapists guide patients through digital worlds populated by Coca-Cola and Tim Hortons. Regardless of the original intention of developers' programming choices, it is clear that the CAREN system has much to teach us about the social impact of clinical virtual reality.

Representation: Chapter Six examines the question: what assumptions guide the creation of human representations and associated digital environments in the CAREN system? The chapter also identifies underlying assumptions that strongly guide representational practices in clinical virtual reality, including: the idea of patients as consumers, attempts to literally reproduce traumatic memories, gender, racialization, class, religion and nature itself. On display are a host of images that fill digital

landscapes with the specter of culture. Documenting this imagery pushes ethnographers, ethicists and clinicians to consider how clinical virtual reality reproduces silences, social values and the politics of power.

ADVERTISING

Coca Cola™ and Digital Medicine

The patient stands on the CAREN platform and shifts his weight from side to side controlling an SUV that glides across the screen. The purpose of the application is to weave in and out of other vehicles without getting hit. It requires balance, muscle control and the ability to anticipate the speed and distance of groups of cars in the foreground and background of the application. As the patient completes the application “tile” it begins again, looping over and over again through the same roadway and cityscape. If the driver is fast, this patient is not, having only just recently experienced hypoxia as a consequence of cardiac arrest, the loop through the city moves much more quickly. In MM City Ride there are images of buildings, parkades and skyscrapers. Cranes are also visible, indicating construction in the city. The ground between the buildings flickers and seems to move with the driver, creating the illusion of a rushing river beneath the buildings. This is a graphics flaw, but adds to the cognitive challenge of sorting out the speed and distance of oncoming cars. An enclosed bus shelter appearing to the driver’s left features a city map on its interior and an advertisement for Coca Cola on its exterior. Patients who have learned to drive quickly pass the Coca Cola ad every 20 seconds as they loop through the city. The average session lasts 3 minutes, encompassing 5 Coke sign passes or approximately 1.7 Coke sign exposures per minute.

Figure 29: MM City Ride Application



Advertisements and corporate branding appear in applications created by both Canadian CAREN technicians and Motek Medical. Canadian CAREN technicians, supported by teams of engineering students, create such imagery in order to enhance a sense of realism or place. For example, Bus 325 features a bus ride through downtown Edmonton. The application, created at Glenrose Rehabilitation Hospital in Edmonton and shared with the Ottawa Hospital, encourages patients to work on “standing balance,” “cognitive dual tasks,” and “visual scanning.” The application mimics standing on the back of a bus as the CAREN platform shakes up and down and side to side. At each bus stop the platform jerks sharply right and stops. The challenge for patients is to remain standing, supported by CAREN’s safety harness. Here bus shelters are covered in signs for the Glenrose Rehabilitation Hospital Foundation, the Edmonton Oilers NHL team, the Edmonton Eskimos (a local football team), and the Oil Kings (a local junior ice hockey team). A sign for Tim Hortons also appears. One patient simply refers to Bus 325 as “the Tim Hortons application.” This imagery was selected to help build a sense of place, referring back to the hospital where the application was created, the City of Edmonton, and Canada through Tim Hortons, a fast food chain often represented in advertising campaigns as a “site and source of Canada’s self image” (Cormack 2008: 368).

Advertisements for fast food and soft drinks are common in hospitals in North America, yet advertisements for junk foods high in calories and low in nutritional value remain a controversial choice for healthcare facilities (Malhotra 2013). Digital ads as part of medical treatments raise entirely new questions about the corporatization of hospitals. When the medicine is the ad, what ethical obligations do clinicians have to patients accessing clinical virtual reality?

Corporate branding has also been used by Canadian CAREN technicians to add to the realism of visual clutter created in applications for therapeutic purposes. In the Train application, created at the Ottawa Hospital, patients are asked to walk down the aisle of a moving train. Objects litter the aisle, including an issue of “Entertainment Magazine,” a bag of Doritos, a Butterfinger chocolate bar, a hat, an umbrella and a bicycle. In this application a busy environment helps physiotherapists test a patient’s ability to complete various cognitive tasks while walking through a confusing environment. The Train application allows patients to practice multitasking skills.

While it is clear Canadian CAREN technicians work with ads and corporate branding to draw users into the applications through a sense of realism and place, Motek Medical’s use of brand names remains obfuscated by Coca Cola’s historical involvement with Motek Entertainment as a client. Motek Medical BV and Motek Entertainment BV are subsidiaries of Motek BV. In 2004 the company’s medical application and entertainment branches split to form two separate companies (Wikipedia 2017). The insertion of Coca Cola advertisements into medical treatments for patients could be construed as a conflict of interest.

Motek Medical also directly advertises its own brand to patients and clinicians within applications and through ingenious marketing campaigns. For example, every year the Ottawa Hospital receives a new Christmas themed CAREN application. The games are played year round by patients and feature a variety of activities such as skiing, decorating a Christmas tree, or playing memory games with images of Santa Claus and Frosty the Snowman. Apart from the obvious issue of cultural sensitivity for a diverse patient base, including practicing Muslims and Jews, upon patient completion the games end with a plug for the company, “Motek Medical Wishes You a Merry Christmas and a Happy New Year!”

Regardless of why the ads are there, they are there. A Coca Cola sign inside an immersive virtual reality experience created for patients as a medical therapy is not a typical advertisement, nor is it a typical population to be advertising to. Many patients accessing the CAREN system have experienced severe brain injuries and other medical conditions. They may be particularly vulnerable to repeated exposure to digital imagery. All patients, by virtue of undergoing a difficult and rigorous recovery process, are more vulnerable than the general population. Patients deserve to be protected when they are at their most vulnerable. CAREN users are patients after all, accessing much needed rehabilitation services at a hospital.

We do not know how CAREN advertisements may be impacting patients or what this means for the future of medicine. What happens to patients’ brains when they are shown a Coca Cola ad every 20 seconds during a 15 minute immersive therapeutic CAREN session? We simply do not know. In MM City Ride the Coca Cola ad also seems conspicuously out of place in an environment that contains no other

advertisements. In other words, it is not just that faster drivers using the application may see the sign more often as they loop through the city, but that it is the ONLY advertisement in the application. This is in juxtaposition to Bus 325 and Train, created by Glenrose Rehabilitation Hospital and the Ottawa Hospital, where advertisements are created for a sense of place, and realism in visual clutter. It also stands in juxtaposition to the actual experience of driving down a busy city street where drivers are exposed to a rich assortment of roadside advertising. While direct-to-consumer drug advertising is illegal in Canada (Law et al. 2008), laws have yet to be formulated to deal with ads in digital therapies at Canadian hospitals.

“Donuts and Coffee Please:” The Impact of Tim Hortons’ Advertising

Physiotherapist: I hope Tim Hortons is sponsoring this given all the advertising.

Technician: No, [the designer] just really likes Tim Hortons.

Physiotherapist: And I’m wondering, why do I want a coffee?

Tim Hortons specializes in coffee and donuts, featuring iconic “Timbits” – sugary sweet dough balls that come in boxes of 10 to 40. During my observations the machine awakened a desire for coffee and donuts in patients and clinicians. A Tim Hortons is also located in a hospital building adjacent to the Rehabilitation Virtual Reality Lab, posing a tempting possibility for those working and accessing healthcare services in the lab. The CAREN system, although a medical technology, is helping to shape consumer preferences. In the administration of Bus 325 ads have become the medicine.

Companies have begun to explore virtual reality as a new platform to reach consumers. Coca Cola, HBO and Nissan have all inserted advertisements into immersive digital geographies for consumers to explore (Delo 2014). For example, at the 2014

Word Cup, Coca Cola staged a VR advertising event that allowed participants to experience the locker rooms and soccer fields of Maracana Stadium in Brazil (Delo 2014). Anthropologists Aihwa Ong and Stephen Collier (2005) emphasize corporate dependencies on ever expanding consumer markets. These markets come with new spaces to occupy and stake out in biomedicine.

In Canada, hospitals have a history of contestation over corporate advertising and privatization (Hospital Employees' Union 2017). Although much of Canada's healthcare system is publically funded, in the midst of provincial and federal cutbacks there is increasing pressure to adopt public-private partnerships (Stinson et al. 2005). For example, a recent study conducted by Toronto's Hospital for Sick Children (Picard 2005) found that a quarter of paediatric hospitals surveyed across North America house fast food franchises and, furthermore, benefit from sales used to fund programs and research. The province of Ontario is also considering legislation to regulate the use of corporate donor names for hospital buildings (Benzie 2017). One physiotherapist felt that advertisements in the CAREN system had the potential to generate revenue for the Physiotherapy Department, which had been subject to increasing cutbacks and a loss of staff at the time of my research:

I think that's opening a big can of worms...I think that's the reality of virtual reality these days, is some form of advertising. Yes, it's a clinical setting but...financially we know the CAREN system costs a lot of money to run and upkeep and etc. And ideally would I like to see no advertising? Sure...If you could get financial help from some big companies to run these systems, I don't see why not. So I wouldn't be opposed to that kind of advertising. But yeah, I think in the Tim Hortons' case, it was just the programmers having a little fun with things. I'm thinking about games and stuff and the computer and pop up ads coming up, you know, when it gets a bit out of control, and obviously you'd want to have it limited in an ideal situation. But anyway, I think it's a good question and if you could have sponsors to help with the medical system and to help with treatment opportunities, then why not. And then yeah, it just makes it more like

real life. We're surrounded by it in real life anyway.

The advertisement's role as part of the medicine situates it in a slippery place between a therapeutic treatment and marketing. The Canadian Code of Advertising Standards indicates "that no advertisement shall be presented in a format or style that conceals the fact that it is an advertisement" (Advertising Standards Canada 2017). Advertisements in virtual reality offered to patients in a hospital shocked me. Practitioners and patients appeared less concerned with the corporatization of the CAREN's digital geographies. They did, however, repeatedly acknowledge the pull the machine had on their desire for coffee and donuts and the new prospects for Capitalism the system posed in a healthcare system stretched to the limit. This tension also highlights the paradox of a multi-million dollar machine with a costly service contract located in a facility where basic physiotherapy services and staff are currently subject to cutbacks. Some clinicians at the hospital resented the machine even as they acknowledged its clinical utility.

Tim Hortons is not just a representation, it is part of an embodied experience of medicine for patients. For example, one patient with Multiple TBIs was required to verbally identify a Tim Hortons' sign on the side of the road of Bus 325 while maintaining balance and stability on the CAREN platform. In this session the patient repeated the words on signs in order to practice cognitive dual tasks.

Physiotherapist: Downtown Edmonton, ok.

Patient: Edmonton Eskimos, Oil Kings, Tim Hortons [struggles with balance and stops].

Physiotherapist: Name a tree.

[Patient has difficulty]

Technician: Maple!

“Experience ads” are a growing area for companies (VirtualSKY 2017). The idea is that the ad is not a representation, but a participatory event that draws the potential consumer in as they develop emotional ties to the product or service and become part of the marketing campaign’s story. Social media campaigns are one example, but so are virtual reality experiences crafted to produce consumers (VirtualSKY 2017). The Advertising Research Foundation (2006) identifies “trust” and “context” as important features of effective experiential advertising. Patients accessing rehabilitation services are highly dependent on their physiotherapists. Many undergo painful rehabilitation processes that require a high degree of trust. Where do experience ads in the CAREN system fit into medical ethics? Does it matter if they are crafted by developers for realism, or are made more explicitly for marketing, if the outcome is the same?

REPRESENTATIONS OF WAR TRAUMA

*Imagine there's no countries
It isn't hard to do
Nothing to kill or die for
And no religion, too
Imagine all the people
Living life in peace.*

*You may say I'm a dreamer
But I'm not the only one
I hope someday you'll join us
And the world will be as one.*

- Excerpt from “Imagine” by John Lennon (1971), a war trauma “de-escalation” song selected by a patient for use in the CAREN system following PTSD sessions.

Popular approaches to psychotherapy emphasize patients reliving trauma through retelling, prompting a “reintegration” of the patient’s past (Herman 2015: 156). Here, talk

voices silences that fuel horror. In Canada, 1 in 10 soldiers returning from Afghanistan are currently collecting disability benefits for PTSD (Galloway 2016). The national rate of PTSD for members of the Canadian Forces is 5.3% (Statistics Canada 2013), although the number is likely under-reported. Increasing veteran suicide rates (Galloway 2016) and reports of PTSD associated with sexual assaults in the Canadian Forces (Mercier and Castonguay 2014) have also garnered recent media attention. The CAREN system takes its place in a broader network of understandings about PTSD in Canada. This includes approaches to “Exposure Therapy” (Abramowitz et al. 2012) and “Eye Movement Desensitization and Reprocessing Therapy” first developed by American psychologist Francine Shapiro (1995). CAREN therapies displace talk therapy as a way of reliving trauma and instead seek to work with trauma held in the body through multisensory experiences. These experiences are crafted to literally reproduce specific memories of horror through sight, sound, movement, and smell.

Reliving War

“Hotel California” (1976) by the Eagles is cued up on the CAREN’s audio system. If it was Austin, Texas’ CAREN system, and not the Ottawa Hospital’s, the smell of jet fuel might be pumped into the room for added realism. The Ottawa Hospital currently does not have olfactory features built into the system. It’s hard to get the smells to leave the room between patients. The treadmill, worn by former soldiers’ panicked running, begins to hum and buzz. The patient steps into the centre of the system flanked by the social worker, with me, the anthropologist, behind. During these observations I keep a distance, more than I usually do. I do not want to add to the patient’s fear or anxiety. Soldiers scan the room, especially former Black Ops, registering potential

threats in every corner. Even an application as mundane as the Park, a walk in the park, becomes a field open to sniper attack. One former soldier “stays on the path” to avoid land mines. At times past and present mix, reality and virtual reality merge into a terrifying present. This is the purpose of the machine. To face fears. It is memory on repeat. I feel uncomfortable, like an intruder. Who am I to watch someone relive their most terrifying memories in a machine? Yet I find myself here, and with the fear, and the music, and the memory so thick in the room, it feels like much more than just watching. I have the sense I am experiencing part of this man’s memory.

The former soldier is strapped into the system. A mental health worker at the hospital once described how patients can feel trapped in the system: “they’re not in control of the floor. Every sense basically, probably other than smell, although maybe sometimes smell, is being hyper-activated.” Some patients wear a heavy vest to “get into the zone,” it reminds them of protective gear worn in combat situations. Others describe full body sensations such as heat – residual memories of desert operations. The 3MDR PTSD application is about to start. There is a flash of light. A landscape then appears. It’s like nothing I’ve seen before.

Figure 30: 3MDR PTSD Escalation Phase



Figure 31: 3MDR PTSD Trauma Exposure



Figure 32: 3MDR PTSD De-escalation Phase



The patient's Subject Units of Discomfort are taken by the social worker. The patient reports their level of discomfort on a scale of 1 to 10. Today it is a 5 at the beginning of the session. It peaks at 8 and returns to 5 by the end of the session. The treadmill roars and the patient begins to walk through a Martian landscape. Pale blues and white fill the screen. Suddenly the application flashes again. The sky is now black. It's filled with what looks like pieces of glass or shards of jagged obsidian. The pale blues and white give way to red and black in a broken landscape. This is the escalation

phase of the application, designed to instil terror and a return to bad memories.

The music picks up. “Hotel California” was selected by the patient. It reminds him of his deployment to Afghanistan. As it turns out, warriors have theme songs. Metallic doors appear and the patient enters them as the music plays. He walks down a corridor. It looks like the inside of a spaceship. I later learn that parts of the application are modeled after Star Trek. Another door opens and an image appears. It is a photo the patient has selected. In this case a photo of improvised explosive devices. Wires burst from pots sitting in a desert. “That’s how the Taliban set their bombs off. Rain builds up, touches the wire, activates the rocket and they really don’t care as long as they hit the base.” But really the image is more than a photo. It is a life-sized memory that the patient walks towards. Eventually, he is confronted with an image so large it takes up the majority of the CAREN system’s space.

Patients relive memories of death, destruction, combat and genocide during PTSD sessions focused on deployments in Iraq, Afghanistan, Northern Ireland and Kosovo. Anxiety fills the room. I can smell the patient’s acid sweat. His small voice quivers and whispers something I cannot hear. The social worker verbally checks in. He is reminded often to separate the past from the present. “What will help with your hyper-vigilance is your ability to distinguish training in Afghanistan, Bosnia and all those other places from the life you have here.”

Some clinicians at the hospital believe men respond better to female healthcare workers, that they are not as afraid to be vulnerable in front of woman in the CAREN system. The CAREN workforce is surprisingly gendered, composed almost entirely of female clinicians. In interviews and during clinical observations I am surprised at the

vulnerability of Black Ops “super soldiers.” They are here for care, to heal the wounds of war, both psychological and physical. Practically speaking, in the CAREN system, the distinction between the two is tenuous. How many of these former soldiers, I wonder, are from the same kinds of neighbourhoods I grew up in, communities racked by poverty and violence? How many joined the military to have access to education, as a way out? This is something I myself considered before turning to anti-war activism in my 20s.

The patient endures several more rounds of image exposures, walking through the hallway and stopping at the improvised explosive devices again and again. At the end of each round a red ball clicks back and forth across the photo from left to right. White numbers appear on the red ball as it clicks: 84, 77, 25, 87, 73, 56, 37, 11, 18, 42, 23, 24, 98, 50, 20, 10, 44, 57. The patient calls out the numbers at the request of the social worker. The exposure therapy ends. Slowly blue and white landscapes return to the CAREN system. The de-escalation phase begins as John Lennon’s “Imagine” (1971) pumps out of the speakers. The patient has chosen this song. It reminds him of good memories.

Eye Movement Desensitization and Reprocessing

Midway through the project I take a video clip of the 3MDR application to a physician friend of mine who is also a medical anthropologist. We try to make sense of the red ball with numbers on it clicking back and forth across the screen. Was the hospital trying to hypnotize CAREN patients? Was it some sort of clinical tool? I later learn that it is the hospital’s attempt to integrate Eye Movement Desensitization and Reprocessing Therapy into CAREN treatments. First used for PTSD, “the procedure requires that the client generate a number of lateral eye movements while engaging in imaginal recall of

significant aspects of a particular traumatic memory” (Cahill et al. 1999: 6). American psychologist Francine Shapiro developed the therapy in the 1980s after she “accidentally” discovered “disturbing thoughts were suddenly disappearing and not returning” following repetitive eye movements (1989: 201).

The technique generally involves the patient following the clinician’s index finger, however, in the CAREN system a moving red ball is overlaid on top of trauma specific imagery instead. Patient “recall” of memories is also eschewed for a sensually enhanced digital reproduction. Following each round the patient reports back to the therapist about how they are feeling, what they are thinking and any sensations they are be aware of. “Subjective Units of Discomfort” (Wolpe 1973) are taken “until the client reports a 0 or a 1” (Cahill et al. 1999: 6). This is another feature utilized in the CAREN system sessions, although the lowest SUDs I observe a patient report is a 4.

Figure 33: Eye Movement Desensitization and Reprocessing Therapy in 3MDR



Eye Movement Desensitization and Reprocessing Therapy has been critiqued by clinical psychologists as a “pseudo-science” (Herbert et al. 2000: 946). However, it is important to acknowledge the nuanced factors shaping therapeutic experiences, including

the intersections of culture, psychology and social context (Hinton and Good 2015). Cahill et al. (1999) emphasize it is doubtful the eye movements themselves have any clinical benefit; rather multiple exposures to fearful memories in a safe environment can have a beneficial effect. 3MDR is not applied without the patient's access to associated counselling outside of CAREN treatments. The social worker's role in directing sessions, in coordination with the CAREN technician, is also key to the 3MDR application.

The Cost of Reproducing War Trauma

As an orienting clinical framework, Exposure Therapy moves away from strictly narrative approaches towards sensory saturation as patients encounter the objects of their fear, anger, and anxiety in an attempt to overcome symptoms associated with PTSD. As far as treatments for PTSD go, Exposure Therapy can be controversial. Well many patients experience improvements over time, the intentional exacerbation of patient fears makes Exposure Therapy one of the most polarized treatments in mental health (Slater 2003; Becker, Zayfert, and Anderson 2004; Olatunji, Deacon, and Abramowitz 2009; Van Minnen et al. 2012). Careful screening for eligibility is understood to reduce risks associated with treatments, including: suicidality, self-harm, alcoholism, and drug addiction (Olatunji, Deacon, and Abramowitz 2009; Van Minnen et al. 2012).

Virtual Reality Exposure Therapy is rooted in the vestiges of behavioural sciences, in psychology this represented a shift from psychoanalysis to Pavlovian conditioning in an attempt to scientifically evaluate human behaviour (Coon and Mitterer 2010). It was a turning point and a recognition in psychology that social conditioning and environmental factors could strongly shape human behaviour. Faced with increasing rates of PTSD in soldiers returning from Afghanistan, at the time of the CAREN system's

purchase in 2011, Canadian clinicians were seeking new treatments for combat related trauma. The Federal Government also faced increasing pressure to demonstrate that it was responding to soldiers' needs, even as it undertook extensive cuts to community-based mental health supports for returning soldiers (Minsky 2014; Beaver and Clarke 2015).

The CAREN system's insertion into the story of Exposure Therapy takes place within a highly masculinized and militarized patient population. Specific types of traumatic memories are privileged in CAREN therapies. Domestic violence, hate crimes, and child abuse do not figure in 3MDR's reimagining of trauma. For example, it is unlikely, and many would argue unwise, that a military "rape" application would be crafted for the CAREN system. A recent study reveals that 27.3% of female members of the Canadian Armed Forces have experienced a sexual assault since joining the military, a rate seven times that of male service members (Statistics Canada 2016). Rape and combat violence are also linked in the history of establishing PTSD as a psychiatric disorder. In the late 1970s the American Vietnam Veterans Working Group and various feminist organizations in the United States collectively advocated for the inclusion of PTSD in the Diagnostic and Statistical Manual of Mental Disorders (McKenzie-Mohr and Lafrance 2014). Its inclusion was viewed as a victory for survivors of trauma seeking services, support and related resources (McKenzie-Mohr and Lafrance 2014). By the late 1980s, rape "listed second only to combat in the DSM III categorization of PTSD" (Shapiro 1989: 200). Today many feminist scholars caution against the over medicalization of rape and highly individualistic approaches to trauma that do little to address systemic inequalities and the root causes of violence (McKenzie-Mohr and

Lafrance 2014). Well the history of rape and combat coalesce in the definition of PTSD, and are furthermore not mutually exclusive, 3MDR remains rooted in selective memories of horror.

The Accidental Fear Response

In 3MDR treatments, there were moments when the machine cultivated the wrong kind of terror. Clinicians sought to craft reproductions of traumatic memories that could be carefully contained, administrated in the machine, and rooted in replications of specific times and places. Memories, however, can be unruly. They are hard to plot. Fear cannot be administered in drops like an elixir. The CAREN system's multisensory features sometimes resulted in an accidental fear response.

The Terror of Observation

As an outsider, the 3MDR sessions look like torture. This is not an unusual characterization of Exposure Therapy, even in literature by psychologists (Olatunji, Deacon, and Abramowitz 2009). During fieldwork I have to remind myself that practitioners and patients, although sometimes sceptically, understand these experiences as therapeutic.

Figure 34: The CAREN System Rifle



One day at the hospital a military physiotherapist asks me if I have had exposure to guns, before handing me a replica of a rifle to test in the CAREN system. The replica is a military issue rifle; it feels heavy in my arms. “Yes,” I reply and relay experiences about hunting and outdoor survival courses I have taken in Northern Canada and talk about what it was like living on a street in the United States with open gun fire. I feel obliged to speak the truth about violence. These neighbourhoods exist. Most middle class contexts I occupy do not acknowledge this and the social scientists I work with often view gun violence as an interesting topic of study, not the lived reality of another researcher. The military physiotherapist, who has only recently returned from pistol and gas attack training, expresses her concern. “I could never live there.” I find this ironic given the possibility of her deployment.

As an ethnographer, I have survived my own battle zones, including the loss of friends to violence that precipitated my involvement in community organizing as a young adult. At 15 I lost four friends in a 12-month period, two of whom were murdered, including one who was shot. My visceral response to images of guns in Afghanistan and Kosovo during 3MDR sessions is horrifying, much more horrifying than physically

shooting the rifle replica at the screen during my CAREN system firearms test. That feels more like a duck hunt Nintendo videogame, not fear. Not like this. Much more than an observer, I have been pulled into the terror of the machine.

The idea of being pulled into the terror of the system as a “viewer” was a primary concern of one of the hospital’s mental health workers. She was particularly worried about the impact of the machine on the CAREN technicians during exposure therapy sessions.

Mental Health Worker: I have that bias which is, can we find a way to get the third person out of the room and have it be operated somewhere else? I just think the number of exposures you have, at what point are we going to do something interesting to those few engineers we've got?

Ethnographer: Right. So your desire to remove the technician from the room is not so much about the clinical outcome for the patient, but to protect the wellbeing of the technician.

Mental Health Worker: I'm hoping we don't end up with another patient.

Unlike forms of “talk therapy,” memories of fear are brought to life through sensation in the system. While CAREN technicians do not experience the system’s movements, they do experience other features crafted to elicit a fear response. During sessions the primary and back up CAREN technicians have been coached to look at positive imagery, such as a picture of a field or a forest posted by the computer. They are also encouraged to debrief with a staff psychologist. There are currently no studies on the impact of multisensory virtual reality on staff directing clinical PTSD sessions.

Star Trek and Patient Aversions

While the aesthetics of the CAREN system look something like a 1950s science fiction movie and comparisons to Star Trek are common, the machine has more direct links to science fiction media.

Figure 35: 3MDR's Spaceship Like Corridors



The Dutch Military, in partnership with Motek Medical, originally created the 3MDR application. A Canadian Broadcasting Corporation article elaborates:

The 3MDR system was developed by military doctors in the Netherlands. Like Canada, the Dutch military is dealing with a rise in PTSD cases after its mission to Afghanistan. The Dutch military spent four years in the country. Twenty-five Dutch soldiers died and another 140 were injured (Parry 2015).

In an early Dutch design of the 3MDR application, later modified in Canada, Star Trek's "Star Ship Enterprise" directly appeared in the application. I was fascinated with the idea that Star Trek imagery would make its way into a treatment for PTSD. Why? I was able to clarify the purpose of the original imagery with a representative from Motek Medical who viewed the application's space like environments as essential to not triggering the patient's PTSD with unnecessary media. In other words, triggering the patient's PTSD with self-selected imagery and targeted memories was ok, but the developers did not want to include any material reminiscent of "real life" that might trigger a response to

another memory, time or place. Locating the application in space was a way of avoiding untargeted memories of earth. Of course, the confined spaceship-like corridors between exposure sessions did trigger former soldiers who felt vulnerable in tight spaces. In CAREN treatments the line between outer space and earthly memories is thin.

I had the opportunity to interview a Mental Health Worker who was involved in transitioning 3MDR from Holland to Canada. The Star Ship Enterprise was removed from the Canadian version of the application due to the fact clinicians were concerned it had the potential to create a strong aversion to Star Trek as an unintended consequence. Star Trek, the worry was, would get mixed up with bad feelings about targeted traumas. When science fiction and medicine collide in digital worlds things can get complicated. Unweaving the stakes tied to these collisions is an important task for ethnographers, clinicians and philosophers of science. Patients, like clinicians, become explorers in new forms of medicine. They also live with the consequences of choices about digital representation.

DISRUPTIVE BODIES

Patient: I think you'd need to go through all of those apps. What are they portraying about gender? What are they portraying about race?

Clinician: I can't think of a situation where gender or ethnicity was an issue at all.

- Interview responses to questions about human diversity

Many of the clinicians and engineers did not like to think about the social role of the CAREN system. By focusing on disease, disorders and rehabilitation the machine was understood as a form of medicine eclipsing culture. However, representations in the CAREN system are deeply cultural. Unlike a CAT scan or MRI (Dumit 2004), in

CAREN application development the craft of removing ambiguity and shaping images in an idealized likeness is also less hidden from view. For the first time, debates about video games, distorted human representations and their social impact turn up in the clinic. Whiteness was also reproduced in a refusal to talk about race, colonization and the way assumptions about bodies leak into the machine.

Marginal bodies disrupt the apparitions on the screen: the Muslim patient, in a Hijab, playing a Christmas themed physiotherapy application; the transgender patient, identifying as non-binary, who is confronted with the machine's gender categories; the Inuit patient, directed to read racist sport team logo signs (the Edmonton "Eskimos") on the side of a digital road as part of their treatment. Illegitimate bodies poke holes in the CAREN system's assumptions about human difference.

Inuit Patients and Racist Sports Team Logos

Confronting the culture of no culture in clinical practice requires difficult conversations about race, colonization and practices that exclude, marginalize and erase certain kinds of bodies. Canada is hailed as kinder and gentler to its minorities than the United States. However, these beliefs often obscure more troubling realities, realities of bodies pushed to the margins, including those in healthcare. Missing and murdered Indigenous women (Amnesty International 2016), the violent deaths of Black Canadians at the hands of law enforcement (Black Lives Matter Vancouver 2017), including in Ottawa at the time of my fieldwork (Cote 2016), and the persistence of White supremacy shape experiences of racialization in Canada. Indigenous peoples in Canada continue to experience disproportionate rates of poverty, hunger (Blackstock and Trocmé 2005), a lack of access to clean drinking water (Mascarenhas 2007), and higher rates of heart

conditions (Waldram et al. 2006), diabetes (Hanley et al. 2005) and tuberculosis (Adelson 2005). Ongoing colonization, and resistance to colonization, is felt in the body.

Furthermore, Indigenous peoples in Canada “often experience healthcare inequalities due to racism” (Goodman et al. 2017: 87). This is unacceptable.

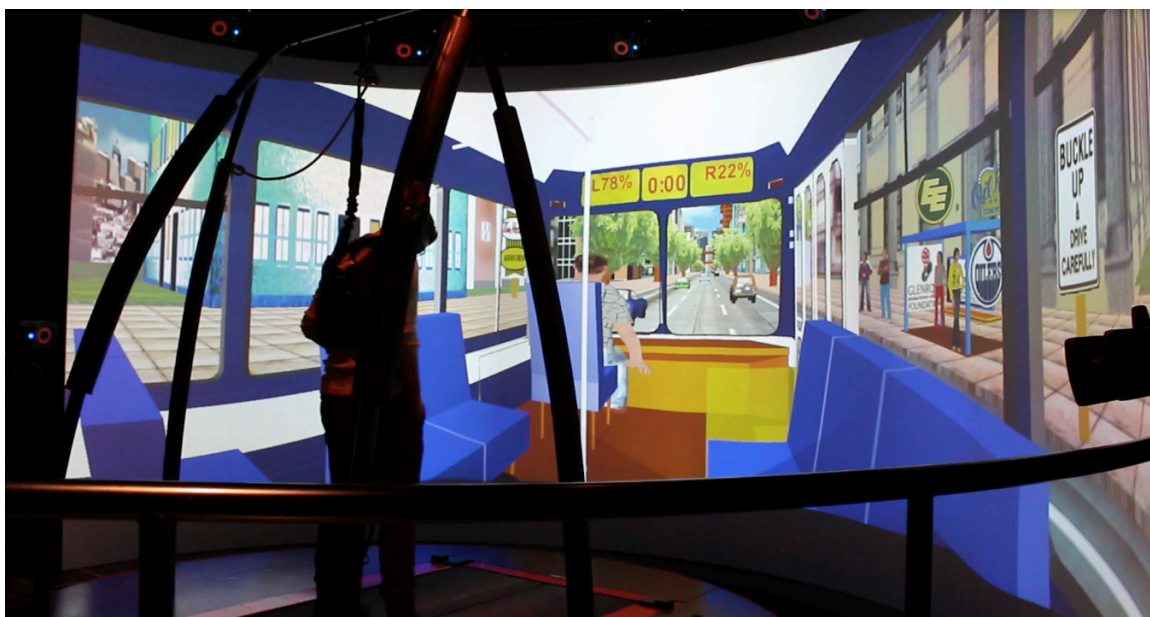
As a virtual reality technology the CAREN system is neither “post-racial” nor “post-colonial;” instead, it is predicated on assumptions about race and racialization, Whiteness, and ongoing colonial practices in healthcare. Helping practitioners who wish to ‘do no harm’ to see these connections is a difficult task when biomedicine and White supremacy work in concert. The majority of practitioners participating in my study self-identified as “White,” “European,” or “Anglo-Canadian;” as an ethnographer I often confronted colour-blind ideology, making it nearly impossible to have productive conversations about power, Whiteness and healthcare.

Questions of access, funding and militarization shape colonization’s links to the story of the CAREN system. Justifications for the territorial boundaries, federal authorities and the legitimized power of “Canada” as a nation state also dissolve when re-conceptualized through Turtle Island’s diverse Indigenous roots. Even the idea of healing painful memories through highly individualized experiences away from community and place in 3MDR are at odds with diverse Indigenous worldviews (Alfred 2005; Sinclair 2007; Cardinal 2016). Virtual reality, however, is Indigenous too, as cultural revival and youth movements demonstrate. For example, in Nemaska the Cree School Board has established a joint program with Minority Media, “a video game company based in Montreal that was co-founded by Cree filmmaker Ernest Webb,” teaching children Cree syllabics in virtual reality (Wapachee and Little 2016). As a Settler on Lkwungen and

WSÁNEĆ Homelands, my first virtual reality headset was gifted to me by a nearby T'sou-ke Elder, also fascinated by the future of virtual reality technologies. If virtual reality in medicine is here to stay, what if healing also looks like removing racist sports team logos from CAREN system environments?

Inuit patients from Northern communities represented a portion of CAREN system users. Inuit patients have accessed the system in the past and will likely continue to do so for physiotherapy in the future. The digital geography in Bus 325, and Car 35, contains the “Edmonton Eskimos” Canadian Football League team logo. In addition, a cognitive dual task question presented to patients requires patients to name Edmonton’s football team - the Edmonton Eskimos. Canada’s national Inuit organization Inuit Tapiriit Kanatami has condemned the use of the term “Eskimo” as a racial slur. Inuit Tapiriit Kanatami has also called for “the owners of the Edmonton franchise to change the team name” (Obed 2015). Natan Obed, President of Inuit Tapiriit Kanatami, rejects the common argument that these issues are trivial, pointing out that derogatory language serves to dehumanize Indigenous peoples. Other community leaders agree, pointing out that such terms are rooted in a legacy of oppression (Winegust, Engle-Hardy and Keri 2015). Racist sport mascots and logos represent more than entertainment; these symbols produce powerful social and psychological effects (Fryberg et al. 2008). Removing the reference to the Edmonton Eskimos will not only help create a more comfortable clinical space for Inuit patients, it will also discourage use of the term by other clinicians and patients.

Figure 36: Racist Sports Team Logos in Clinical Virtual Reality



Christmas Themed Applications Used with Practicing Muslims and Jews

Ethnographer: So the first question you can think of as the Canada census question. It's to get an understanding of the background of my research participants. So I was wondering if you could state your age and self-identified cultural or ethnic background.

Respondent: Okay, I'm 19 years old, Somalian, I'm Muslim. What made me decide to become a Muslim is because Muslim is all about being positive and giving back to the community and being religious; not being a terrorist. People that's terrorists is usually people that's going against their religion...I'm a big basketball fan, and I hope I go forward with basketball, like give back to community and improve everybody's ability in basketball and go far in my studies if I have to. Also I'm a big designer clothes fan. I like dressing myself...I love getting haircuts, cleaning myself, making myself smell good.

Ethnographer: Walking with pride.

Respondent: Yeah. I'm a healthy guy, not the kind of guy that drinks alcohol or smokes. I'll be one day an example to society and I hope I will be in the future. That's all I can tell you.

Ethnographer: Alright. I get the sense you might already be an example.

Respondent: Thank you very much.

Ethnographer: And point taken about Islam. I think there's a lot of Islamophobia right now...and it's not right.

Respondent: Yeah... some people show bad example, that makes the other people that are feeling like Islam is not a great religion [sic]. But really the meaning of Islam is believing in god, Allah, and helping homeless people, helping everybody, praying, basically doing all the positive basic things...It's not a big religious artifact. This is basic things. That's what made me love that religion, and I'm still... that religion made me a good person, a really good person. I was never a bad person because of that religion.

Figure 37: Decorating a Christmas Tree as Physiotherapy in MM Christmas 2011



The patient, who is Muslim, leans left on the snowboard and zooms through a landscape of Christmas trees. Each tree is topped with the star of Bethlehem and decorated with ornaments, bobbles and red garlands. Frosty the snowman holds arrows directing the patient. The song “We Wish You a Merry Christmas” (Warrell 1935) plays. The song is punctuated by jingling bell sound effects every 20 seconds. In the upper center of the screen the time appears. Each numeral is decorated with tiny Christmas trees, presents and bobble icons. The patient successfully navigates this virtual reality

based winter wonderland crafted for physiotherapy. “Motek wishes you a Merry Christmas and a Happy New Year,” flashes across the screen.

As a Jew I’m having a hard time understanding how Christmas made it into a virtual reality physiotherapy application at a Canadian hospital. As an ethnographer and activist I’m having an even harder time getting practitioners to understand why it might be a problem for Muslim and Jewish patients. At one point, in an email exchange with the hospital, I am asked to identify religious symbolism in the Christmas, literally “Christ’s Mass” (Barnett 1946), themed applications. I respond with a history of Christmas iconography and register a growing irritation with the culture of no culture.

Every year the Dutch company Motek Medical ‘gifts’ the Ottawa Hospital a Christmas themed physiotherapy application for use with CAREN patients. The gift, although well intentioned, is inappropriate to Canada’s large, diverse, multicultural patient populations. MM Christmas 2011, MM Christmas 2012, MM Christmas 2013, and MM Christmas 2014 feature elves, Santa, and religious imagery in a landscape of Christmas trees and snowmen. The application soundtracks feature “Silent Night Holy Night” (Gruber 1818), “Jingle Bells” (Pierpont 1857), and “We Wish You a Merry Christmas” (Warrell 1935). Of the 210 observations, Christmas themed applications were used year round in 16 of the clinical sessions, including with practicing Muslims and Jews. Even overtly Christian themed applications could not penetrate popular understandings of the CAREN system as a culturally neutral medical technology.

Two Genders, Three Races

Figure 38: "European Woman," "Asian Woman," and "African Woman" Templates



Figure 39: "European Man," "Asian Man," and "African Man" Templates



The bus in Bus 325 pulls over at a bus stop. It's hard to stand, to keep my balance and not fall over. It feels realistic, just like the 99 B-Line in Vancouver I've taken so many times before. As I ride I pass small groups of people huddled on the sidewalk. I peer at their faces, clothing, and bodies. I notice similar variations of the same digital people appearing again and again. Are there any butch women, I wonder, who look like me? But the women all look like Barbie dolls. The men, with buzz cuts, look more like

me, but they are not quite right. I sigh. I add virtual reality to the list of places my body doesn't seem to belong: public washrooms, US Customs, and now digital medicine. For once, I'd like to escape hetero-normativity into worlds populated by drag queens, third genders, Two-Spirited folks, and trans utopias, but this reality will have to do. As developers craft CAREN's digital environments they also program in assumptions about gender. Patients encounter gender not as it is, but as it is narrowly depicted.

Medical imagery produced by X-Rays, CAT Scans and MRIs is very different from the creation of human figures featured in CAREN environments for physiotherapy and the treatment of PTSD. For the first time debates about human representations in video games and other forms of media carry over into the clinic. Here the clinic is not producing diagnostic imagery, but is involved in the creation and use of human figures to populate digital worlds. There is a social responsibility to consider the kinds of human representations patients encounter during their treatments. Human imagery in media, for example, has been powerfully linked to eating disorders in young women (Peroutsi and Gonidakis 2011), racism (Oliver, Ramasubramanian and Kim 2007), and internalized homophobia (Macedo and Steinberg 2007).

In my own ethnography, research participants rarely fit into the CAREN system's framework for human bodies. For example, participants came from diverse backgrounds from both within and outside of Canada. This included Anglo Canadians, Francophone or Québécois participants, Canadian participants from Sri Lankan or Somalian families, and participants originally from China, Lebanon, Jordan, Ireland, South Africa, and the former Yugoslavia. It is possible patients would prefer to occupy digital worlds with people who look more like them, including representations of people who use assistive

devices such as wheelchairs, walkers and canes.

Motek Medical's human templates provide two options for gender and three for race: "European Man," "Asian Man," "African Man," "European Woman," "Asian Woman," and "African Woman." Categorical imperatives shape understandings of what it means to be human (Star and Bowker 1999). In this sense, the machine helps produce ideas about race itself. These three options do little to account for the diversity of research participants in the study, let alone the highly multicultural and diverse populations that occupy the rest of Canada. Removing the framework of three races and providing easily customizable and diverse skin colours, hair textures, hair length, and body width and height variations, representing a gradual scale of body types with mix and match customizable options for human figures, would provide a platform more sensitive to human diversity. The ability to easily switch options between gendered figures would also allow more room for gender diversity in digital environments. Indicative of Ottawa's diversity, LGBTQ2+ practitioners, patients and members of patients' families were present during CAREN session observations. Not all of the individuals who accessed the system fit easily into the dichotomous portrayals of gender appearing on the screen. For example, female figures commonly had hourglass figures, while male characters were commonly presented as lean and muscular.

A young solider accessing physiotherapy is practicing his balance and stability in an application called "Physics Box Drop." Stacks of boxes appear on a platform. The solider must tilt the platform correctly to match the colour of the boxes to corners of the screen with corresponding colours. "Triple Stack!" the machine squeals in a sing-songy

voice as the patient correctly hurls a stack of three boxes into the correct quadrant of the screen. “That voice is so gay!,” cries the attending physiotherapist.

The night before the observation I attend a memorial for victims of the Orlando Massacre with an old roommate of mine, who is transgender. 49 people have been shot dead with a semi-automatic rifle at a gay nightclub in Florida. Many of the victims are People of Colour, who had come for a Queer Latin themed dance night (Brammer 2016). We come to the memorial to gather in community. My former roommate and I are not just old friends; a decade ago we experienced a hate crime together on a camping trip.

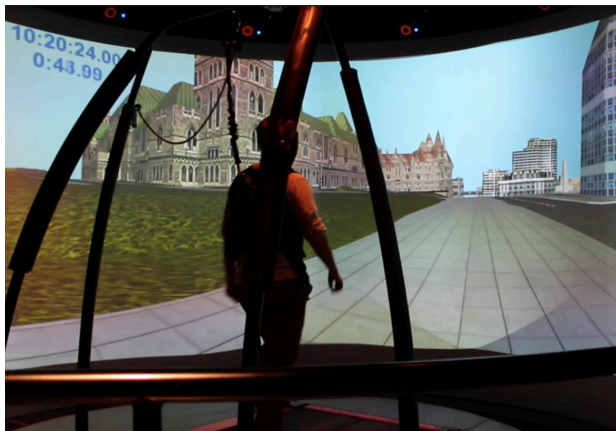
A group of young men drop acid and circle our tent all night long screaming “kill the fags, kill the fags.” Because they are high we can’t tell if they are going to kill us or not. This is not the first time something like this has happened. Despite many passers by, nobody helps us. In the morning the owner of the campsite brushes it off. The West Coast island we are staying on is so small there is no police force to contact. We are horrified by the apathy. Our lives, it seems, as trans and butch folks, don’t seem to matter that much. With memories of hate crimes swimming in my head and the need to maintain a rapport with my research participants, especially the young soldiers steeped in homophobic environments, I speak out after a second “gay” comment from the physiotherapist. “Hey, you’ve got a gay right here, what’s wrong with that?” A complacent observer I am not. The physiotherapist apologizes and we later meet for coffee. We talk about the impact of language on minority patients, how easy it is to use homophobic language in a homophobic culture and ways to make clinical spaces safer for minority patients. Despite the initial awkwardness of the encounter I can’t help but like the physiotherapist. I leave the conversation feeling hopeful.

As an ethnographer there is nothing objective about me, but that's not the point; "neither ethnographers nor their subjects hold a monopoly on the truth" (Rosaldo 1993: xix). What if I had been not an outraged anthropologist, but a Queer patient? In clinical environments shaped by society's broader homophobia and racism there is no such thing as an entirely safe space, but when health outcomes are tied to inequalities we can try to do better. Anti-oppressive medicine in Canada means accounting for difference, including in clinical virtual reality.

THE SIMULACRA

Reproductions of Edmonton and Ottawa and the Politics of Erasure

Figure 40: A Walk by Ottawa's Virtual Parliament Buildings



In the CAREN system, nature, geography and memory are recreated and re-experienced. Nostalgia and reproduction feature largely as a form of entertainment in North America today. Virtual reality has become increasingly commercialized and made available to consumers at home. For example, the Oculus Rift headset features roller coaster rides, mountain climbing, soccer, and an opportunity to participate in the Apollo 11 moon landing (The Rift Archade 2017). Here, reproduction as entertainment is rooted in an aesthetics of socio-political sanitization. For example, Hunt and Frankenberg

(1997) comment on the de-politicization of space in Disneyland's reproductions of America, a de-politicization that serves another kind of politics— those of erasure (Casper and Moore 2009). However, it is not just a question of the politics of erasure; it is also a question of *whose* bodies are erased? In the CAREN system's reproduction of Ottawa there is no poverty, panhandlers, or dirt. The Black Lives Matter protestors I linked arms with, circling the walls of the parliament buildings, do not appear in digital reproductions. In clinical virtual reality, the nation's capital is devoid of the politics Ottawa evokes. CAREN applications reveal what is considered worthy of reproduction. The politics of place are rooted in specific geographies the replications bring to mind.

When reproductions claim not to entertain, but to heal, the aesthetics of socio-political sanitization and the missing bodies they hide can be a form of violence against marginalized patients. When clinicians direct Inuit patients to identify racist sports team logos as therapy in a CAREN bus ride through downtown Edmonton the poison and the cure coalesce. If healthcare practitioners do not want to wound with replicas that claim to heal, how do we address socio-political geographies and missing bodies in an attempt to populate digital worlds? Should we replicate? Or in the spirit of 3MDR, attempt to create otherworldly landscapes, however imperfectly, to stop patients from mixing up real worlds with virtual ones? Is there even the will to address the politics of replicas when systemic inequalities so fiercely occupy biomedicine and its cultural authority?

Assumptions about class, primarily the refusal to portray poverty class bodies in idealized landscapes, are also reflected in the stylistic aesthetics of human models. As a teenager facing homelessness after 'coming out' as Queer, my biggest asset was the ability to hide my class status in order to access food and other services. A suit jacket

from Value Village went a long way in deterring the gaze of mall security eager to stop homeless populations from eating leftovers at the mall food court. I learned early on to approximate middle class aesthetics in a bid to survive in a world hostile to poverty class bodies. Like my suit jacket, Motek Medical's human figures – clothed in neatly wrapped digital robes – are designed to make people comfortable with human representations. However, sparkly digital models of women who look like they stepped out of a Lululemon store stand in stark juxtaposition to poverty class patients who struggle to feed and clothe themselves. One patient, Barbara, describes this tension “I'm on disability now, so definitely there's an economic factor that affects my treatment and my way of life and everything.”

At the time of my research Barbara was having a difficult time finding enough money to purchase adequate shoes for her swollen and infected feet. Her poverty had a pronounced impact on her experience of CRPS, her social life and her interactions with clinicians. Veterans (Thompson 2014), immigrants and refugees (Citizens for Public Justice 2016) and persons with disabilities (Council of Canadians with Disabilities 2013) experience disproportionate rates of poverty in Canada – all are CAREN users.

Real, But Not Too Real

For practitioners involved in CAREN system software development there is a need to make applications “real” but “not too real,” just real enough to immerse the user. Replications are resource intensive, both in terms of staff time required to do the programming and in terms of the hardware and software necessary to operate the system. One CAREN technician involved in application development emphasizes that a single strawberry can crash the system:

You can never make anything really, really too realistic because it would just crash. I once had a student make me a lovely strawberry that crashed the system. It was a beautiful strawberry but I couldn't even have a box of strawberries in the system because I'm like okay, well that takes up all the computing power.

CAREN environments are built from basic shapes. Leaves evoke leaves, but don't quite look like leaves; rather, an assortment of triangle shapes patched together. Human figures are blocky and move in unnatural ways. Patients, some of whom were professional gamers, commented extensively on the system's poor graphics; "it reminds me of playing video games when I was a child, comparing it to like a Nintendo." The CAREN system's medical virtual reality relies less on the hyper realism of virtual reality for entertainment, and more on evoking just enough similarity to real world settings to draw users into therapeutic experiences. Graphics are also a safety issue. Unlike a virtual reality headset, body movements are coordinated with the system's treadmill and pistons. The program has to operate in real time; a system delay could seriously injure a patient. Manageable graphics help prevent the system from crashing and keep patients safe.

Reproducing Nature

Figure 41: The Park Application



The Park, featuring a walk in a park, is loosely modeled after alpine environments in the "The Sound of Music" (Wise 1965). Chirping crickets, singing birds, and barking

dogs help bring the Park to life. Many patients find the application relaxing and a welcome respite from some of the more busy digital environments.

System settings also impact the difficulty of the Park's environments. For example, I once prompted the technician to put the application on the most challenging setting; it felt like a hearty climb up Mt. Seymour in North Vancouver. Lightening storms and night-time settings are strategically added challenges. Oak, maple and aloe vera (not an alpine plant) incongruently populate each scene, prompting comical responses from patients with a knowledge of horticulture: "aloe vera, aloe vera, I'm not sure this plant would be in the Rockies!" Forest Road and MM Boat also feature natural environments patients are drawn to, including walks through forests thick with pine trees, and ocean voyages between islands and inlets. In the CAREN system birds, butterflies and sharks become therapeutic tools:

Tech: Do you want to do sharks?

Physiotherapist: No, we don't do sharks with her.

Sharks, birds and bugs offer possibilities for physiotherapy. In Forest Road patients get points for slapping birds and butterflies.

Features of nature are digitized and reimagined as medicine in the CAREN system. The idea of nature as therapeutic is not new and is embedded in the history of medicine. For example, in Victorian England fresh air, sun exposure and saltwater baths in the sea were viewed as medical techniques that fostered robust health (Braun 2013). Today psychologists promote "public health and mental well-being through ecotherapy" (Burls 2007: 24). Counsellors integrate nature into therapy for families and couples (Burns 2009) and physicians encourage patients to cultivate healthy bodies through

notions of self-care that include participating in outdoor activities like hiking and skiing (McCurdy et al. 2010). Understandings of nature and culture are intertwined (Haraway 1997); this is evident in assumptions about health and healing.

The sounds of ocean scapes and birds singing also have a lot to do with many patients' experiences of relaxation in applications located in natural settings. The sounds are reminiscent of audio recordings used by psychologists in guided meditation exercises used to reduce anxiety (Alvarsson, Wiens and Nilsson 2010). It is possible an actual walk in the park would be just as beneficial to patients; however, when patients cannot walk without the assistance of the system's harness or remain unable to tolerate Ottawa's cold snowy winters CAREN's virtual experiences of nature have to do.

CONCLUSION

Multisensory hospital ethnography prompts a rethinking of research into virtual reality. Here, I highlight the ways specific bodies are pulled into representational practices in the machine. Attentiveness to sensation and representation also reveal the ways anthropologists' own bodies can disrupt assumptions. As an ethnographer I could not escape my position as a Queer, Jewish, Butch woman, from a poverty class background conducting research on the CAREN system. Assumptions about bodies recast debate on virtual reality and its social implications. Representational practices do not take place in a vacuum; they are mediated by social values. Advertisements, reproductions of traumatic memories, digital geographies, and depictions of humans all point to important junctures for explorations of sensation, power and new technologies in digital medicine. They are anything but benign.

SIGNIFICANCE OF RESEARCH: CHAPTER SEVEN

In previous chapters I have documented clinical virtual reality's reach in one Canadian hospital. I focus on the ways the CAREN system reproduces normative assumptions about the human body. Moving beyond anthropology's tendency to fixate on diagnostic imagery and virtual reality as a technology of visualization I have highlighted how new technologies shape experiential forms of digital medicine. As a feature of medicine in Canada, the CAREN system raises questions for practitioners, researchers and ethicists. In Chapter Four, I call attention to the ways bodies and the machine move together. Inherent in assumptions about movement are clinical values – of correct technique, body preparation, and aftercare. In the CAREN system movement is also enlivened with the aesthetics of science fiction media. Furthermore, playful bodies in the machine engage in a back and forth with physiotherapists, finding just the right balance between freedom and cultivated self-control.

In Chapter Five I document multisensory assumptions that shape how patients are expected to receive their CAREN treatments. How patients are expected to see, hear and feel in the machine can be quite different from actual patient experiences. Part of the problem with curating a multisensory “event” or “experience” is that perception itself is contingent on the particularities of patients' lives. Here intersectional bodies cannot be flattened. In practice, clinicians improvise with the CAREN system. As prefaced in Chapter Four, clinical virtual reality is in fact far from corporate desires for automated healthcare. Adaptable clinical techniques are a priori at the hospital's Virtual Reality Lab.

In Chapter Six I lay bare assumptions about the body inherent in representational practices associated with the CAREN system. Colonization, processes of racialization and ideas about class and gender are mirrored in clinical digital realms. Most practitioners I encountered were ill prepared to deal with the consequences of representational practices for their patients. Anti-oppressive approaches to medicine and more effective anti-racist education for clinicians are required. Finally, clinical virtual reality's focus on reproductions – of traumatic memories of war, advertisements, and nature – reveal startling assumptions about healing, consumers and militarized healthcare.

Chapter Seven provides an overview of the critical contributions this study makes to research, including contributions to method, theory and practice. Thematically these findings address intersections of virtual reality and power, human perception and sensitization to multisensory digital treatments, the value of embodied methodologies in disembodied cyberspaces, interface design and human creativity, and the dangers inherent in fostering human preferences and aversions in a machine.

VIRTUAL REALITY AND POWER

Sensation, power and perspective shape experiences of virtual reality in the clinic. In Canada, the CAREN system reveals new intimacies with digital technologies in medicine. As a joint project of a hospital and the Canadian military, the system also represents historical continuities with virtual reality's past. Anthropologist, peace activist, and former soldier Jose Vasquez (2008) documents the military's involvement in the development of virtual reality technologies for training and recruitment. He critiques the bloodless “techno-spectacle” used to emotionally distance soldiers from the act of

killing (92). In my own research the line between video games and violence was thin, a lesson driven home to me the day I fired a replica of a rifle at a screen in a hospital as part of my fieldwork. Located in a clinic, the CAREN system evokes Foucault's "right of death and power over life," through the strange and winding intersections of clinical practice, killing and computers (1978). But how virtual reality is experienced by healthcare practitioners and patients teaches us that there are multiple stories tied to virtual reality's reach in healthcare.

Multisensory ethnographies of digital technologies are a relatively recent addition to anthropology (Pink 2015). Studies of sensation have also shied away from fundamental questions of power. In biomedicine it is not just a question of access to healthcare and social determinants of health, but how inequality is embedded in assumptions about movement, perspective and representation. As a multisensory technology, the use of the CAREN system in the clinic provides fertile ground for ethnographers struggling with questions of inequality and sensation. Intersectional theory, addressing intersecting exclusions, has gained popularity with policy makers and academics (Hankivsky et al. 2012). It is also in line with feminist anthropologists' attempts to avoid reducing identity to flattened caricatures. However, this work has been critiqued for a disassociation from its roots in the work of lawyer and activist Kimberle Crenshaw (1989) in her characterization of the experiences of African American women and the law – a failure to acknowledge its original context in Black women's lives and an avoidance of broader questions of power results in disappointing scholarship. Black lives matter (Black Lives Matter 2017), both in the history of intersectional theorizing and in the virtual scapes shaped by White supremacy in the CAREN system. As Yasmin

Gunaratnam (2008) points out, attention to sensation can reveal hidden articulations of power. By rooting my analysis of virtual reality and the clinic in the body while remaining attentive to exclusion, I posit a new way forward for anthropologists, healthcare practitioners and researchers concerned with power in healthcare and digital medicine.

EMBODIED RESEARCH AS RESISTANCE

Who are anthropologists? What do they study? This research rejects the assumption that culture is elsewhere (it is everywhere), that marginal bodies are passive subjects, and that ethnographers are detached from the topics they study. Sensory ethnography is one way to engage with these complexities. Here, reflexive accounts of virtual reality in the field help to disrupt assumptions about the normative body. Leslie Brown and Susan Strega (2005) explore “research as resistance,” they characterize reflexivity as critical methodology for disrupting the status quo. Reflexivity has also been a feature of feminist attempts to democratize science, technology and medicine since the 1980s (Haraway 1997).

Sensory ethnography doesn't just map research participant's experiences of sensation, but ethnographers' own sensory accounts. Sensations of sight, sound, movement, smell, taste and touch become vehicles for research (Pink 2015). Like the practitioners and patients who participated in my study, my own intersections of identity help cultivate experiences of sensation and perception over time. For example, class impacts taste (Charlesworth 2000) and racialization can impact the ways people express themselves and occupy space (Ramos-Zayas 2011).

Here I insert my own body into the study: in sensations of sickness prompted by the system's aftereffects; in the trouble my own Queer Butch body posed during clinical observations of homophobic interactions; and in visceral responses to CAREN depictions of war shaped by gun violence in the poverty class communities I grew up in in the United States and Canada. Participant narratives, and my own experience of the CAREN system, reveal how assumptions about the body in virtual reality can be rooted in power.

Sensory ethnography points to socially mediated experiences of human perception and the relationship of perception to assumptions about the body and power. This study is also a call for Canadian anthropology to diversify its topics of inquiry by including more robust support for domestic fieldwork in Canada. As Chapter Three indicates, this is a principle task in ongoing efforts to decolonize anthropological practice. Finally, this research demonstrates how perspectives from the margins have much to offer anthropology today. The study of minorities is one thing, opening the doors to minority scholars is another altogether. Knowledge can be acquired from the pain(s) of exclusion. The subaltern cries out for justice.

Throughout this dissertation, I have turned to Queer scholars, Woman of Colour, disability activists, and Indigenous researchers to inform the anthropology of the body and virtual reality. This is a different approach from common 'go to' citations that celebrate heteronormativity, ableism, White supremacy and misogyny, not always in their overt content, but in the writers that are celebrated, privileged and cited. In their research on academic citation and exclusion, Carrie Mott and Daniel Cockayne (2017) point out:

This important research has drawn direct attention to the continued underrepresentation and marginalization of women, people of colour, and those othered through white heteromale hegemony by focusing on the politics of knowledge and how particular voices and bodies are persistently left out of the

conversation altogether... To cite narrowly, to only cite white men, to form citation cartels (informal agreements between authors to continually cite one another's work) to boost 'impact,' or to only cite established scholars, does a disservice [to] researchers and writers who are othered by white heteromasculinism (2).

It is not enough to study how bodies are included or excluded in digital worlds.

Anthropologists must reflect on their own exclusionary practices. Knowledge production is also based on assumptions about the normative body, including in anthropology.

PERSPECTIVE(S) ON VIRTUAL REALIT(IES)

Throughout my research physiotherapists, clinical social workers, patients, CAREN technicians, psychologists, managers, and Motek Medical representatives shared their perspectives on the CAREN system. At times perspectives on virtual reality diverged substantially. For example, the material poverty of some CAREN patients meant that shoes (the most mundane technology), not virtual reality, might offer more prospects for healing. Others described the thrill of participating in 'future medicine now' as they explored digital worlds in their treatments. The CAREN system, like the bodies that occupy it, is unstill, shifting and fraught with diverse social meanings.

Research participants in my study came from diverse socio-cultural backgrounds and economic realities. Gender, sexuality, ability, immigration status and participants' first language all impacted participant experiences – not as a "laundry list" (Volcano and Rogue 2013), but in terms of how nuanced intersections of identity shape lived experience in dynamic ways (Calafell 2014).

When the Somali patient I interviewed, who was receiving CAREN treatments for an ABI, prefaced his interview with the statement that being Muslim was "not being a

terrorist” it spoke to painful experiences of Islamophobia. Assumptions about bodies circulate into the heart of inequality. This patient knew too well that assumptions are not abstract in their outcome, but mirrored in the social injustices people bear in their day-to-day lives. This, of course, does not operate outside of virtual reality. Muslims are erased when they are required to decorate digital Christmas trees as part of their therapies and are treated to a soundtrack of Christmas carols.

Anthropologists document multiple perspectives in their work on medicine, healing and technology (Ong and Collier 2005). This includes attention to the contested viewpoints ethnographer’s face during their fieldwork in clinical settings (Lock 2002; Rapp 2000; Mitchell 2001). Little work, however, has been done on perceptualization and embodied accounts of virtual reality. In the CAREN system advertisements become medicine, corporations initiate a future of virtual reality driven healthcare, and patients struggle to feel just the ‘right’ kinds of feelings in their multisensory treatments. What these narratives reveal are not just divergent agendas, feelings, roles, and clinical practices at one Canadian hospital, but also how very difficult it is to cultivate perception itself with a multisensory technology.

First, technologies of perceptualization are built on assumptions about bodies. Applied multisensory virtual reality technologies utilizing features like sight, sound, movement, and smell reflect assumptions about normal and atypical users in their design. However, in applied contexts behind the interface there is always an agenda – be it healthcare, advertising or military training. As the CAREN system reveals, medical, technological, military and corporate agendas can be tightly intermingled. Second, atypical bodies disrupt the interface – this can also unsettle and challenge agendas.

Bodies don't always look, think, act and feel the way they are supposed to in the CAREN system. For example, 3MDR applications attempt to control and harness human fear for PTSD treatments; however, human fear can't be contained in the machine. Others present in the room may experience vicarious trauma. Soldiers react to photos of combat zones, but they also react to digital corridors designed not to instil fear because they are afraid of tight spaces. Physiotherapy patients, whose treatments are predicated on fun, can also recoil in horror from birds added to create a sense of playfulness or experience suicidal ideation based on CAREN system hardware like the harness ropes.

Virtual realit(ies) brackets not just the ways diverse interfaces invite the body to participate in virtual reality in different ways, but also how securing one "reality" with technologies of perceptualization in even tightly controlled environments, like a hospital, is difficult. The conclusion to this study is an invitation: How can ethnographers, and other researchers, take up research agendas that unsettle the idea of universal user experiences in technologies of perceptualization? In what ways can these projects support more inclusive digital practices? Working across disciplinary boundaries, how can practitioners be invited into these projects?

UNSETTLING SENSATIONS

Clinical virtual reality can distort patients' sense of time, place and space. As Chapter Six documents, soldiers seeking treatment for PTSD in the machine can lose tender threads of time, experiencing digital reproductions of memories to the extent that they forget they are in a machine at all. Time, place and space warp in a moment of embodied terror. Attempts to reproduce specific traumatic memories in virtual reality for the purposes of exposure therapy can include profound deletions, including a lack of

personal, cultural and economic context. In virtual reality a digitally reproduced memory becomes medicine, but it is also a fetish of the original. Reproducing patient histories in an immersive digital chamber is an approach to care born from biomedical values of individualism.

Anthropologists of the body refer to “sensations that evoke and are triggered by embodied memories” (Nichter 2008: 164). CAREN patients can be predisposed to “perceptions of sensation” associated with terror, vulnerability, safety and happiness (Nichter 2008: 164). How these predilections come together in multisensory treatments can be hard to predict even when efforts are made to direct human emotions.

When patients are lost in the joy of the machine’s games they also describe time speeding up, or time can drag on, especially when patients feel clinicians are holding them back. This is not unique to CAREN system therapies; however, as Chapter Five documents, CAREN clinical therapies are enlivened with the prospect of competition, speed, nostalgia, and play as powerful driving forces in physiotherapy treatments.

Experiences of movement in space can also be disrupted as patients describe a sense of perpetual movement even after the machine has stopped – something I also experienced as an ethnographer. Sea legs wobble after MM Boat. The carnivalesque atmosphere in a sterile hospital setting also disrupts assumptions about clinical care in hospital spaces. The joy of a digital racing speedway is not what physiotherapy patients generally think of when they think of rehabilitation at a hospital. Aftereffects, therefore, are not just embodied as “simulator sickness” but in more nuanced experiences of disruptions of time, place and space at the hospital. Fresh from living in a memory on repeat patients must recover their sense of time and place. Bodies in motion don’t just

stop; they continue to experience sensations of movement. The machine toys with human perception in complex ways.

TOWARDS MULTISENSORY BODYSCAPES

Pamela Geller (2009) is careful to link Nicholas Mirzoeff's (1995) notion of bodyscapes to day-to-day experience. Far from a simple representation of an idealized likeness of the human form, the values that inform bodyscapes shape social encounters. The CAREN system reveals how bodyscapes in medicine can be built on ideas about human perception. Sight, sound, smell, touch, and movement bring bodyscapes to life in clinical virtual reality. "Soundscapes" have been explored by sensory ethnographers in so far as listening has been conceptualized "as a cultural practice," but the totality of perceptualization new digital technologies attempt to harness and exploit, for example in the case of 'experience ads,' remain under theorized in anthropology today (Samuels et al. 2010: 330).

Representational practices in the CAREN system could easily be, and were, dismissed as trivial. Christmas elves, Coca Cola advertisements and digital reproductions of Ottawa were often viewed as window dressing to the more important work of medical treatments in the machine. However, the politics of place are rooted in the specific geographies replicas bring to mind – be it Kandahar or Edmonton. Tired tropes about race, gender, and class are also carried over into CAREN treatments, impacting patients' experiences of healthcare. Medical media is never value neutral in its production or outcome (Marchessault and Sawchuk 2000).

Interface design also reflects forms of sociality. In attending to multisensory virtual reality in anthropology it is also important to document the different ways

technologies of perceptualization invite relationships with other bodies. For example, the CAREN system bodes well for physiotherapy, in part, because of the performativity of the technology. Patients take centre stage and are cheered on by onlookers, be it clinicians, the CAREN technician, friends, family or a bewildered anthropologist.

SENSITIZING PATIENTS TO VIRTUAL REALITY

Ablest notions of health, wellness, and healing can be stigmatizing (Clare 2017). There is not a correct way to be ill, a correct way to experience disability, a correct way to respond to an injury or disease. People's life experiences are diverse; attention to this diversity enhances the capacity of clinicians and other healthcare practitioners to encounter their patients with empathy and appropriate forms of care. Disability activist Eli Clare (2017) points out that biomedicine's cures can be both troubling and foster ease – it all depends on context.

In anthropology the therapeutic aspects of play in biomedicine have mostly been explored through the experiences of children (Van Blerkom 1995). The CAREN system, however, reveals that adults too can benefit from fun and that fun can be good medicine. Fun was a taboo topic in the clinic where I conducted observations. CAREN practitioners did not want their work to be perceived as trivial by hospital administrators. This is, in part, why CAREN software is referred to as an “application” not a “video game.” Medicine is serious business, even when throwing snowballs at digital elves or racing cars through a digital city.

Patients played most gleefully when they had embodied the physiotherapists' prescribed techniques and, in concert, learned the ‘ins’ and ‘outs’ of working with full body immersion virtual reality as part of their therapies. They became habituated to both

the CAREN system and clinicians' directives, sometimes to the point of unconscious action, this freed patients from the stress of having to remember to play games the 'right' way. Digital technologies like the CAREN system are manipulated by users' bodies; however, digital technologies also manipulate users bodies as the idiocentricities of interface use become habituated over time. Anthropologist Loïc Wacquant's (1995) concept of "body sensitivity" points to the physiological resocialization required to use the CAREN system. One way for anthropologists to reground digital practices in the body is by attending to body sensitivity. Diverse virtual reality techniques reflect unique corporeal schemata and conventions of practice.

EMBODIED METHODOLOGIES IN DISEMBODIED CYBERSPACES

Critically this study brings intersectionality to sensory ethnography and digital anthropology. As Chapter Two documents, anthropologist Thomas Csordas has explicitly called for embodied accounts of virtual reality; however, the majority of studies, with the exception of work by Joseph Dumit and Natasha Myers, have centered on virtual reality as a technology of visualization. Attentiveness to perceptualization opens up new areas of inquiry and pushes researchers to explore hidden relationships of power. Chapter Three also identifies how narrative based inquiry, in conjunction with multi-sensory focused participant observation, has the capacity to elucidate the complex ways corporeal norms are experienced, resisted and reproduced. Furthermore, my own experiential use of the CAREN system, in conjunction with photography and film, brings heightened attention to sensation, kinetics and movement to visual anthropology and studies of embodiment and new technologies. Experiences of virtual reality are not just about sight; rather, they are dynamically linked to other sensory modalities.

Minds and bodies, nature and culture, realities and virtual realities are not diametrically opposed; they are enmeshed in every day practice at one Canadian hospital. As an ethnographer I sought to describe the unsettled spaces virtual reality occupies in Canada today. What emergences from this picture are not closures, but openings for lines of inquiry: about the body, about technology and about healthcare. There is nothing post-racial, post-colonial or post-human about the CAREN system. Body sensitivity is required in CAREN treatments. Processes of racialization in the production of ideas about race itself inform clinical practice. Inequalities persist and the poison and the cure coalesce in treatments using racist sports team logos. It's hard to take the culture out of medicine, even when we want to. At the Virtual Reality Lab the materiality of being human is always enmeshed in digital practice. Here anthropologists' calls for concurrent ethnographic projects in digital research (Green 1999; Isabella 2007; Nardi 2010) one mapping digital scapes, the other lived experience as it extends outside of virtual reality chambers, internet chat rooms and gaming platforms, is welcome.

TROUBLING 'THE' INTERFACE

As Chapter One demonstrates, intersectional theorizing fits comfortably with anthropological accounts of the body. More specifically, intersectional approaches to the body acknowledge that human beings do not experience their bodies or identities in one-dimensional ways. This has salience for immersive virtual reality interfaces. Chapter Two's literature review of multi-sensory research into virtual reality reveals a startlingly flattened corporeal plane offered to users in many applied interfaces. Intersectional theorizing also draws attention to the varied ways exclusion can be a multi-sensory

experience. The perspectives, movements and representations of the human form virtual reality technologies offer produce contingent forms of digital corporality.

This study documents how an overarching emphasis on ‘digital accessibility’ in fact works to obscure ongoing inequalities tied to digital practices in the 21st century. The discourse of digital accessibility also blocks from view the need for multiple accessibilities in interface design if researchers, practitioners and anthropologists are to address the messy intersectional bodies people occupy in their day-to-day lives.

This study takes up Brill’s challenge to remain open to the diverse forms of perceptualization immersive virtual reality interfaces offer. The relational categories IFP, TW, and MW technologies encompass not only provide a conceptual framework for immersive virtual reality, but also draw attention to shifts in corporeal assumptions inherent in different interfaces.

There is evidence to suggest that subjective identification with application content and personal relevance fosters an enhanced sense of presence in immersive virtual reality. As Chapter Two demonstrates, in applied practitioner-directed studies of virtual reality this has been linked to the efficacy of related technologies. Perceptual and representational absences have consequences for users and practitioners. For example, if users do not feel they are reflected in application content, it may diminish user experiences and, therefore, the effectiveness of these technologies in applied contexts for physical therapy, training and education. Furthermore, while there has been much interdisciplinary collaboration in the development of applied immersive virtual reality interfaces, this has mostly taken place across the sciences. Today there is an ongoing disconnect between the social sciences and computer scientists and practitioners actively

working to develop immersive interfaces. This study, therefore, endeavours to undertake important bridgework. What is apparent to an anthropologist might not be apparent to a physiotherapist or computer engineer, and vice versa. I argue that the lack of engagement with the social sciences has also likely impacted representational practices in immersive virtual reality today. It is my hope that as communities, agencies and individuals come to terms with the growing perceptual immersion virtual reality fosters we are attentive to the kinds of bodies put forward. This has implications not just for efficacy, but also for just, socially grounded digital practices.

Software engineers, tech developers and even anthropologists focus on how digital technologies are *designed to be used*. A more productive line of inquiry for all involved might be: how are digital technologies *actually used*? This study documents a disconnect between how CAREN system is designed to be used and how the system is actually used by clinicians. Rather than diminish clinical practice, this subversion is in fact a key feature of CAREN clinical approaches as clinicians modify their techniques for diverse patient populations. A great deal of “riffing” and improvisation is required for patients with complex health needs. Clinical virtual reality is not a ‘push button’ operation. Furthermore, many clinical techniques are in the process of being developed. Normative assumptions about the body also inform choices about system hardware design and software programming. Biomechanical normativity, fat phobia, and algorithms based on bodies without disabilities shape ideas about bodies in interface design. In theorizing virtual reality and power it is important to attend to directives in ideas about sensation and the particular insertion points for bodies in different interfaces.

FROM HERE TO THERE

As my study drew to a close I debated whether or not include the more controversial elements of the CAREN system that came through in my clinical observations. For example, as Chapter Six demonstrates, Tim Hortons' advertising in the CAREN system was impacting clinician and patient preferences for coffee and donuts. Psychologists at the hospital were also concerned that the original Star Ship Enterprise imagery in CAREN treatments for PTSD might unintentionally condition a negative response to science fiction media outside of hospital settings. A key feature of research ethics for ethnographers is not just anticipating how research data will be used, but how research data might be used. When my study is released, I wondered, would advertisers rush to populate hospitals with digital ads? Would the Canadian military use the CAREN system to try to program aversions and preferences in people in other settings? At one point, research participants provided design recommendations that would make a better CAREN system rifle to rehabilitate trigger fingers – I withheld these recommendations. By bringing the capacity for multisensory virtual reality to shape patients' preferences and aversions, however partially and problematically, into the spotlight I hope to open up public debate about the role of multisensory digital technologies in healthcare and other spaces.

As a principled approach to research I turn to multiple forms of research dissemination to reach out to diverse audiences. At the end of my study I participated in a forum hosted by the Canadian Military in Toronto. I stand in a room full of generals and colonels, most of whom are men. Prince Harry (of Wales) welcoming speech at the forum, which coincides with the 2017 Invictus Games, an international sporting event for

wounded vets, adds to the surreal quality of the experience. I stand and speak at a podium: a not quite pacifist peace activist, who participated in ‘die ins’ on Vancouver streets during the war in Iraq in the early 2000s; a formerly homeless Queer teenager from communities where poor people turn to war to pay for post-secondary education; and a Jew mindful of the turn war can take in attempts to destroy entire ways of life. I know I don’t belong at the forum but I’m here anyway to talk about the personal stakes for veterans posed by virtual reality. It does not go well. Prior to my podium presentation I am nominated for an award, but as my critiques of aspects of CAREN treatments begin I can see I’ve lost the award. Despite the difficulties, I will to continue to engage in outreach. Research, like the CAREN system, has consequences and marginal bodies, even silenced ones, always have stories to tell.

Perceptual immersion invites us to consider the corporeal stakes of new technologies. In virtual reality the body isn’t just a digital representation, it’s way of being. Sensory experiences are crafted around our ideas of what bodies are, how they behave in addition to what they look at and like. This power to define digital presence can marginalize people or bring specific bodies into our awareness.

In the 21st century the discourse of digital accessibility obscures ongoing inequalities tied to emerging technologies. As this study demonstrates, this has implications not only in terms of direct access to technologies, but also in terms of who is represented and accommodated in digital interfaces. Attentiveness to intersectional bodies and, therefore, multiple accessibilities in interface design has the capacity to foster more inclusive practices. This study also draws attention to the fact exclusion can be a multisensory experience, inviting anthropologists and others to consider how corporal

assumptions and multi-sensory modalities can contribute to suffering, erasure and, therefore, persistent silences. Ultimately, this study examines how and why the kinds of bodies invoked in digital interfaces matter.

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APPENDICES

Appendix A: Semi-Structured Interviews with CAREN Patients

Clinical Context

- Describe a typical session.
- What other therapies, treatments and services are you accessing for the condition that brought you to the Virtual Reality Lab? For example, are you accessing other physiotherapy services at The Ottawa Hospital or through community-based health clinics? This could also include things like yoga or resources provided through non-profit organizations like the Ottawa Independent Living Centre.
- How does the CAREN system fit with the other treatments you are accessing?

Accessibility

- Do you have any disabilities, injuries or diseases that impact your ability to use the CAREN system?
- If you have multiple disabilities, please indicate.
- What do you think of the depictions of humans or body parts in the CAREN simulations?
- What do you think of the landscapes provided in simulations in terms of how they look and how you feel moving around in them?
- Is there anything that would make you feel more included and comfortable when you are using the CAREN system or accessing physiotherapy services at the virtual reality facility?

Patient Background

- This research study addresses CAREN interface accessibility and body diversity. It would be helpful for the researcher to get a sense of the diversity of research participants. Could you speak into the microphone and state your age, gender, self-identified cultural or ethnic background and any other relevant demographic information you think would be useful for the researcher to know about? For example, this could also include your socio-economic background if you think it's important.
- Could you tell me a little bit about your condition and what brought you to use the CAREN system?
- How were you referred?

Efficacy

- Can you identify key challenges and opportunities associated with your use of the CAREN system?
- Is there a design feature you'd ideally like to see in the system to make it work better? This could be in terms of hardware, like the treadmill, screen or support bars, or in terms of the computer simulations. What do you think?
- Do you have a favorite simulation? If so, why, what makes it your favorite?
- Has the CAREN system ever made you feel sick? If so, describe what happened.
- Have you ever had to quit a session early? If so, describe what happened.
- Have you experienced any improvements in your day-to-day functioning associated with the use of the CAREN system?
- What specific tasks has the system allowed you to accomplish?
- Do you ever have problems seeing what's on the screen?
- Does it feel like you can move your body in the way the technician wants you to?
- Do you have any neck problems that make turning your head difficult when you are in the simulation?
- If you reflect on CAREN's sights, sounds and movements, what would you change, what would you leave the same? Are there any features you'd like included?
- Overall, do you like or dislike the CAREN system? Why or why not?

Appendix B: Semi-Structured Interviews with CAREN Practitioners

Practitioner Role and Background

- This research study addresses CAREN interface accessibility and body diversity. It would be helpful for the researcher to get a sense of the diversity of research participants. Could you speak into the microphone and state your age, gender, self-identified cultural or ethnic background and any other relevant demographic information you think would be useful for the researcher to know about? For example, this could also include your socio-economic background if you think it's important.
- Could you tell me a little bit about your role at the hospital and how long you have been working here?
- How did the CAREN system come to be used at your hospital?
- How do you work with the CAREN system?

Efficacy

- What simulations would you characterize as particularly successful?
- What have you learned from simulations that are less successful?
- If you reflect on CAREN's sights, sounds and movements, what would you change, what would you leave the same? Are there any features you'd like included?
- Can you identify key challenges and opportunities associated the use of the CAREN system?
- Have patients reported any improvements in their day-to-day functioning associated with the use of the CAREN system?
- What specific tasks has the system allowed them to accomplish?
- Patients can sometimes accomplish simulation goals without adopting correct body posture or movement that is conducive to the goals of physiotherapy, resulting in a disconnect between what patients are told to do and what patients actually do in simulations. Could you talk a little bit about this? Any advice for practitioners dealing with this issue?
- Do patients ever terminate simulations early? Why?
- Do you have a favorite simulation you use with patients? Why?
- Do patients usually achieve the primary goals of each CAREN physiotherapy session?
- Is there a design feature you'd ideally like to see in the system to make it work better? This could be in terms of hardware, like the treadmill, screen or support bars, or in terms of the computer simulations. What do you think?